ABSTRACT

Title of Dissertation: MUDAN – A CHINA MODEL FOR MULTISECTORAL DEVELOPMENT ANALYSIS

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As the Chinese economy develops into the next century, it is faced with many critical challenges, such as liberalizing the domestic market and reviving state enterprises, which add great uncertainty on the direction of the economic development in the future. Empirical economic models are useful to improve the understanding and reduce uncertainty of the evolution of an economy. This study describes the construction and application of a multisectoral, dynamic macroeconomic model of the Chinese economy (MuDan), which is built with input-output techniques and extensive use of regression analysis based on the historical time series of national accounts and a 117-sector input-output table of China for 1992. The strengths of the model lie in its sectoral details and reliance on the time-series based regression analysis. By employing a bottom-up approach that determines macroeconomic aggregates through summing up individually modeled sectoral and commodity level results, the model can provide richer simulation results than can models relying on a top-down approach that relies on macroeconomic aggregates to drive the sectoral level results. The time-series based regression analysis enables the model not only to predict the economy at some future date, but also to provide a time path of economic variables.

The dissertation is organized into eleven chapters. The first two chapters review alternative modeling approaches and China's economic reform in the last two decades. Chapters III through VIII describe functional specifications and estimation results for the model's macroeconomic and sectoral level econometric behavioral equations covering consumption, investment, imports, wages, profits, depreciation, and labor productivity. Chapters IX presents a benchmark forecast of the Chinese economy to 2010. Chapter X assesses the impact on the Chinese economy of China's entry into the World Trade Organization (WTO), and concludes that, despite the initial contractions of output in most industries, China would benefit from the WTO membership in the long run. Chapter XI concludes the study and points out the directions for further work.

MUDAN – A CHINA MODEL

FOR MULTISECTORAL DEVELOPMENT ANALYSIS

by

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CHAPTER I :

INTRODUCTION

This dissertation is about the development, estimation and application of an interindustry macroeconomic model of the Chinese economy. The aims of this dissertation are two-fold. The first aim is to describe historical behavior of the Chinese economy since economic reform started in 1979, with emphasis on the period between 1984 and 1994. The reason for choosing this particular period is based on the availability of data that is required by a disaggregated economic study. The research of the recent past is not only of academic interest, but also of empirical significance in providing the best evidence as to what will happen in the future. The second aim of the research is to provide a consistent framework in which policy analysis can be conducted and possible consequences of alternative economic policies can be presented. Experience has shown that the quantitative model is a useful tool to conduct economic analysis.

The structure of this Chapter is organized as follows. The first section raises the questions on which issues call for a model. In the next section, a general discussion of macroeconomic modeling is provided, with emphasis on two primary modeling approaches, the structural modeling approach and the equilibrium modeling approach. Strengths and weaknesses of the two types of models are also discussed. The third section focuses on the specific type of macro models that include industrial detail. The fourth section is a brief survey on modeling the Chinese economy, and the last section concludes the chapter with a brief outline of the dissertation.

Modeling the Chinese Economy: The Questions

China's economic reform is entering its third decade, and economic development is facing many critical challenges. The initial success of China's economic growth during the last twenty years has been largely based on the expansion of the non-state sector while many state enterprises have struggled to break even. As state enterprises continue to drag the national economy, economic growth becomes more difficult to maintain unless the state enterprises are energized and regain efficiency. However, reviving state enterprises is costly. Overhauling the state enterprises requires improving efficiency, which inevitably leads to reduction of redundant labor and causes unemployment to rise. Meanwhile, rising unemployment jeopardizes the stability of the society and may cause social unrest, and government's efforts to create jobs for the redundant employees of state enterprises have yielded little success. Apparently, policymakers are facing a daunting challenge with few choices. Can the economy provide enough jobs for the labor force of 700 million people? What are the sectors with the most potential to create new jobs? Does the creation of new jobs require huge investment? Is it possible to maintain high growth and significant increase in employment without igniting high inflation?

Huge investment financed by high domestic savings and massive foreign capital inflows are among the keys for China's phenomenal growth in the last two decades. While China is determined to deepen economic reform, external economic conditions are not favorable to China as the economies of neighboring countries such as Japan and Korea are in their worst shape in the last two decades. With financial crisis continuing in Asian countries from which 80% of total foreign investment in China in 1996 originated, foreign investment seems sure to slow. Consequently, the government may have to rely on domestic savings to finance ambitious investment plans. While investment leads to accumulation of capital and hence is a key factor for the country's long-term growth, the efficiency of the investment matters as much as its scale. If investment is executed hastily, the result may be waste, not prosperity, as have been seen in the recent crisis in Asia. Therefore, for China's high growth to be sustainable, the key is better investment, not necessarily more. Better investment requires better investment decisions. Is investment on energy, transportation, communication, and raw material sectors adequate? Should the government pour more public funds into the construction of infrastructure? Or should the government increase investment on sectors such as automobiles that are vulnerable to foreign competition? Questions such as these involve systematic economic analysis, and appropriate economic models are useful to conduct such analyses.

China's exports, which have been helped by China's seemingly unlimited inexpensive labor supply, have fueled China's economic growth. China's bid to entry the World Trade Organization (WTO) will provide even wider opportunities for Chinese exporters. At the same time, the pressure to open the domestic market will pose challenges to many Chinese industries. Some sectors, such as textiles, garments, and footwear, seem certain to benefit. Other sectors, such as agriculture, chemicals, transportation equipment, and financial services, will face serious competition from abroad. There are still other sectors whose fate is far from clear. Once again, careful economic analyses are necessary to clarify issues, evaluate alternatives, and hopefully help make better decisions.

Analysis of these issues requires careful studies on the Chinese economy in a systematic way. Such analysis involves not only the basic allocative problems such as the distribution of national output between current consumption and investment, the way investment expenditures are spent by different industries, and the amount each industry has to produce in order to satisfy the needs of consumption and investment. It also involves the studies on the productive capabilities of the economy and the preferences of the society for different categories of consumption goods and for present consumption as compared with future consumption. For economists, the analysis is undertaken through economic models. While even a good model may be unable to answer all these questions, an answer without a consistent framework is often incomplete and unsatisfactory.

This dissertation attempts to provide a tool to address these issues and to be used to answer some of these questions. Its focus is on the construction of a China model for Multisectoral Development Analysis (MuDan). MuDan is an empirical macroeconomic model constructed within the framework of INFORUM models. Its goal is to trace China's industrial economic development from 1980 to 2010 through highly disaggregated economic analysis. The production relationship of MuDan are described by a series of input-output (I-O) tables, which are estimated based on the 1992 input-output table and historical time series of total output, final demand and value added at industry levels.

A feature distinguishing the MuDan model from many other China models is its highly disaggregated industrial detail, which allows users of the model to investigate the interactions among industries and macroeconomic impacts of a policy in a meaningful way. Such analysis can be conducted with the model in a consistent way that closely mimics the actual economic activities. Unlike many other macroeconomic models with sectoral details, MuDan's industry detail is an integral part of the model. Final demands such as consumption, investment, exports and imports are not driven by macro variables. Instead, they are modeled separately and estimated through behavioral equations by industry. Value-added components such as wage, depreciation, profits and taxes are also modeled at the industry level. Macroeconomic variables such as GDP are simply computed as the sums of sectoral variables, and their impacts on the sectoral variables are modeled through explicitly specified behavioral equations. This bottom-up approach allows the model to behave much like the operation of the real economy, and, therefore, it may provide more realistic results than the ones constructed otherwise. Before the details of modeling MuDan are described, it seems useful to discuss briefly the alternative approaches of macroeconomic modeling and the current status of modeling the Chinese economy.

Macroeconomic Modeling

A macroeconomic model is a system of mathematical equations describing interactions among macroeconomic variables such as inflation, interest rates, employment, and gross domestic output (GDP). Macroeconomic models generally fall into three classes: structural models, equilibrium models, and non-structural models.

Structural models are the macro models that are built in the system-of-equations tradition based on explicit macroeconomic theories such as the Keynesian theory. Equations in structural models are specified in the form of a set of decision rules such as consumption and investment functions, and their parameters generally are estimated, analyzed and tested in a variety of ways and are held to a high standard of goodness of fit. Structural models are especially useful in making conditional forecasts in which forecasts of one or more variables are conditional on maintained assumptions such as the behavior of policymakers. The structural modeling approach is relatively mature and time-tested with proven track records. There is an extensive body of literature on structural macroeconomic models; good introductions to this type of models can be found in Almon (1998), Brayton et al. (1997), Brayton and Tinsley (1996), Fair (1994, 1984), Taylor (1993), and Masson et al. (1988).

Equilibrium models rely heavily on neoclassical general equilibrium theory, and the equations in equilibrium business models are based on assumptions of optimization behavior such as utility maximization of households and profit maximization of firms.

Modeling efforts of equilibrium models focus on the determination of the fundamental parameters of tastes and technology for the postulated utility and production functions. The parameters of the utility and productions in most cases are calibrated, or chosen in other words, to be in line with parameters estimated in the literature (Kydland and Prescott, 1982), and only in rare cases are estimated by econometric methods. When parameters are econometrically estimated, procedures such as maximum likelihood (Altug, 1989) and Hansen's GMM method (Christiano and Eichenbaum, 1990) are typically used. Discussions of the estimation of equilibrium models can be found in Chow (1991) and Canova, Finn, and Pagan (1991).

Nonstructural macro models are unrestricted reduced-form macro models. They impose few restrictions, other than the selection of variables to include in the model, from economic theory, and they employ a small number of estimated equations to summarize the dynamic behavior of the entire macro-economy. There are no built-in economic structural equations in the model. Therefore, nonstructural models are useful for unconditional forecasts, which center on the likely future path of the economy when policy remains unchanged. Descriptions of nonstructural models can be found in Diebold (1998a), Cooley (1995), Christiano and Eichenbaum (1992), Lucas (1987), Kydland and Prescot (1982), and Sims (1980). However, economic models are useful mostly because they can be used to analyze scenarios that differ from the presently prevailing conditions. Therefore, non-structural models, which can only provide unconditional forecasts, do not appear interesting. Hence, they are excluded from our discussion,

The construction of traditional structural macro models started in the 1930s, and acquired widespread acceptance in both academic and practical forecasting fields from the late 1950s to the 1970s. However, interest in traditional macroeconomic modeling among the academic profession started fading amidst blunt criticism launched against structural macroeconomic models in the late 1960s and early 1970s. One factor contributed to the declining interests is simply that structural models make mistakes. Structural models almost always make time specific forecasts. Because they have been around long enough, their track record is not always perfect. Indeed, there are occasions in which their forecasts and analyses have proved incorrect. The poor performance of many structural models in the face of oil shocks in the 1970s is a frequently quoted example of structural models' failure. Another important factor is the structural models' lack of a microeconomic foundation. Because of that, structural models appear less elegant and less attractive than alternative models such as real business cycle or equilibrium models. In addition, the rapid commercialization of economic forecasting may also have contributed to the decline, as basic research was forced to give way to the needs of maintaining the models up-to-date and meeting the special needs of clients (Fair, 1994). However, the most damaging criticism came from Lucas (1976), who argued that structural models were not likely to be useful for policy analysis. Lucas showed – theoretically – that, while structural models captured empirical regularities among macro variables, they failed to take into account of all the interactions in the underlying or structural behavior of consumers and firms in the economy. Therefore, structural models were not truly structural. The risk to this approach, he argued, was that even if the underlying structural behavior of economic agents remained stable, the measured relationships among aggregate variables could easily shift as conditions changed in the linkages not incorporated into the aggregate relationships (Lucas, 1976; and Lucas and Sargent, 1978).

The logic of the Lucas Critique is theoretically valid. However, its significance should be measured quantitatively rather than theoretically. While the main objective of empirical macroeconomic studies is to develop a model that approximates how the real economy works, even the best econometric model is only a good approximation.

A model that is subject to the Lucas Critique is not necessarily fundamentally flawed if the effect of the Lucas Critique is not empirically significant. Obviously, it is the empirical significance rather than the theoretical appeal or reasoning of the Lucas Critique that matters in judging the usefulness of a model.

There are reasons to believe that the Lucas Critique is not as serious a problem in practice as it might be in theory. For example, since most policy proposals are incremental, the "regime change" effects would likely be small. Furthermore, even though the regime changes may cause coefficients to change in a structural model, these regime change effects may be overwhelmed by other effects that may also cause coefficients to change. One such other effect is the use of aggregate data (Fair, 1994). As Fair pointed out, changes in age and income distributions of the population may be a more important cause of changes in coefficients in aggregate equations than are the effects noted in the Lucas Critique. This suggests that as long as macroeconomic models have to rely on aggregate data, the effect of the Lucas Critique on structural parameters may be secondary in quantitative significance.

Equilibrium modeling is not the solution for structural model's problems even though they are not subject to the Lucas Critique. Because equilibrium models have to be built on postulated production and utility functions that are not observed, ad hoc assumptions have to be made in choosing specific functional forms. Therefore, the theoretical elegance of equilibrium models has to be based on arbitrarily postulated utility and production functions. For this reason, equilibrium models are hardly on a better footing than structural models although the arbitrariness of the latter in specifying decision functions has been much criticized. Furthermore, even if the utility and production functions can be properly specified, the determination of their parameters is often problematic. In the equilibrium modeling literature, calibration is the primary method of determining parameters. However, it is well documented that calibration fails to provide a complete and probabilistic assessment of agreement between model and data and therefore, fails to deliver the goodness of fit necessary for forecasting with equilibrium models (Sims, 1996; Hansen and Heckman, 1996; Quah, 1995). If parameters of equilibrium models are not calibrated, they generally are estimated from the first order conditions. Empirical results, however, are not supportive of this approach (Mankiw, Rotembery, and Summers, 1985).

The theoretical elegance of the equilibrium models is appealing. However, a function or a model with elegant theoretical derivations from utility maximization is no assurance of the goodness of the functional form or the model. For example, Almon (1997) showed that two popular forms of consumption expenditure systems, the Almost Ideal Demand System (AIDS) and the Linear Expenditure System (LES) that were derived from utility maximization, were flawed and almost useless in a long term-growth model. Fair (1994) pointed out that structural models generally had better goodness of fit than did equilibrium models despite the "micro foundations" that equilibrium models had. The reason, he argued, was that equilibrium models, in measuring goodness of fit between the model-computed paths and the actual paths of the endogenous macro variables, had relied only on a few moments in a very limited way such as similar variances, covariances, and autocovariances. If more precise and objective procedures were applied, equilibrium models compared very poorly even to a simple first order autoregressive equation, let alone structural models.

Equilibrium models too may be subject to changes of parameters. Since equilibrium models are built on aggregate data just like any other macroeconomic models, their coefficients in aggregate equations also are subject to change as structural macroeconomic variables, such as age and income distribution of the population, change. Such effect of coefficient changes may quantitatively swamp the problem of coefficient changes caused by policy change. Therefore, there may simply be no sensible approach to use aggregate data to estimate function parameters of equilibrium models (Fair, 1994).

It is apparent that both structural and equilibrium modeling approaches have limitations. However, it would be too simplistic to conclude that neither model is useful. After all, macroeconomic modeling is a craft, not an exact science. Macro models can never be fully comprehensive. They each emphasize only a few determinants of the real economy while giving other determinants no explicit role. Because different models may respond differently to changing economic conditions, and different models may represent the real economy from different perspectives, no single model consistently dominates all others so long as these models are reasonably well built. The choice of a specific modeling approach should depend on the purpose of the model and the capability of the modeling approach. As the discussion goes on, the reasons for choosing the structural modeling approach for a China model will become clear.

Structural macro modeling technique has benefited from theoretical criticism, from confrontation and competition with other alternative approaches such as equilibrium models, and from careful studies of the models' mistakes. As a result, structural modeling has incorporated many new techniques. One example is the way in which expectations are modeled in macro models. While the adaptive expectation technique is still used extensively in practical modeling for its simplicity, many structural models have embraced a variety of alternative mechanisms to form expectations. For example, FRB/US, a new macroeconomic model of the U.S economy built by the Board of Governors of the Federal Reserve System, explicitly models two alternative forms of expectations: VAR expectations and rational expectations (Brayton, 1997). However, these alternative expectation formations are modeled at significant costs, and whether the benefits from applying these alternative forms are worth the costs is an open question. In addition, while agreement exists that expectations play a prominent role in the economic theories that underpin most macroeconomic models and in economic decision making, economist are divided on the basis on which individuals from expectations and thus on the way to model them. Because data adequate to measure the expectations is lacking, model builders have to specify a priori assumptions about the ways in which expectations are formed, and then model them accordingly. Therefore, it appears that modeling a specific form of expectation is only as good as the particular assumption about the form of specification.

Many structural models have also embraced the long-run properties similar to neoclassical growth models while the short-run responses maintain the Keynesian tradition. In these models, prices are sticky and aggregate demand determines output in the short run. In the long run, however, prices are fully adjusted and supply factors determine the equilibrium. Therefore, while demand changes like monetary and fiscal policies can affect the level of output in the short to intermediate run, supply forces such as available labor, capital, and technology prevail in the long run, determining the level of output. Consequently, inflation neutrality in the long run is maintained in these models.

Macroeconomic models with Sectoral Detail

Economic analyses assessing industrial impacts of macroeconomic policies or macroeconomic impacts of industrial policies require a combination of macroeconomic and industrial models. While macroeconomic models in general are capable of providing forecasts and policy simulations that deal with economic aggregates such as GDP, total employment, and inflation, they are seldom capable of providing useful sectoral detail. This section presents several alternative approaches in building macro models with sectoral detail. While this is not intended as a critical review of the alternative approaches, it provides different perspectives along with brief comments on the strengths and weaknesses of these approaches. The discussion is inspired by Monaco (1997).

There are three primary approaches in constructing macro models with highly disaggregated industry details: the Macro-IO (macroeconomic models linked to an input-output model) approach, the IM (interindustrial macroeconomic) approach, and the AGE (applied general equilibrium) approach. While the three types of models share a common root, i.e., the simple I-O (input-output) model, each has evolved far beyond the simple I-O model.

The Simple I-O Model

The simple I-O model does not include macro aggregates such as GDP and inflation, and is therefore not a macro model. However, because many disaggregated macro models are extensions to the simple I-O model, it seems useful to begin the discussion with a brief discussion of simple I-O models. The static I-O model in its simplest form has the following equation:

$$q = A * q + f \tag{1}$$

where q = gross output by I-O sector,

f = final demand by category, and

A is a product-to-product input coefficient matrix and I is the identity matrix.

From Eq. (1), output q can be determined by

$$q = (I - A)^{-1} * f \tag{2}$$

For static I-O models, the A-matrix is always assumed given. Regression-based behavioral equations are seldom used in static I-O models. For a given vector of final demand, output is easily computed by Eq. (2). Likewise, for a given vector of output, the calculation of the corresponding vector of final demand is straightforward from Eq. (1). The final demand vector in static models generally include the final use of both consumption and investment goods.

Static I-O models are often used in static analysis involving the impact of a small change in final demand f on output q. The I-O model is useful because even the simplest I-O model captures the very essential feature of the economy, the interindustry dependency and equilibrium of production. To the extent that the proposed changes are small, the simple I-O model can provide a reasonably good estimate on how the economy would really respond to the changes. However, static I-O models have obvious limitations. For example, the final demand vector f is completely exogenous to the model, and a static model simply assumes that values of final demand come from somewhere. Therefore, the model misses the interesting question on how final demand is determined. The model is also timeless, and it does not answer how long it takes, in real time, to produce the increased output. Furthermore, static I-O models fail to address a host of interesting economic issues because they do not respond to macroeconomic conditions. Production of the extra output under different economic conditions would, in reality, yield different results to the economy. For example, if the economy were at full employment of all factors, labor and capital alike, prices and wages would likely have to be bid up and therefore affect the composition of final demand. At the same time, the extra output would generate extra factor income, some of which would go to personal income as increased wages. As income rises, consumption increases. Such interactions are not present in the simple static model. Because static I-O models do not distinguish final demand between consumption and investment, they are by design not suitable to address important dynamic issues such as the impact of capital investment on production capacity and productivity. Therefore, while static I-O models are probably adequate to analyze the economic impact of a small change under very restrictive assumptions, most economic issues need to be analyzed more realistically.

Leontief's dynamic I-O model is a natural extension of the static I-O model. In dynamic I-O models, investment and consumption demands are explicitly distinguished, and investment demand is endogenous to the model. Capital investment is required so that technologically necessary stock of capital can be accumulated. A simple dynamic I-O model, therefore, has the following form:

$$q_t = A * q_t + f_t + B * (q_t - q_{t-1}) \qquad (3)$$

where q_t = gross output by I-O sector at period t,

f_t = final demand by category, excluding capital investment, at period t,

A is a product-to-product input coefficient matrix, I is the identity matrix, and B is a matrix of fixed capital coefficients. Matrices of A and B are assumed given, as well as the time path of all components of final demand and the initial output level q_0. The solution to the model, a time path of output q_t, can be obtained by simply solving a system of difference equations.

A major shortcoming of the dynamic I-O model is that with an arbitrarily given time path of final demand and some given initial endowments, there is no guarantee that the solution to the model will always have non-negative output levels. Another problem is that the model fails to deal with situations in which one or several industries do not fully utilize their productive capacity, and, therefore, exhibit excess capacities. In addition, non-investment final demand is exogenous to the model, and regression equations are seldom used in dynamic I-O models in establishing interactions among economic variables. Therefore, dynamic I-O models are generally "too rigid to be used to describe and project the actual process of economic development and change" (Leontief, 1987). With proper care, however, dynamic I-O models can still have very useful applications (see, for example, Leontief and Duchin, 1986).

Macro-IO models

Macro-IO models represent a further extension to I-O models by attempting to determine the final demand vector that is exogenous to I-O models. A macro-IO model is a two-model model, including a macro model and an I-O model. The macro model is used to generate the aggregate totals of final demand components such as investment, consumption, imports, and exports. The behavior of these aggregate totals is then used to control the movement of the final demand vectors in the I-O model. In a simple Macro-IO model, for example, the macro model's prediction for growth of private consumption expenditures would be used as the growth for each of the consumer consumption categories in the I-O model. Similarly, the predicted growth of foreign demand by the macro model would be used by the I-O model as the export growth for each I-O product. A more sophisticated version of a Macro-IO model would employ regression equations to allow the relative industry shares to vary with the available aggregates while maintaining the constraint that the predicted shares sum to unity.

The Macro-IO approach has several advantages. In particular, a Macro-IO model, by design, generally has good macro properties assuming the macro model itself is good. Therefore, Macro-IO models can achieve a good approximation of the economy at the industry level and respond reasonably to the changes of fiscal and monetary policies at the same time. Furthermore, the construction of a Macro-IO model does not require a large set of data. Once the macro model is built, an I-O table for a single year suffices to generate industrial results. However, a Macro-IO model's easiness to build carries costs as the Macro-IO approach does have its limitations, many of which were documented in Almon (1986).

One of the main problems in constructing Macro-IO models is the difficulty to maintain the model's internal consistencies, including the consistencies between aggregate output and industrial output, between aggregate income and sectoral income, and between overall price levels and sectoral prices. The consistency between aggregate output and industrial output is specified by Eq. (1) and is therefore warranted when sectoral output is solved from Eq. (2). However, the I-O accounting also requires the consistency between aggregate income and sectoral income. Such income consistency is implicitly expressed in the following equation of unit production costs:

$$p = p * A + v \tag{4}$$

where p = a vector of sectoral prices,

v = a vector of final costs per unit of real output, and

A is the product-to-product direct requirement coefficient matrix. The final costs of production include capital depreciation, labor costs, taxes, interest charges, and profits, which represent the costs of capitals employed in the production. Final costs and value-added are equivalent by accounting identity.

Eq. (4) is straightforward. The price of a product i, p_i, is equal to total intermediate costs per unit of output i plus v_i, the total final costs per unit of output i. Total intermediate costs per unit of output i is nothing but the weighted sum of prices of all input products, where the weights are the A-matrix coefficients in column i, and hence can be calculated as $\sum_{j=1}^{n} p_j * a_{j,i}$. Consequently, price of product i is computed as

$$p_i = \sum_{j=1}^{n} p_j * a_{j,i} + v_i$$

which is exactly the *i*th equation in Eq. (4).

Maintaining the income and price consistencies in the Macro-IO model means that sectoral prices and income that are implicit in Eq. (4) must be consistent with the general price levels and aggregate income predicted in the macro model. Unless sectoral variables such as output, prices and income are allowed to feed back to the macro model, the combined predictions of aggregate and sectoral variables from the Macro-IO model will be consistent only by accident. Another problem for a Macro-IO model is that the model likely will behave erroneously when simulating a sector specific shock, such as a price shock to a relatively small industry (Monaco, 1997). Despite these weaknesses, the Macro-IO approach is a cost efficient way of building a highly disaggregated macro model.

AGE Models

AGE, also called CGE (computable general equilibrium), models, have gained popularity in the last two decades as a tool to study government policies. They have been used extensively in the areas such as tax and trade policies (Shoven and Whalley, 1972, 1984) as well as energy and environmental policies (Jorgenson, 1984; Jorgenson and Wilcoxen, 1990). Most AGE models are static, although a dynamic version of AGE models also exists. The main differences between static and dynamic models involve how intertemporal decision making and capital accumulation are modeled. In static models, investment is modeled as another final demand for products, just like consumption, and savings are not explicitly modeled. In dynamic models, however, consumers save for future consumption; investment by a sector in one period is accumulated into capital in the next and therefore increases the productive capacity of the investing sector. Therefore, a dynamic AGE model conceptually adds a single sector growth model to each of its sectors and incorporates them with the inter-temporal decision making in one model.

The static AGE model is a generalization of the static I-O model and the equilibrium business cycle model. Just like the equilibrium business model, the static AGE model also relies heavily on neoclassical general equilibrium theory and the implications of equilibrium conditions. Some AGE models are constructed based on a set of artificial representative agents: consumers, producers, a government, and foreigners. Consumers maximize utility while producers minimize costs. Explicit assumptions are made about the forms of utility functions of consumers and production functions of producers. Each industry has a production function with intermediate inputs and factors of production such as capital and labor specified explicitly. Parameters of these functions may be estimated by statistical estimation techniques (Jorgenson, 1984) based on time series of data, but most often are chosen or calibrated[1] (Mansur and Whalley, 1984) so that the equilibrium of the model replicates observed data in one single year. Once the model is calibrated, policy changes can be simulated through comparative statics studies by altering the relevant policy parameters and calculating the new equilibrium. Such comparative statics studies are done in much the same ways as are static IO calculations.

The main extension of static AGE models over the static IO model is that AGE models functionally integrate consumer, investor and employer behavior. Moreover, the solution of the AGE model must satisfy a set of equilibrium conditions. These

[1] There is a significant distinction between estimation and calibration of parameters in economic modeling. Estimation of parameters means that the parameters are determined by statistical techniques based on time series data. Calibration of parameters, however, suggests that the parameters are chosen, based on data for a single year, so that the equilibrium of the model replicates observed data in that year.

conditions include requirements (1) that demand equals supply for all goods and factors; (2) that each industry earns zero profit; and (3) that gross investment equals aggregate savings, which is the sum of domestic savings plus foreign capital inflows. The AGE model is closed with macroeconomic accounting balances and specific assumptions about adjustment behavior. The macroeconomic balances in the model include (1) the government budget; (2) aggregate savings and investment; and (3) the balance of payments.

The AGE approach has a number of appealing features. Because the AGE approach depends explicitly on neoclassical general equilibrium theory and the underlying structure of the economy is explicitly specified in mathematical forms, markets are allowed to determine prices and quantities demanded and supplied in goods and factor markets. Consequently, market imperfections such as imperfect competition and product differentiation can be modeled relatively easily by mathematically specifying the form of market interactions among participants. Deviation from equilibrium conditions such as full employment can also be incorporated fairly easily in the model. For example, the real wage is generally specified in terms of an index of other prices and is typically modeled as being downwardly rigid. By specifying a mathematical function on how labor responds to the real wage and calibrating that function along with the rest of the model, changes in demand for labor result in varying rates of unemployment. If demand for labor rises so much that full employment occurs, the real wage then rises so that supply is equal to demand.

AGE models can be built fairly easily. Because the underlying structure of the economy is specified in the form of mathematical functions, the relatively small number of parameters significantly reduced the degrees of freedoms of the model. Consequently, data requirement for AGE models is moderate to minimal. This is particularly important to many developing countries where high quality data, especially time series data, is sparse.

The AGE approach has a number of weaknesses, many of which arise from the very same features that are regarded as the strengths of the approach. AGE models are built based on explicitly assumed forms of utility and production functions. However, neither utility nor production functions can be observed, nor is there data to suggest appropriate forms of these functions in most cases. Furthermore, the results of AGE models often depend crucially on the forms chosen. For a given set of economic data, the number of combinations of production functions, utility functions, and market behavior that can be made consistent with the actual data by calibrating the parameters is endless. Therefore, the usefulness of the theoretical elegance of the AGE approach seems intimately dependent on the validity of a set of assumptions, many of which can not be served or tested.

The equilibrium assumption is another weakness of AGE models. The moderate data requirement of AGE models is based on assumed functional forms whose parameters have to be calibrated by assuming the economy in equilibrium. It seems rather difficult to conceive that the economy in the year that happens to have data available must be in equilibrium. If the economy is not in equilibrium, however, the whole calibration exercise becomes meaningless. In addition, because most AGE models are static, they generally miss the dynamic role of saving and investment in determining economic growth.

IM models

The interindustrial macroeconomic or IM models are structural econometric models. They are constructed by using regression analysis of time series. In that regard, they are similar to Macro-IO models. However, a feature differentiating an IM model from a Macro-IO model is how the macro aggregate variables and industrial details are connected. Macro-IO models, following a "top-down" approach as described earlier, first estimate macro projections and then allocate them to industries. In comparison, IM models follow a "bottom-up" approach. Sectoral details are projected with econometric equations, and macro aggregates are obtained by summing the projected industrial details. IM models include the INFORUM type of models and the Cambridge Econometrics models. Descriptions of INFORUM type of models can be found in Grassini (1998), Almon (1991), McCarthy (1991), and Almon et. al. (1974). The Cambridge Econometrics model was described in Barker et. al. (1987). MuDan is an INFORUM type model. A detailed description of the model structure and the solution algorithm is provided in Chapter III.

The primary advantage of the IM approach over the Macro-IO approach for interindustrial study lies in the economic consistency. The bottom-up approach used in the IM models derive the aggregate variables such as GDP and total employment from sectoral details. In this regard, it is much like the AGE approach. The bottom-up approach ensures that the consistency between aggregates and industrial details is always maintained.

The primary advantage of the IM approach over the AGE approach is the close attention to historical data. IM models are intimately based on time series data. They rely heavily on econometric equations that are estimated based on observed economic outcome, and emphasize a high standard of goodness of fit. This is in direct contrast to the AGE approach and its heavy reliance on calibration, which ignores the historical time series and fails to provide a complete and probabilistic assessment of agreement between model and data.

The advantages of the IM approach carry costs. The primary difficulties in building an IM model lie in organizing and maintaining the data necessary to support the disaggregated econometric studies. In addition, the large number of equations, while useful in providing sectoral details, are costly to maintain. Because sectoral details are intimately connected, aberrant behavior of one sector can upset the whole model.

Macroeconomic Models of the Chinese Economy

Modeling the Chinese economy has a relatively short history. Construction and application of macroeconomic models of the Chinese economy started emerging in the early 1980s when China began the modernization drive and foreign technologies were introduced into China. Most early macro models did not include sector details. Wang, Li an Li (1993) surveyed a collection of nineteen models, among which sixteen models were national macro models while the remaining three models dealt with specific industries such as energy and transportation. Except one dynamic I-O model (Xia and Hu, 1993), no models offered sectoral details.

More recent literature on modeling the Chinese economy has been largely focusing on AGE models, which have been used to evaluate economic impact of price reform (Garbaccio, 1995) or trade liberalization (Xu, 1994; Lewis et. al., 1995; Zhuang, 1996; and Wang and Zhai, 1998). These models generally distinguish about twenty sectors. Garbaccio (1995) used an AGE model to examine the sectoral and economy-wide effects of price reform in the heavily subsidized coal and crude oil sectors and other sectors. Zhuang (1996) constructed an AGE model to simulate the Chinese economy under a system of free markets. His main findings included that substantial distortions in prices and resource allocation existed in the Chinese economy. In particular, labor was overpaid and capital underpaid in most non-agricultural sectors. Wang and Zhai (1998) used a 22-sector AGE model to evaluate the distributional effects of trade liberalization and government tax replacement policies during foreign trade reform. Among the alternative tax instruments, they found the most appropriate tax policy for the government was a progressive household-income tax, which would reduce the Gini coefficient while retaining most of the efficiency gains.

Chen (1991) reported the construction of a 24-sector model based on the INFORUM approach. The model used a 1981 I-O table and the accounting framework was based on the Material Production System (MPS) framework. However, the model has not been updated and is not in active use.

Outline of the Dissertation

The rest of the dissertation is organized as follows. Chapter II provides an introduction to the Chinese economy. It describes the Chinese economy from three different perspectives: the reform process, the macroeconomic conditions, and the industrial development. Chapter III introduces MuDan's structure, theoretical background, major components, and accounting identities.

The next three chapters focus on MuDan's product side. More specifically, Chapter IV describes the empirical results on modeling personal consumption with a non-linear expenditure system. Chapter V presents empirical results on investment, and proposes a new approach to model priority investment sectors in the MuDan model. Chapter VI discusses modeling issues related to other final demand components, and presents empirical results on the two components that are modeled in MuDan, namely inventory and imports.

Chapter VII discusses the income side of the model, which includes function specifications and the estimation results on wages, profits, depreciation, and taxes. Chapter VIII presents empirical results on modeling sectoral productivity as well as macro variables such as personal income, savings rates, and the nominal interest rates. Chapter IX presents a base forecast of the Chinese economy. Implicit in the base forecast is the assumption that China stays outside the WTO. Chapter X describes the assumptions and reports the findings of the impact on the Chinese economy of China's entry into the WTO. Chapter XI concludes the dissertation, and points out the directions for further studies.

CHAPTER II :

THE CHINESE ECONOMY: AN OVERVIEW

The successful story of China's economic development started in 1979 when economic reform officially began. The following rapid economic growth, significant improvement of the standard of living for almost a quarter of the world population, and the relatively smooth and very successful transition from central planning toward a market-oriented economy have been one of the most significant developments in world history during the last two decades. China's success has stimulated an extensive body of literature on China's experience of economic reforms. For example, Qian (1999a, 1999b) not only provide a detailed account of China's transition from central planning to a market economy, but also analyze the institutional foundations of the transition. Chai (1997), Lin et al. (1996) and Naughton (1995) provide general descriptions on the paths and strategies in China's economic reform and development while Jin (1994), Lo (1997), Lin et al. (1996), Naughton (1995), and Wang (1998) cover more specific sectors of the economy. This study attempts to contribute to the understanding of the Chinese economy by constructing a quantitative model. Although the emphasis is on the description of the technical side of the model, a general discussion of China's economic reform and the current situation of the economy seem both necessary and helpful to understand the model and the economy that the model tries to depict.

This chapter presents an overview of the Chinese economy. It has three main sections, each of which describes the Chinese economy from a different perspective. The first section is a brief review of China's reform process. While a detailed discussion is beyond the scope of this study, our discussion documents important milestones that the reform achieved during the transition from central planning toward a market-oriented economy. As economic reform has brought profound changes in the institutional setting and the mechanisms that balanced demand and supply, understanding such institutional settings and mechanisms is a critical first step toward modeling them. To the extent that structural changes may destabilize the parameters of a structural model, the piecemeal nature of China's economic reform is likely to have kept the impact of such structural changes at minimum. The background information on economic reform forms a basis for further discussions in the subsequent chapters.

The second section is a description of the Chinese economy from a macroeconomic perspective. Historical statistics such as income, consumption, investment, inflation, and unemployment are presented to offer a bird's eye of view of the macroeconomic conditions, the accomplishments and problems of the economy during the last two decades. While these historical values are the foundation of building MuDan, projection of their future course is among the most important objectives of the model.

The third section is a discussion of China's economic development from an industry perspective. As an interindustrial macroeconomic model, MuDan possesses a distinguishing feature with its highly disaggregated industrial details. It is natural to give a brief description of China's industrial sectors at the outset of presenting technical details of an interindustry model.

Economic Reform

The Third Plenum of the Eleventh Communist Party Central Committee in December 1978 marked the beginning of China's economic reform. The initial objectives of the reform were to relax the central government's direct control over production decision, to foster the application of the law of value, and to provide more incentives to the economic agents: the enterprises, workers and farmers. Establishment of a market system was not on the initial reform agenda. Over time, however, the power of the market force has been gradually recognized, and leads the Chinese economy toward a more open and more market-oriented system.

A unique characteristics of China's economic reform is its gradual and pragmatic strategy of "no strategy", which contrasts sharply with the more orthodox "big-ban" or shock therapy that was applied by other former central planning economies. This strategy of "no strategy", of course, was not intentionally designed. Rather, it resulted from the Chinese government's lack of knowledge on the destination and routes of economic reform. It probably also alleviated the resistance from conservative or anti-reform forces by allowing more time for the reform-minded to experiment. This pragmatic strategy was officially promulgated by the now famous maxim, "groping for stones to cross the river", and has always been applied throughout the reform process, from the rural reform at the very beginning until more complicated state enterprise reform that is going on today.

China's economic reform can generally be divided into three stages. The first stage of reform ran from 1979 to 1984, and the focus was on reforming the rural sector. The focus shifted from rural reform to urban reform during the second stage from 1985 to 1992. The proclamation by the Chinese Communist Party's Fourteenth Congress in October 1992 on establishing a socialist market system marked the beginning of the third stage.

Initial and Experimental Stage of Reform: Rural Reform (1979 – 1984)

The rural reform has been generally regarded as the most successful episode in China's reform process. It started with replacing the old commune system with a household production responsibility system that provided rural households the opportunity to negotiate contracts with the state to rent parcels of land, which remained state-owned. The contracting households were held responsible for delivering a given quantity of product to fulfill the procurement quota, and free to keep or sell the surpluses at higher prices to the government or in the free market, which had been just opened to complement the institutional change. The new system motivated farmers because now they could organize inputs and production more efficiently to maximize profits. In addition to the contract system, agricultural prices were also readjusted. Prior to reform, the prices of agricultural products had been artificially depressed relative to manufactured products by the central planning authority in order to support government's industrialization drive. To complement government's effort to reform the agriculture sector, government raised procurement prices of agricultural commodities, and also dramatically increased the share of output purchased at the higher above-quota prices.

The household contract responsibility system fostered rapid output growth in the rural area, significantly improved production efficiency, and greatly increased the standard of living at the same time. (Lin, 1992; McMillan et al., 1989; Jefferson et al., 1992). However, productivity improvement also resulted in labor surplus that had been disguised in the commune system. To absorb the surplus labor resulting from limited arable land and improved agricultural productivity, the government started allowing rural laborers to engage in other economic activities, which had previously been closed to rural residents. As a result, township and village enterprises (TVEs) flourished, mostly in response to the demand created by the rising household income. Operations of these TVEs, however, were limited to a small number of consumer goods industries.

While agricultural reform was the most important piece of reform during the initial reform stage, progresses were made in other areas. A significant development was the price reform. In the agricultural sector, purchasing prices for agricultural and sideline products were raised, as well as the retail prices of major types of non-staple food that was heavily subsidized. As a first step, the procurement prices of main crops increased by 22% in 1979. By 1984, the procurement price of grain had almost doubled from the 1978 level; procurement prices of cotton, oil bearing crops, and other main industrial crops also increased by more than 50% over the 1978 levels. In industrial sectors, the government started experimenting with floating prices on some electronic, machinery, chemical and other products so that manufacturers of these products were allowed to charge higher prices for the products that were produced above the government quota. Experiments in pricing consumer products went a step further. Manufacturers of about 160 consumer products, mostly textiles and other light industrial products, were allowed limited autonomy in deciding the wholesale prices (Ma and Lu, 1994). A significant step in this stage was that prices began to be set jointly by industrial and commercial sectors through negotiation, by moving closer to reflect actual market conditions.

Reform in the commerce sector marked significant progress for the Chinese economy in departing from the central planning. In 1979, all state and collective commercial enterprises, which accounted for more than 99% of total retail sales at the time, started a profit sharing system. Commercial enterprises were allowed to retain part of profits. At the same time, rural collective enterprises and individuals were allowed to engage in retail sales of certain industrial consumer products. Free markets of agricultural products, excluding grain, cotton, and other essential crops that remained controlled by government, emerged from underground trading and started blooming. Reform of the commerce sector during this period was successful in increasing distribution channels and facilitating communications among producers, distributors, and consumers.

While reform in rural areas was still underway, experiments of urban reform had already started. In an attempt to revitalize the sluggish state sector, the government started by partially relaxing the administrative control over state enterprises. To provide incentive to the management, various forms of the director responsibility system were instituted. Under such a system, the authority and responsibility to manage production went to the enterprise director rather than the Party secretary. At the same time, workers were given more responsibility to make decisions through many types of incentives. Bonuses and other forms of financial reward were reintroduced to encourage good performance of workers and managers alike. Government also introduced a profit sharing system under which an enterprise agreed to remit certain amount of base profits to the state. Additional profits above the base level would be shared among the state, the enterprises, and the workers. By 1981, 80% of enterprises included in the state budget had adopted some variations of the enterprise responsibility system. Overall, however, reform of state enterprises by 1984 had been rather cautious.

Expansion of Reform from Rural to Urban Areas (1984 – 1992)

Extensive reform of state enterprises did not start until 1984 after a series of steps had been followed by the central government to ease its direct involvement in production decisions. In particular, the production quota system was relaxed and floating prices were instituted. At the beginning, state enterprises were allowed to sell and purchase products in excess of planned quotas at floating prices, which could move within a certain range above or below the planned prices. They were also granted the right to dispose of retained profits, although the portion that could be distributed to workers was still limited. Furthermore, planning was significantly decentralized, and most mandatory planning was replaced with guidance planning. The relationship between the state and the state enterprises was straightened out with a series of policy changes, which included (1) replacing profits with taxes as the government's revenue collection instrument; (2) adopting the contract management system, which further emphasized defining the role of the enterprise directors; and (3) allowing the government to promote the separation of ownership from the right of management of state enterprises. By June 1988, 90% of state enterprises were using some form of the contract management system (Hanna, p147). The most popular one was the "double-guarantee, one-link" contract management responsibility system. Under it, the director guaranteed (1) to remit a specific level of profits and taxes to the state and (2) to fulfill technical transformation tasks set by the state. The "one link" was that the total wage bill of the enterprise was tied to economic performance, and a certain percentage of realized profits after meeting the requirement set by the two guarantees was added to the wage bill. Meanwhile, the director was permitted to determine the form and method of the wage distribution, authority that had previously been saved exclusively for the government.

Price reform was a crucial step in the transition from central planning toward a market economy, and it also was one of the most difficult steps. If prices did not reflect the true cost of production, profit seeking would not necessarily be efficient. While the government understood the importance of price reform, it also recognized that successful price reform would be difficult to accomplish. Therefore, the government adopted a slow but steady process rather than lifting price control overnight. During the early 1980s, the price reform was mainly through readjusting prices within the planning system, and most prices were still artificially set. Starting in the mid 1980's, the government shifted gear by freeing prices of a greater number of products and letting market forces take over. By 1995, prices of 80% of investment goods, 85% of agriculture products, and 95% of manufactured consumer products were freed from government control and determined in the market (Xinhua News, Feb. 25, 1996.) By 1997, the government has freed prices of all but five commodities.

Reform in China's financial sector was another important step toward decentralizing the Chinese economy. Before 1984, China's banking system was comprised of the People's Bank of China (PBC) and the rural credit cooperatives. As China's only bank, the PBC performed functions of a central bank, a commercial bank, and a policy bank. For most part, however, the PBC primarily acted as a bookkeeper of the central and local governments, responsible for disbursing budgetary grants for fixed investment and working capital. The primary instruments of monetary control during that period were the cash and credit plan, which was determined by government in its overall planning process and was derived from government's investment and consumption plans. The primary functions of the rural credit cooperatives included taking deposits from rural residents and extending loans to rural collectives.

Reform in the financial sector started with the designation of the PBC as a central bank on January 1, 1984. The commercial and policy banking functions of the PBC were shifted to four specialized banks, which included the Industrial and Commercial Bank of China (ICBC), the Agricultural Bank of China (ABC), the Bank of China (BOC), and the People's Construction Bank of China (PCBC).

The ICBC specialized in domestic currency business of enterprises in urban areas and savings deposits of urban residents. The ABC primarily engaged the domestic currency business of rural enterprises and individual savings deposits. The BOC specialized in foreign exchange business and, in a much smaller scale than the ICBC and the ABC, conducted domestic currency business based on borrowing from the PBC. The PCBC, originally established in 1954 as a policy bank, maintained its original function to disburse budgetary funds for capital construction. However, the funds it provided were changed from grants to interest-bearing loans. The rural credit cooperatives were closely associated with the ABC and maintained their role in primarily serving the rural areas.

All the specialized banks and rural cooperatives were under the supervision of the PBC. Despite the fact that the specialized banks were assigned different functions, however, state banks had little autonomy in making independent business decisions. For example, the interest rates on deposits and loans were specified by the PBC, and the specialized banks were not allowed to deviate from them. Furthermore, the specialized banks must follow the government's credit plans and provide loans to state enterprises as it directed. Therefore, these banks could rarely make independent business decisions or conduct independent evaluations concerning loans for fixed assets investment.

Toward a Market Economy (1992 – to present)

As early as in 1985, the government officially abandoned the state monopoly over product distribution, and declared that the market system was an integral part of the socialist economic system. Abolishing price control had been another crucial step toward establishing a well functioning market system. However, it was not until 1992 that establishing a socialist market economy was officially adopted, and an ideological obstacle toward market economy was finally quelled even though the compromise was apparent as China's market economy was confined to be "socialist."

The removal of the ideological obstacle toward a market economy has allowed a steady development of a market system, which has played an ever-increasing role in expediting exchange and distribution of goods and services. Agricultural products are now actively traded in tens of thousands of free markets and country fairs throughout the country as well as in numerous wholesale markets. In recent years, commodity markets have emerged, and commodity future contracts of wheat, corn, soybean and so on have been regularly traded. In manufactured consumer product market, a retail network has been formed to include retail stores, free markets, whole sale stores and whole sale markets. Non-state commercial enterprises have exceeded state enterprises to account for more than half of the total retail values of the whole society. At the same time, reform in the distribution of capital goods market has made progress. Capital goods are now recognized as commodities and are beginning to be traded in the wholesale market and the commodity future market. The financial market started from a short-term money market in the early 1980s and now includes banks, security exchanges, investment and trust companies. Company stocks and bonds as well as securities issued by the government have been actively traded. In addition, the separation of the central bank and specialized banks marked a significant progress in reform of the banking system. The central bank began open market operations in treasury bills and bonds in April 1996. China has adopted a unified, fixed exchange rate[2] regime since January 1, 1994, and started allowing free conversions of foreign exchange under current account since December 1, 1996.

While China's efforts to move a centrally planned economy toward a market economy have met with much success, there remains much to be done. For example, one of the top priorities for China's economic reform has been revitalizing state enterprises, which are experiencing grave financial difficulties. In an attempt to improve efficiency and productivity, state enterprises have started dismissing redundant workers in recent years, resulting in rapidly rising unemployment. Because China lacks a national social security system, however, the rising unemployment has cause serious financial difficulties to the families affected by the dismissals and jeopardized the social

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[2] Because China allows the foreign exchange rate to float within a very narrow band, it appears that China is adopting a managed-floating exchange rate regime. However, because free conversion of foreign exchange under capital account is not allowed, China's foreign exchange rate system is probably more appropriately described as a fixed exchange rate regime.

stability. Therefore, any further actions in reducing redundant state workers may trigger serious social and political problems. Apparently, reforming state enterprises will be a long-term process and requires coordinated efforts such as establishing a national social security system.

Reforming the financial system is another crucial but difficult task. As mentioned in the previous section, China's state-owned banks enjoy little freedom in making independent business decisions, are often required to extend loans to under-performing or non-performing state enterprises in order to bail out state enterprises. As a result, huge losses incurred by state enterprises have resulted in a rapid rise of bad loans, which has increased vulnerability of the financial system to an adverse disturbance, and deteriorated economic performance of state banks. By a recent official estimate of PBC, state banks' bad loans amounted to 5-6% of total loans. However, outside estimates have suggested that state banks' bad loans by western standards may amount to 20% to 80% of total loans outstanding, equivalent to 18% to 70% of GDP (Economist, Feb. 14, 1998.) Measured as a percentage of GDP, the potential problem in China's state banks is perhaps twice as serious as South Korea's banking problem, or 20 times America's savings-and-loan crisis of the early 1990s. As a result, some financial institutions in China have become de facto insolvent, as their net assets have been negative. Therefore, the overall picture of China's banking system appears dismal even using the official estimate of 6% of bad loans. At the end of 1995, the state banks had a total declared capital fund of only 227 billion yuan while the total loans outstanding reached 3939 billion yuan. By the conservative estimate that bad loans amounted to 6% of the total, total bad loans at the end of 1995 would have reached 236 billion yuan, more than the total capital declared capital fund of the entire banking system. Therefore, the state banking system as a whole appeared already bankrupt. Unless the government takes immediate actions to reform the financial sector, the consequence from a potential banking crisis would be disastrous.

The Chinese government is aware of the problems in the financial sector, particularly in the non-bank financial institutions, which often took on short term borrowings to finance long term fixed asset investment and offered higher returns on deposits than banks, a violation of China's banking regulations. In the wake of Asian financial crisis where non-bank financial institutions were often at the heart of the financial crises, China has acted decisively to deal with the weakness in the non-bank financial institutions. In October 1998, the PBC ordered the closure of Guandong International Trust and Investment Company (GITIC), which had become insolvent, and twelve credit cooperatives in Beihai. Although GITIC's default on foreign obligations caused concerns of foreign banks and prompted some of them to retreat from lending to other International Trust and Investment Companies (ITICs), the government's dealing with GITIC seems desirable in the long run. Through consolidation of non-financial institutions, state banks may be able to win back depositors' funds from ITICs and credit cooperatives, and, therefore, to build up the strength and importance of banks.

A Macroeconomic Perspective of the Chinese Economy

The Chinese economy has registered spectacular growth since the late 1970s. From 1978 to 1997, China's real GDP increased almost five-fold with an average annual growth of 9.4%, an incredible pace of doubling the national economy every eight years. During the same period, real GDP per capita grew at 8.0% per year. Nominal GDP reached 7.48 trillion yuan in 1997, averaging 6,079 yuan per capita. By the official exchange rate of 8.3 yuan to a dollar, GDP reached $900 billion in total and $732 per capita.

While China achieved basic macro stability during the transition period, the recurrence of boom and bust cycles has raised concern over the sustainability of the rapid growth. The stop-and-go processes resulting from the business cycles caused severe costs to the society. Since the early 1980's, China has incurred three major business cycles. It appears that both the frequency and the severity of the business cycles have increased.

Investment

The Chinese have consistently saved a large portion of their total output. During the 1978-97 period, total investment accounted for between 32% and 44% of total GDP. A large influx of foreign capital has further fueled the booming economy. In light of Asian financial turmoil, however, speculation reemerges that China's economic growth may have been fueled more by increasing investment and input rather than technology and productivity improvement, a growth pattern that was associated with the old central planning system.

China's total investment has been roughly evenly split between industry and service sectors. Investment in manufacturing, construction and mining industries typically accounted for 50% of total investment, and investment in service sectors generally accounted for 45% to 48%. Agricultural investment by the government was rather small and generally accounted for a mere 2% of the total.

Consumption

Personal consumption illustrates the sharp difference between recent economic growth and the economic development prior to 1979. Prior to economic reforms, rapid industrialization was the only goal for economic development, and huge investment was at the cost of consumption. Economic reform has re-focused economic development toward improving the standard of living. As a result, Chinese people have benefited greatly and enjoyed a significantly better life since reform started. For example, in the twenty-two years from 1956 to 1978, the personal consumption per capita in real terms increased by only 47%, an average increase of 2% per year. In contrast, personal consumption per capita from 1979 to 1997 increased by 257%, an average growth of 7.3% per year. The rural reform in the early 1980s was particularly beneficial in raising the income of rural residents and narrowing the income gap between rural and urban residents. However, as emphasis of reform moves away from the rural area, the gap in the standard of living between rural and urban residents has been widening again.

Foreign Investment and Foreign Trade

The growth of China's foreign trade since 1979 has been spectacular. From 1979 to 1997, the total value of imports and exports grew from $29.3 billion to $325.1 billion, an average annual growth of 14.3%. More importantly, the transition from autarky to an open economy has helped shape an economy to improve its efficiency and become an important competitive force in the global economy. During the 1980-97 period, the export/GDP ratio, measured in renminbi in current prices, more than doubled from 13% to 35%. Therefore, exports have become a major driving force of China's economic growth. A summary of China's foreign trade is presented Table 1.

Table 1 - A Summary of China's Foreign Trade

(Levels in billions of U.S. dollars, growth in percentage)

Year	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	80-97	90-97
Exports												
Total	18.1	27.4	62.1	71.8	84.9	91.7	121.0	148.8	151.1	182.7	14.6%	16.7%
Primary goods	9.1	13.8	15.9	16.1	17.0	16.7	19.7	21.5	21.9	23.9	5.8%	6.0%
Chemicals	1.1	1.4	3.7	3.8	4.3	4.6	6.2	9.1	8.9	10.2	13.9%	15.5%
Textiles & rubber products	4.0	4.5	12.6	14.5	16.1	16.4	23.2	32.2	28.5	34.4	13.5%	15.5%
Machinery	0.8	0.8	5.6	7.1	13.3	15.3	21.9	31.4	35.3	43.7	26.1%	34.2%
Miscellaneous products	3.0	6.9	24.3	30.3	34.2	38.8	50.0	54.6	56.4	70.4	20.3%	16.4%
Imports												
Total	20.0	42.3	53.3	63.8	80.6	104.0	115.7	132.1	138.8	142.4	12.2%	15.1%
Primary goods	7.0	5.3	9.9	10.8	13.2	14.2	16.5	24.4	25.4	28.6	8.7%	16.5%
Chemicals	2.9	4.5	6.6	9.3	11.2	9.7	12.1	17.3	18.1	19.3	11.8%	16.4%
Textiles & rubber products	4.2	11.9	8.9	10.5	19.2	28.5	28.1	28.8	31.4	32.2	12.8%	20.2%
Machinery	5.1	16.2	16.8	19.6	31.3	45.0	51.6	52.6	54.76.	52.8	14.7%	17.7%
Miscellaneous products	0.9	4.4	11.1	13.6	5.6	6.5	7.4	8.3	8.5	8.6	14.3%	-3.7%
Trade balance	-1.9	-14.9	8.7	8.1	4.4	-12.2	5.3	16.7	12.2	40.3		

China has maintained a trade surplus during much of the 1980-97 period. Until the early 1980s, as much as one-half of Chinese exports were in primary goods such as agriculture products, food, raw materials, and minerals. Textiles and wearing apparel constituted the bulk of the other exports. Since then, exports of the manufactured goods have increased steadily. In 1997, over 85% of total exports were manufactured goods although a large portion of them were labor-intensive products such as footwear, toys, and wearing apparel. In 1996, for example, China exported 6.8 billion pieces of garments and 1.2 billion pairs of shoes with a combined value of US$27.3 billion, representing about 18% of total exports. Among the fastest growing categories of exports, however, is machinery and transportation equipment, whose exports grew from US$0.8 billion, or less than 5% of the total exports, in 1980 to US$43.7 billion in 1997, accounting for over 24% of the total exports in that year. Between 1990 and 1997, export growth of machinery reached more than 34% a year.

Table 2 shows China's main trading partners. As shown in the table, China's foreign trade is highly concentrated in a few regions of the world. Hong Kong, Japan and the United States are China's three biggest export markets. If the re-exports from Hong Kong, often to the United States, are taken into account, then the U.S. is the largest export market for Chinese goods. In fact, the Chinese statistics on exports to the U.S. from China have been frequently under attack by the U.S. with the focus of the dispute on the treatment of re-exports from Hong Kong of goods made in the Mainland China. The statistical impact of the different treatment of the re-exports is enormous. In 1994, for example, China shows a trade surplus of $7.5 billion with the United States. In contrast, China's surplus was $29.5 billion by the U.S. account. Since neither of the governments has any intention to change its accounting practice, the difference will likely hold up. Even the return of Hong Kong to China in 1997 has not made a difference because Hong Kong as a special administration district of China still keeps an independent statistical system.

Chinese imports showed a similar pattern of concentration of importing sources. Japan, Taiwan and the United States are the three largest sources for Chinese imports, and nine of the top ten export markets were also among top ten import sources. There is a similar shift in imports from primary goods to manufactured goods, particularly machinery and equipment. The import share of primary goods, mainly food and non-edible raw materials, declined steadily from almost 40% in the early 1980s to below 20% in the 1990s. During the same period, the reduction of the primary goods imports was offset by the machinery and equipment imports, whose share rose from around 20% to about 40% (TJNJ 1997, T16-5).

Table 2 - China's Main Trading Partners in 1994

Country (Region)	Exports	Imports	Trade Balance	Import Rank
Hong Kong	32.4	9.5	22.9	4
Japan	21.6	26.3	-4.7	1
United States	21.5	14.0	7.5	3
Germany	4.8	7.1	-2.4	6
South Korea	4.4	7.3	-2.9	5
Singapore	2.6	2.5	0.1	9
United Kingdom	2.4	1.8	0.6	
Taiwan	2.2	14.1	-11.8	2
Italy	1.6	3.1	-1.5	8
Russia	1.6	3.5	-1.9	7
Australia	1.5	2.5	-1.0	10
Canada	1.4	1.8	-0.4	
Subtotal	97.8	93.4	4.5	
World Total	121.0	115.7	5.4	
Subtotal as % of Total	80.8	80.7	83.8	

The huge supply of inexpensive labor has been one of the most important factors contributing to the export boom. With 610 million people in the labor force in 1994, the supply of labor seems inexhaustible. Table 3 lists average annual wages and salaries for non-agriculture employees. At the 1994 average exchange rate of 8.62 yuan to the dollar, the average wage of 4538 yuan in 1994 was equivalent to $516 a year, or roughly $0.25 per hour, a tiny fraction of the minimum wage in the U.S. Since there are more than 300 million people work in the countryside and their average labor income is only half as much as the non-agriculture employees, many agriculture workers are ready to take manufacturing jobs.

Table 3 - Average Labor Cost

	1980	1985	1990	1991	1992	1993	1994	1995	80-95	90-95
Exchange rate, yuan per $100	170.5	293.7	478.4	532.3	551.5	575.2	861.9	835.1	11.2	14.9
Average annual wages, yuan										
Total	762	1148	2140	2340	2711	3371	4538	5500	14.1	26.6
Manufacturing	752	1112	2073	2289	2635	3348	4283	5169	13.7	25.7
Average annual wage, US$										
Total	447	391	447	440	492	586	527	659	2.6	10.2
Manufacturing	441	379	433	430	478	582	497	619	2.3	9.3

There are factors other than the huge labor supply that contributed to the surging exports. Evidences suggest that the fixed exchange rate may have been actively managed by the government to maintain the price competitiveness of Chinese products and labor. For example, as shown in Table 3, the exchange rate was devalued by about 80% from 1990 to 1994. During the same period, the general price level was increased by only 50%. Consequently, although the nominal wage grew on average at about 20% a year, or 10% a year after adjusted for inflation, in terms of domestic currency, the wage increase in dollar terms was only about 4% a year. Obviously, the over-depreciated Chinese currency helped keep the inexpensive Chinese labor even more attractive to foreign investors. Because the Chinese currency may have been historically undervalued, there is room for China to keep the currency value and remain competitive in the international market despite devastating pressure of devaluation from the neighboring countries in recent years.

Foreign investment in China has also been spectacular. In 1995, foreign investment reached $37.5 billion, $3.6 billion more than in 1994. That was the third consecutive year that China, behind the United States, had the second largest foreign capital inflows. Just as in foreign trade, the majority of foreign investment in China originated from a small number of countries. As seen in Table 4, Hong Kong is by far the largest investor, accounting for over half of the total direct foreign investment. Together with Taiwan, Japan, the United States and Singapore, these five sources account for more than 85% of the total direct foreign investment.

Table 4 - Foreign Capital by Source

(Billions of US$)

Country (Region)	1993			1994		
	Total	Foreign Loans	Direct Foreign Investment and Others	Total	Foreign Loans	Direct Foreign Investment and Others
Hong Kong	18.9	1.4	17.4	19.8	0.0	19.8
Taiwan	3.1	0.0	3.1	3.4	0.0	3.4
United States	2.7	0.6	2.1	3.0	0.5	2.5
Japan	4.9	3.5	1.4	3.1	1.0	2.1
Singapore	0.7	0.2	0.5	1.2	0.0	1.2
South Korea	0.4	0.0	0.4	0.8	0.1	0.7
United Kindom	0.6	0.4	0.2	1.1	0.4	0.7
Germany	0.3	0.2	0.1	0.6	0.3	0.3
Canada	0.4	0.2	0.1	0.6	0.4	0.2
Italy	0.4	0.3	0.1	0.5	0.3	0.2
Subtotal	32.2	6.8	25.4	34.1	3.1	31.1
Total	39.0	11.2	27.8	43.2	9.3	33.9
Subtotal as % of total	82.7	61.0	91.5	79.0	32.9	91.5

Table 5 lists the contracted foreign investment[3] in 1993. Generally, foreign investment projects remain small in size, and have focused on manufacturing and real estate industries. For example, the average contract of foreign investment in 1993 was only $1.3 million. Manufacturing, construction and mining industries have an average contract size of only $0.9 million, and accounts for 46% of total direct foreign investment in China. Real estate development attracts another 39%, with an average

[3] Contracted foreign investment refers to the value of foreign capital that foreign investors agree, through signed contracts or agreements, to provide. Contracted foreign investment is not necessarily actually used.

size at $3.9 million. As the government sets up the automobile, real estate, and electronic products as the new pillar industries of the economy while striving to improve infrastructure such as energy, transportation and communication, opportunities are abundant for foreign investors. The government's relaxation of restrictions on foreign investment in retail trading, financial services, and foreign trade sectors are further diversifying foreign investment. With large multinationals joining the force and gaining confidence in investing in China, the size of the foreign investment projects will likely increase.

Table 5 - Average Size of Foreign Investment in 1993

	Amount (bil. of US$)	Avg. Amount per project (mil. of US$)
Total	111.4	1.3
Agriculture	1.2	0.7
Manufacturing and Mining	51.2	0.9
Construction	3.9	1.2
Transp.and Telecommunications	1.5	1.6
Commerce	4.6	1.0
Real Estate	43.8	3.9
Tourist Hotel	1.5	1.8
Health, Sports and Soc. Welfare	0.5	2.3
Education, Culture and Arts	0.5	1.0
Scientific Research	0.6	0.7
Others	3.8	1.1

The Chinese Economy from an Industrial Perspective

China still maintains a large agrarian economy even after two decades of rapid economic development. In 1997, for example, the agricultural industry employed 50%

of China's total labor force and produced 19% of GDP. Consequently, the performance of the agricultural industry has a significant impact on the national economy and changes in rural labor market have a strong influence on labor supply conditions. However, as China's modernization drive continues, the agricultural sector's influence continues to decline.

China has been fairly successful in industrializing the national economy. From 1978 to 1997, the Chinese industrial output recorded an average annual real growth of 11.3%, two percentage points faster than the GDP growth. Industrial output as a share of GDP increased from 36.7% to 52.4% during that period of time.

China's service sectors have achieved above-average growth during the last two decades with average annual GDP growth of 10%, and created many employment opportunities. Particularly, industries such as Communication, Commerce, Restaurant, Finance, and Social service sectors have increased their employment share of the total from 4% in 1978 to 10% in 1995.

China's industrial development during the last two decades displayed the following five characteristics.

First, a vibrant non-state sector emerges as a driving force of economic development in the post-reform Chinese economy. Before economic reform, China's industrial enterprises had been either state or collective owned and there was no role for private or foreign capital to play in the industrial production. In 1980, for example, state enterprises accounted for 76% of production while collective owned enterprises accounted for the rest. Economic reform has fostered a vibrant non-state sector, whose strong performance became a main engine for industrial growth. Figure 1 displays the shares of nominal industrial output by type of ownership. As shown in the graph, the share of total industrial output produced by state-owned enterprises shrank steadily from 76% in 1980 to 27% in 1997 while the share of the collective-owned enterprises increased from 24% to 39% during the same period. Meanwhile, individual ownership and other ownership, such as joint ventures, that were almost non-existence in 1980 surged to account for one third of the total with their shares roughly evenly split in 1997. In the short run, competition from non-state sectors has created difficulties for the state enterprises, placing millions of jobs in state enterprises in jeopardy. In the long run, however, it should improve efficiency and do more good than harm to the overall health of the economy.

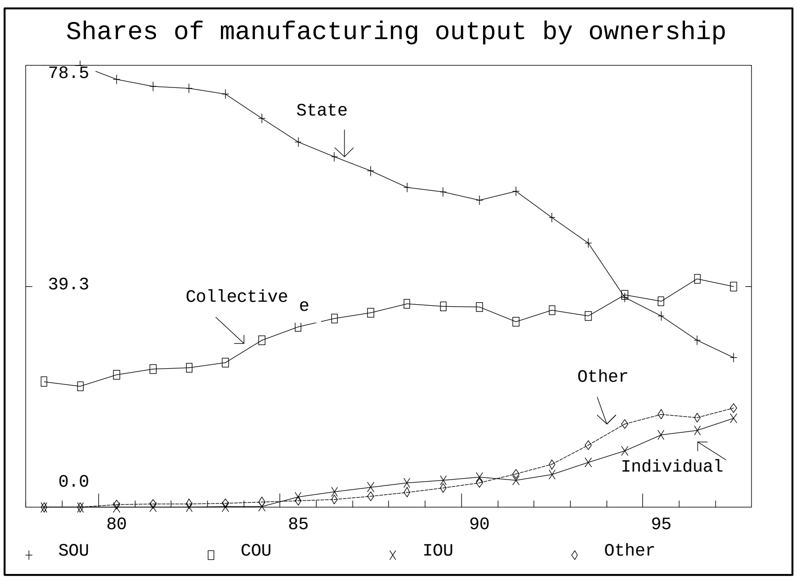


Figure 1 - Shares of Manufacturing Output by Ownership

(Current prices)

Second, state enterprises remain a dominant force in capital goods production. Of the total industrial output produced by state enterprises in 1995, sixty-eight were in capital goods production and only thirty-two percent were in consumer goods production. Overall, state enterprises accounted for 56.2% of the total capital goods production and only 35.0% of the total consumer goods production. A few industries such as Logging and Crude petroleum and natural gas extraction are virtually controlled by a small number of state enterprises, whose productions accounted for more than 95% of the totals in 1995. Several other industries such as Gas, Water, Electricity, Petroleum refining and coking, Coal mining, and Primary iron and steel industries were also dominated by state enterprises, accounting for 70% to 90% of the total production in these industries.

Third, state enterprises have yielded their dominance in consumer product industries to other non-state enterprises. China's consumer goods industries are generally very competitive and state enterprises account for only a very small share both in terms of output and the number of firms. For example, in industries such as Wearing apparel, Leather products, Furniture, Arts and crafts, Plastic products, Metal products, and Sawmills, state-enterprises accounted for less than 20% of total production and less than 10% in number of firms in 1995. The only exception is in tobacco production, which is a state monopoly. Since consumer goods industries are demand driven, their future is sensitive to the growth of income. Meanwhile, because consumer goods industries such as textile, wearing apparel, leather products, shoes and toys are labor-intensive and China has the world's largest inexpensive labor force, these industries have had a competitive advantage in the global market. In fact, some of these industries have been strongly oriented toward exports. For example, net exports of Wearing apparel, Leather products, and Arts and crafts articles including toys have accounted for 40% to 60% of total domestic gross output of their products. For these industries, foreign demand has become a more important factor than domestic demand in determining their future growth.

Fourth, most of China's capital-intensive and high technology industries, such as automobiles, aircraft, and computers, are underdeveloped and lack the strength to compete in the world market. Therefore, they rely heavily on imports of products and technologies. To nourish the development of these infant industries, the government has set up tariff and non-tariff barriers on imports of products of these industries. One of the policies that the government adopted in governing foreign investment is the "technology for market" policy. Under such policy, foreign investors who are lured by the huge potential of the Chinese market have to transfer technology to China in exchange for the entry right of their product to the Chinese market. Such policy has particularly benefited industries such as the auto industry, whose development has accelerated in recent years. In the auto industry, for example, all major domestic automakers have teamed with foreign auto manufacturers to make some models or use certain technologies of the foreign partners. In the short run, the negative effects of the "technology for market" policy can not be avoided altogether as increased foreign competition resulted in dominance of foreign design and technology in the industry. In the long run, accumulation of human capital in these joint ventures may speed the catching-up process and result in greater presence of domestically owned and operated enterprises in these industries. However, such policy is inconsistent with WTO requirements of "mutual benefit" and "non-discrimination" in multilateral trading. As China continues its efforts to join the WTO, such policy is bound to be phased out before long.

Fifth, the development of the service industry had been largely neglected before the economic reforms started. During that time, economic development was narrowly focused on industrialization and material production, and the government monopolized transportation, telecommunication and product distribution. Business and most personal services were exclusively rendered by state or collective enterprises, and there was little room for private business. For example, in 1978, 55% of total retail sales were made by state enterprises, and 43% were by collective firms, mostly in rural areas. The private sector accounted for a mere 2% of total retail sales (Figure 2). Economic reforms have led to the relaxation of the government's control over commodity distribution, and the private sector has quickly established its position in retail business. In 1996, for example, the private sector accounted for 54% of total retail sales. As private business competes with the state-owned stores, the consumer is the winner, receiving both lower prices and better services than they have had previously. A buyer's market has emerged for consumer products.

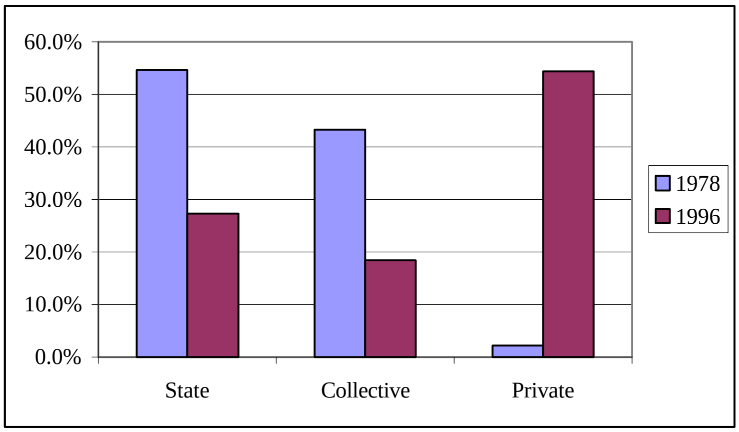


Figure 2 - Retail Sales by Ownership

(Current prices)

The progress in the trade and financial sectors is encouraging. After all, the market economy relies on an efficient market system. Indeed, the Chinese economy is moving steadily to that direction. From 1980 to 1994, the real gross output of Wholesale and retail trade grew at an average rate of over 10% per year, one and a half percentage points faster than the average growth of the service industry. Its output share in the service industry rose from 21% in 1980 to 26% in 1994. The Finance and banking industry recorded the fastest growth among all service industries, with average annual growth reaching 11.9%. While the banking sector is still subject to the government's tight control, the government's effort to separate the central bank from commercial banks and to allow the participation of private and foreign institutions is making progress and has contributed to the industry's growth. Although reforming China's banking sector will likely be a long process, an efficient and healthy banking system is critical in improving the economy's investment efficiency. The recent miserable experiences of Japan and Korea have shown what damage a problematic banking system can cause to the economy. Hopefully, there is a valuable lesson that China can learn from the recent financial turmoil in Asia.

CHAPTER III :

THE STRUCTURE OF MUDAN

The Framework of MuDan

MuDan is a long-term interindustry model aimed at tracing the industrial development of China from 1980 to 2010. It is built based on a 59 sector commodity-to-commodity input-output table of the Chinese economy, and follows the basic framework of INFORUM models. The basic input-output accounting structure of MuDan is the following dual pair of input-output equations:

$$q = A * q + B * f \tag{1}$$

$$p = p * A + v \tag{2}$$

where vectors q = gross output by I-O sector,

f = final demand by category,

p = output prices, and

v = value added per unit of output by I-O sector.

A is a product-to-product input coefficient matrix, and B is a bridge matrix to convert final demand by category to final demand by product. Because MuDan is an annual model, these equations must be satisfied for all years as accounting identities. Each vector and matrix in both equations should be thought of as having a time subscript, for all of them change in each year.

There are three logical components in MuDan: the real or product side, the price-income side, and the accountant. The real side estimates final demand, output and labor requirements. The price-income side determines factor income or value added and estimates prices. The accountant closes the model with respect to income, and computes economic aggregates based on sectoral variables.

The Real Side

The centerpiece of the real side of MuDan involves estimation of the final demand vector *f* of Eq. (1). Output by producing sector is computed for given A and B matrices based on *f* by Eq. (1), which can be solved for *q* as

$$q = (I - A)^{-1} * B * f \tag{3}$$

where I is the identity matrix. Labor requirements are subsequently determined by output and estimates of labor productivity.

There are six broad components of *f*, including private consumption, investment, government expenditures, imports, exports, and other final demand. Each component, except government expenditures, exports, and the other final demand, is estimated by econometric equations. Equations for consumption are estimated based on consumption categories, 24 for urban and 10 for rural residents, that are subsequently translated through time-varying bridge matrices into 59 producing sectors. Investment equations are based on 52 purchasing sectors that are then translated into capital goods in 59 producing sectors. Government expenditures are policy variables and specified exogenously. Imports and inventory changes are endogenously determined by behavioral equations. Exports are determined by a bilateral trade model in the INFORUM international model system. Therefore, they are exogenous when MuDan is run as a standalone model but endogenous when it is run in the international system. The basic accounting identity that corresponds to Eq. (1) for MuDan is

$$q = A * q + B_{cr} * h_{cr} + B_{cu} * h_{cu} + c_s + B_{\mathrm{inv}} * i_{nv} + i_{vn} + x - m + o_{thdm} \tag{4}$$

where q = gross output by 59 sectors,

h_{cr} = household consumption of rural residents by 10 categories,

h_{cu} = household consumption of urban residents by 24 categories,

c_s = social or public consumption by 59 sectors,

i_{nv} = investment in fixed-assets by 52 purchasing sectors,

i_{vn} = inventory changes by 59 sectors,

x = exports by 59 sectors,

m = imports by 59 sectors, and

o_{thdm} = other final demand, an error term, by 59 sectors.

A (59×59) is the I-O A-matrix; B_{cr} (59×24) and B_{cu} (59×10) are bridge matrices for urban and rural consumption expenditures, respectively; B_{inv} (59×52) is a bridge matrix to convert investment by purchasing sector into products that are purchased.

Complete specification and estimation results are shown in the following chapters; a brief description of each component of the real side of MuDan is given in the rest of this section.

Private consumption expenditures are estimated based on consumption per capita of rural and urban residents. There are two consumption demand systems in MuDan, one for rural and the other for urban residents. Each system is based on a nonlinear demand system, a Perhaps Adequate Demand System (PADS), and estimated by consumer categories based on household survey data. There are 24 categories for urban residents and 10 for rural residents in MuDan. Consumption depends on income, relative prices, and a time trend. Expenditures on the consumer categories are estimated as a system so that consumer goods can be substitutes or complements with respect to relative prices within the rural or urban consumption system. Total expenditures are predetermined and equal to disposable income minus savings, all on a per capita basis. If the sum of the estimated expenditures on each category does not equal to the total spending, a “spreader” is used by PADS to allocate the difference in proportion to the marginal propensities to consume with respect to income at the current prices. The national totals of consumption by category are simply the products of the consumption per capita of urban and rural residents multiplied by the population of urban and rural residents, respectively. B_{cu} and B_{cr} then translate total consumption by category into consumption by producing sectors.

Fixed investment expenditures are estimated by 52 purchasing sectors, aggregated from the 59 sectors, and are explained by an accelerator model. A separate equation for the aggregate investment is also estimated. The aggregate investment can be used to control the sectoral investment, but such control is optional. If the option is enabled, sectoral investment expenditures are scaled so that the sum of the sectoral investment matches the aggregate investment. If the option is disabled, the aggregate investment function will simply be ignored and the aggregate investment is computed as the sum of the sectoral investment. This option of controlling sectoral investment to the aggregate may be useful in some occasions. For example, this scaling process may be a proxy for simulating the investment controls that are often applied by the Chinese government. It may also be useful because the aggregate investment function responds to macroeconomic variables such as money supply conditions and the interest rate while sectoral investment functions do not. Once investment by purchasing sector is determined, it is translated into demand for capital goods by the bridge matrix B_{inv}.

Inventory change equations are extremely crude at present because adequate inventory time series are not currently available. The only available time series of inventory data is the national total, and the only available data on inventory changes by product are those in the I-O tables. Rather than using econometrically estimated equation, inventory changes are postulated as following a stock adjustment process.

Export demand comes from the INFORUM international model system and is computed as the sum of demand for Chinese goods by foreign countries. Therefore, it is endogenous to the INFORUM international system but exogenous to MuDan. Imports by product are determined simultaneously with output based on import shares. The import shares, expressed as the ratios of imports and total domestic demand, are explained by a set of logistic functions. Explanatory variables of the import share equation include an import-share weighted time trend and the relative foreign to domestic prices. MuDan's import prices come from INFORUM's international model system and are converted through exchange rates into prices denominated in domestic currency.

The coefficient matrices, including the I-O matrix A and bridge matrices B_{cr}, B_{cu}, and B_{inv} are not constant but are forecasted with logistic curves in response to time trends. Output is solved through an iterative procedure by

$$q = (I - A)^{-1}(B_{cr} * h_{cr} + B_{cu} * h_{cu} + c_s + B_{\text{inv}} * i_{nv} + i_{vn} + x - m + o_{thdm}) \qquad \textbf{(5)}$$

Because current output and imports depend upon one another, they are determined simultaneously.

Labor productivity, defined in MuDan as simply the ratio of gross annual output per employee, is explained by changes of output, time trends, and the lagged value of capital-employment ratios. Labor requirements by sector are computed by multiplying the estimated labor productivity and the output computed from Eq. (5). Unemployment is computed as the difference between the total labor force and the labor requirements. If demand for labor is so strong that the implied unemployment rate would be less than 2%, our assumed value of the natural rate of unemployment, sectoral labor productivity is scaled up to reduced the labor requirements so that unemployment rate is at least 2%. Similarly, if the implied unemployment rate would be greater than 8%, sectoral productivity is scaled downward to increase labor requirements. The rationale for such scaling is that disguised unemployment in the Chinese economy is very significant and it provides ample room to support a broad range of output through changes in productivity rather than in employment. While MuDan's productivity function includes a simple cyclical variable that models productivity's response to a change in output, the simple variable may not be up to the task and extra help seems necessary. Since productivity affects wages, a change in productivity will change sectoral wages, which will affect income and prices. Therefore, the productivity change will have real effect, as changes in prices and income will affect final demand such as consumption.

The construction of the MuDan model in this dissertation has evolved from two previous versions. However, the present study represents significant improvements. In previous versions, private consumption expenditures by category were estimated not in a system, but by individual linear regression equations with explanatory variables including relative prices and personal income. Complementarity and substitution between consumption categories were not considered. Investment was exogenous to the model and therefore simply consumed resources without making any productive contribution to the economy. Productivity was exogenous in the first version of MuDan, and was explained only by time trends. Neither investment nor capital stock had any impacts on productivity. These unrealistic assumptions have been replaced in this third version.

The income side of the model was not present in the previous versions of the model and is added to the current version. In addition, macro variables such as the interest rate and the saving rates are also added. Table 6 provides a summary of the three versions of MuDan, with MuDan III indicating the version constructed by this study.

Table 6 - Summary of MuDan -- The Real Side

	MuDan I	MuDan II	MuDan III
Number of sectors	33	63	59
Base I-O table	33 sector 1987 table	117 sector 1987 table	118 sector 1992 table
Private consumption: Data	19 urban categories 12 rural categories 2 bridge matrices	19 urban categories 12 rural categories 2 bridge matrices	24 urban categories 10 rural categories 2 bridge matrices
Functions	2 linear systems: income, relative prices	2 linear systems: income, relative prices	2 PADS systems: income, relative prices, groups of consumption goods
Public consumption: Data	33	63	59
Functions	Exogenous	Exogenous	Linear: GDP last period and sectoral prices
Fixed-asset investment: Data	33 sector	51 state investment 13 urban collective investment 5 rural collective investment 1 bridge matrix	1 aggregate investment 52 investing sectors 1 bridge matrix
Functions:	Exogenous	Exogenous	Aggregate: money supply, lag GDP. Sectoral: accelerator model – change in output, capital stock
Inventory investment: Data	33 sectors	63 sectors	59 sectors
Function	Constant inventory/output ratio: same as in base year	Constant inventory/output ratio: same as in base year	Constant inventory/output ratio: same as in base year
Exports and imports: Data	33 sectors	63 sectors	59 sectors derived from 4-digit SITC series
Functions:	Imports: linear -- domestic demand and time trend Exports: linear – time trend	Imports share: log linear –import share-weighted time trend, relative foreign & domestic prices Exports: linear -- time trend	Imports share: log linear –import share-weighted time trend, relative foreign & domestic prices Exports: from BTM, the INFORUM international model system.
Productivity: Data	33 sectors	49 sectors	52 sectors
Function:	no	Log linear: time trend	Log linear: time trend, ratio of output to its previous peak, capital-labor ratio

The Price-Income Side

The price-income side of MuDan determines four types of income or value-added: (1) depreciation, (2) labor income, (3) taxes, and (4) profits for the 59 producing sectors at current prices. Unit value added, the value added per unit of real output, is computed simply by dividing total valued added by real output for each of the 59 sectors. Prices are found by solving Eq. (2) by a Seidel procedure. Thus:

$$p = (d + p + w + t) * (I - A)^{-1} \qquad \textbf{(6)}$$

where p = domestic prices,

d = depreciation per unit of real output,

π = profits per unit of real output,

w = wage per unit of real output,

t = taxes per unit of real output, and

p,d, π, w, and t are all row vectors.

There are two aggregate wage equations and 51 sectoral wage equations. The aggregate wage equations determine the nominal wage per employee for two broad sectors, the agriculture and the non-agriculture sectors. The aggregate wage equations have similar specifications with three explanatory variables, including the lagged inflation, the unemployment rate, and labor productivity.

The sectoral wage rate equation employs uses the ratio of the sectoral wage rate to the aggregate non-agricultural wage rate as the dependent variable. The independent variables include a constant and the ratio of the sectoral employment to total non-agricultural employment. Total nominal wages by sector are computed by multiplying the sectoral wage rates by sectoral employment.

Profits, depreciation allowance, and taxes are estimated in a similar fashion. Because detailed value added data are not available, the time series of the sectoral value added data of the three components have to be constructed (Yu, 1997a). Although the constructed value added data seems usable for simple estimation, their quality probably does not warrant elaborate econometric studies. Therefore, simple equations for each type of the value added in current prices are specified in terms of per unit of real output and estimated by I-O sector. Depreciation is explained by a measure of current capital stock. Profits are estimated as a mark-up over costs and explained by growth of sectoral gross output, the unemployment rate, and a simple time trend. Taxes as a ratio of nominal output are explained by a simple time trend. All these value-added components are estimated by I-O sector.

The Accountant

The main task of the accountant of MuDan is to compile the aggregate national account tables by summing up the sectoral details for final demands and income by industry, the same work that a national income accountant does. Since MuDan uses an iteration procedure to solve the model, the accountant also checks and determines the convergence of the iterations.

A set of complete national income and product accounts is a byproduct of the construction of MuDan. The product and income accounts in the official statistics are incomplete, containing no more than a set of scattered numbers. MuDan, however, has constructed a complete set of national income and product accounts that are consistent with each other and show useful details. Table 7 shows GDP identities that are used in MuDan. Compilation of such accounts is a task of the Accountant, which computes real GDP by summing up the sectoral final demands in constant prices, and nominal GDP by summing up the sectoral value added in current prices. The GDP deflator is

Table 7 - GDP Identities in MuDan

Real side (Constant prices)

+	C		Private national consumption
	Cu		Consumption of urban residents
	Cr		Consumption of rural residents
+	G		Government consumption
+	I		Investment
	Ifa		Fixed capital investment
	Ivn		Inventory change
+	X		Exports of goods and services
-	M		Imports of goods and services
=	GDE	Gross domestic expenditures	
+	O		Other final demand
=	gdp	Gross domestic product	

Price-Income side (Current prices)

+	dep		Depreciation of capitals
+	wage		Labor incomes
+	tax		Taxes and subsidies
+	prf		Profits
=	gdpN	Gross domestic product	

gdpD=gdpN/gdp GDP deflator

simply the ratio of nominal GDP and real GDP. The accountant also computes disposable income of the nation, and breaks the income into savings and consumption of urban and rural residents. Because transfer payments and asset accumulation are not modeled in MuDan, private consumption is assumed to be a function of disposable income of the current period. However, the total disposable income is not simply the sum of wage income. Instead, it is estimated by regression as a function of wages and profits.

The total disposable income for urban residents is explained by total wages and total profits of agricultural and non-agricultural sectors. A similar regression equation is used for total disposable rural income. The national total of private disposable income is computed simply as the sum of rural and urban disposable incomes.

The savings rates of rural and urban residents are estimated separately and are explained by the lagged value of the dependent variable, the nominal interest rate, the unemployment rate, and the real income growth. Total consumption expenditures are computed as the total disposable income minus savings, which is simply the product of the disposable income and the savings rate. Per capita private consumption is computed by dividing the total consumption expenditures by population.

All the variables up to this point, including income, consumption and savings, are in current prices. Deflating the consumption per capita in current prices by the consumption deflator yields the consumption per capita in constant prices, which is then fed into the two PADS systems to compute consumption demand by category. The procedure is carried out for rural and urban residents in an exactly parallel fashion.

Urban and rural consumption deflators are computed as weighted-averages of user prices, the average prices that users pay for the mixture of domestic and imported goods and are computed as weighted-sums of import prices and domestic producers' prices. Details about the estimation of the consumption deflators can be found in the last section of this chapter.

The solution of the model proceeds year-by-year. The solution process starts with a set of assumed values of income and prices, then the real side of the model takes control and computes final demands, employment, and output based on the assumed values. The control is then passed to the price-income side, which computes value-added and prices. Finally, the Accountant takes control and computes incomes and compares the computed rural and urban incomes with the ones that have been assumed at the beginning. If they are very "close", a solution has been reached and the model goes to the next year. If they are not, the newly computed income and prices are taken as the new set of assumed value, and the cycle of computation continues. This process in illustrated in more details in the next section.

Solution of MuDan: The Algorithm

MuDan is solved through an iterative process, which is displayed in Figure 4 at the end of this chapter. In any given year, MuDan begins by estimating the A and B matrices, which are forecasted by time trends and, therefore, determined before the iteration process starts.

In the iteration process for a given year, the calculations of MuDan start from the real or production side with assumed values of disposable income for rural residents, of disposable income for urban residents, and of prices paid by rural and urban consumers. Savings functions are used to determine savings and consumption in current prices based on the assumed incomes. Total consumption is then deflated into constant prices, and fed into the PADS system to calculate per capita consumption by category in constant prices. These demands are then translated through bridge matrices into the producing sectors. Investment functions are then estimated by purchasing sectors, and translated into the purchased capital goods through the investment bridge matrix. Inventory changes by I-O sector are computed next. Exports, government expenditures and other final demand are specified exogenously. Then household consumption, investment, exports, and government consumption and other final demand are added together to reach a final demand from which imports have not been subtracted. This final demand is then used in a Seidel iterative solution of the input-output equations in which imports and outputs are simultaneously calculated. (The imports depend on the total demand for the product, which is known at each step in the Seidel process.) The imports thus calculated are then subtracted from the final demand. Labor productivity is then computed, followed by labor requirements to be computed simply by dividing output by productivity. The real side computation completes and the price-income side follows.

The price-income side computation starts with estimations of value-added components. Equations are called to determine the wage rates, defined as the wage income per employee by sector, which are multiplied by sectoral employment to obtain total wages by sector. Depreciation, taxes, and profits by sector are then estimated by the corresponding regression equations. A vector of total value added is computed by summing up the depreciation, wages, taxes and profits vectors. Dividing the total value added vector by real output yields "unit value added", the value added in current prices per unit of real gross output.

Producer prices are solved, through Eq. (6), in a Seidel procedure based on the unit value added vector and the A-matrix. Since sectoral prices are used in determining profits and taxes, the price-income side computation iterates until the price solution converges. A vector of user prices is computed as weighted-average of domestic and import prices. Consumption prices by consumer categories are computed based on the consumption bridge matrices and a vector of scaling factors. The scaling factors, one for each consumption category, are estimated by their lagged values and trends, and are used to account for the price differences among heterogeneous consumer products produced by a single input-output sector. For example, the price of vegetables, a consumer product, may move differently from the price of the entire Farming sector. Consumption in current prices is computed by multiplying real consumption expenditures by consumption prices, all by consumer category. Nominal and real consumption by category is converted through the consumption bridge matrix into nominal and real consumption by I-O sector from which consumption prices by I-O sector are computed. The overall consumer price index for urban residents is computed by dividing the sum of consumption by category in current prices by the sum of consumption by category in constant prices, and the overall consumer price index for rural residents is similarly computed. The overall consumer price indexes for all residents are computed by dividing the sum of total consumption of all residents in current prices by the sum of consumption of all residents in constant prices.

The final step in the calculations is to compute total disposable income for rural and urban residents, and national aggregates such as GDP. Total disposable incomes are estimated by regression equations, as explained in previous section, based on wages and profits in the value added. Both are nominal incomes, and have been assumed at the beginning of the cycle of calculations. If the implied values are sufficiently close to the assumed values, a solution is reached and the model goes on to the next year; if not, the cycle starts over with the implied values just calculated as the assumed values.

Price Deflators

MuDan's final demand components such as consumption, investment, government expenditures, and foreign trade are modeled in terms of constant prices. Price deflators are necessary in order to convert the final demand components from constant prices into current prices. Because of the differences in product composition and the mix of domestic products and imports, different final demand components may have different price deflators. For example, the price deflator of agricultural products for consumption may not be the same as the one for investment because consumption and investment demand may require different sets of agricultural products. Even within consumption, rural and urban residents may have a composition of agricultural products, which results in a different set of price deflators.

MuDan includes several sets of price indexes. For each sector in the model, MuDan includes at least the following price indexes: a domestic producer price index, a price index for rural consumption, a price index for urban consumption, a price index for exports, and a wholesale price index. A complete list of price indexes is shown in Table 8. Throughout the dissertation, I have used "prices" and "price indexes" interchangeably. Unless specified otherwise, the prices that I refer to are price indexes, not actual price levels. In this section, I present a brief description on the computation of the price indexes in MuDan.

Table 8 - A List of Price Indexes in MuDan

Name[1]	MuDan Name[2]	Content	History[3]	Size
The following vectors are prices by I-O sectors				
p	prices	Domestic producer or output prices	Yes[4]	59x1
p^{m}	priceimp	Import prices	Yes[5]	59x1
p^{x}	priceexp	Export prices	No	59x1
p^{mx}	pricepmx	Mixed foreign-domestic prices	No	59x1
p^{uc}	pricecu	Urban consumption prices by sector	No	59x1
p^{rc}	pricecr	Rural consumption prices by sector	No	59x1
p^{o}	priceoth	User prices	No	59x1
The following two vectors are prices by consumption categories				
ph^{uc}	up	Urban consumer prices by category	Yes	24x1
ph^{rc}	rp	Rural consumer prices by category	Yes	10x1
The following prices are scalars				
gdpD	gdpD	GDP deflator	Yes	scalar
cD	cD	Overall consumption deflator	Yes	scalar
cuD	cuD	Overall urban consumption deflator	Yes	scalar
crD	crD	Overall rural consumption deflator	Yes	scalar
invD	invD	Overall investment deflator	No	scalar
exD	exD	Overall export deflator	No	scalar

Note:
1. Variable names used in this dissertation.
2. Vector names in MuDan.
3. Availability of historical data. Computed if no historical data available.
4. Available for Agriculture and 15 aggregated industrial sectors
5. From the INFORUM International Model System

1 Output Prices

The output price measures the unit cost of a domestically produced product. Historical output prices by sector are constructed based on the published prices for 4 agricultural and 15 industrial sectors and GDP deflators for service sectors. In the forecasting period, output prices are solved in MuDan from Eq. (2) based on the A-matrix and estimates of unit value added. Import prices are exogenous to MuDan and converted from INFORUM's international model system by the exchange rate.

2 Export Prices

The export price measures the unit cost of a domestic product that is exported. Export prices are computed as weighted-averages of import and domestic producer prices because there are no published export price deflators. Although we may simply use domestic producer price deflators to deflate exports, there are problems associated with this method. For the period in which there is substantial currency devaluation, a separate export price vector that is different from the vector of domestic producer prices becomes absolutely necessary. For example, renminbi was devalued by almost 50 percent in 1994. With such a drastic devaluation, properly converting U.S. dollar denominated imports and exports into domestic currency becomes critical and tricky. This can be illustrated by a simple numerical example.

Suppose the exchange rate is 6 yuan per dollar for 1993 and 9 yuan per dollar for 1994. Suppose also that only two goods are traded, exports of garments and imports of textiles: the exports of garments are 18 billion yuan in 1993 and 27 billion yuan in 1994, and imports for textiles are 2 billion dollars in both years. Nominal trade balances are 6 billion yuan in 1993 and 9 billion yuan in 1994, a 50% increase in terms of renminbi. Questions arise on how to compute the real growth. Since both international and domestic producer prices are unchanged, we may deflate exports by domestic producer price deflators, 1 for garments for 1994, and deflate imports by international prices converted into renminbi, 1.5 for textiles for 1994. Both deflators are in terms of 1993 prices. Therefore, the real balances in 1993 prices are 18-12=6 billion yuan for 1993, and 27-18/1.5=15 billion yuan for 1994, a stunning growth of 150%, which does not make much sense. It seems clear from the example that the asymmetric use of exchange rates in computing the two deflators is to blame, but it is not clear what the true growth is, 50%, 150%, or neither? While the true growth may depend on information that we do not have, such as the original prices of the imports and exports and the exchange rates associated with the transactions, the matter can be improved by changing either or both deflators. In MuDan, I opt for trying a different export deflator.

The deflators for exported goods are different from the domestic producer price deflators, even though exports are part of domestically produced goods. First of all, export goods are a subset of domestically produced goods, and their prices can certainly be different from the average domestic producer prices. Second, intermediate inputs for producing exported goods may be different from those for producing goods for domestic sale. For example, exported garments may use more imported textiles than the garments for domestic uses. Third, while exporters may be price takers in the international market, they have certain leverage in setting the domestic wholesale prices of exported goods close to international prices. Therefore, while a devaluation of renminbi by 50% makes Chinese goods cheaper for foreign importers, it does not necessarily imply 50% savings. Some portion of the savings is offset by the rising intermediate costs, if imports are used in production, and by possibly larger trade margins of exporters. Although we do not know the actual vector of export price indexes, it seems appropriate to assume that the "true" export prices lie somewhere between domestic producer prices and domestic currency denominated international prices converted by official exchange rates.

I compute the export price vector as a weighted-average of domestic producer prices and the international prices. Without any further information, I opt to use the same constant weights for all sectors for all years by the following form:

$$p_{it}^{x} = a * p_{it} + (1-a) * p_{it}^{m} \qquad \textbf{(7)}$$

where p_{it}^{x} = the export price index for sector i in year t,

p_{it} = the domestic producer price index for sector i in year t,

p_{it}^{m} = the domestic currency denominated import price index converted by official exchange rate for sector i in year t, and

a is a constant to be calibrated.

The calibration of a is done in the process of balancing historical data to make a time series of I-O tables. Because a major devaluation occurred in 1994, a is chosen based on 1994 data. The only criterion that is used in choosing a is to make the computed real growth of GDP close enough to the published one. The computed real GDP growth is calculated as the ratio of the published total nominal GDP and our own estimate of real GDP, which is the sum of deflated final demand components. Consumption is deflated by the published household consumption deflators. Investment, government expenditures, and other final demand are deflated by a vector of user prices that will be explained later in this section. Imports are deflated by import prices and exports are deflated by export prices to be calibrated. The calibrated a in MuDan equals 0.7, which suggests that while domestic producer prices account for 70% of export costs, foreign import prices are also important in determining export costs. Therefore, there seems a certain degree of integration between exports and imports.

3 Average Wholesale Prices

The average wholesale price measures the average wholesale price of a product that is available in the domestic market. Because products in the domestic market are a mixture of domestically produced products and foreign imports, the average wholesale price is computed as the weighted average of output prices, import prices, and export prices as follows:

$$p_i^{mx} = \frac{q_i * p_i + m_i * p_i^m - x_i * p_i^x}{q_i + m_i - x_i} \tag{8}$$

where p_i^{mx} = the foreign-domestic mixed price index

p_i^x = the export price index

p_i = the domestic producer price index

p_i^m = the domestic currency denominated import price index, and

q_i, m_i, and x_i are output, import, and export in constant prices.

Although subscript t has been omitted in Eq. (8), all variables should be thought of as being at time t.

4 Consumer Price Indexes

The consumer price measures the average retail price of a consumer product. Two vectors of consumer price indexes are used in MuDan: one for urban residents for 24 categories, and the other for rural residents for 10 categories. Historical time series of consumer price indexes for all 24 categories[4] have been published since 1985, with most categories having price indexes earlier than 1985. Consumer price indexes in the

[4] Prices for some MuDan categories are not published, but they can be constructed based on the published prices.

forecasting period are computed based on the foreign-domestic mixed prices, the consumption bridge matrices, and a set of adjustment factors that are forecasted. The computation of urban consumer price indexes is illustrated below. The same process is used for computing rural consumer price indexes.

In the historical period, the urban consumption bridge matrix and the foreign-domestic mixed prices are known. For a consumer category j, an "expected" price index for urban consumption (uc) in year t, phb^{uc}_{jt}, can be computed as

$$phb^{uc}_{jt} = \sum b_{ijt} * p^{mx}_{it}, \quad j = 1, \ldots, 24 \qquad \textbf{(9)}$$

where b_{ijt} is the coefficient in row i, column j and time t; p^{mx}_{it} is the foreign-domestic mixed price for I-O sector i in time t. If every p^{mx}_{it} were the actual price, in the I-O sense of the producer price, that a urban consumer pays to obtain consumer good j, then phb^{uc}_{jt} should equal ph^{uc}_{jt} , the actual price for category j. For example, if i is the MuDan sector of Electric machinery and instrument, and j is the household consumption category of Home appliances and furniture, ph^{uc}_{jt} and phb^{uc}_{jt} are actual and computed price index for Home appliances and furniture while p^{mx}_{it}'s include the foreign-domestic mixed price for Electric machinery and instrument, Furniture, and so on. However, appliances such as refrigerators account for only a small portion of output in the Electric machinery and instrument sector, therefore, the prices of appliances may be quite different from that of the whole sector. Similarly, the average price of furniture for household use may be different from the average price in the Furniture sector. Hence, ph^{uc}_{jt} and phb^{uc}_{jt} could be very different. In fact, for many categories they are. How close the two are depends on such factors as the mixture of imports and domestic goods for consumption in the national average, the value shares of the consumer goods in the I-O sectors, and price movements of the I-O sector and its consumption goods. If a consumer category includes products that are homogeneously priced, $ph^{uc}{}_{jt}$ and phb^{uc} must be close. Otherwise, they may be quite different. In either case, $phb^{uc}{}_{jt}$ appears to be a plausible estimator for $ph^{uc}{}_{jt}$, although adjustments may still be needed. To make the adjustments, it is assumed that the difference between $ph^{uc}{}_{jt}$ and $phb^{uc}{}_{jt}$ has a simple trend. More specifically, the ratio between $ph^{uc}{}_{jt}$ and $phb^{uc}{}_{jt}$., $s_{jt} = ph^{uc}{}_{jt} / phb^{uc}{}_{jt}$, is assumed to follow the following equation:

$$\log s_{jt} = a_0 * (1 - \frac{a_1}{T} + \frac{a_2}{T^3}) \tag{10}$$

where T is a trend variable. Therefore, in the forecasting period, $phb^{uc}{}_{jt}$ will first be computed based on the p^{mx} vector, and then scaled by the forecasted s_{jt} to get $ph^{uc}{}_{jt}$, the consumer price for category j.

With the vector ph^{uc} being computed, we want to compute the implicit consumption prices by sector for urban consumers. The question is equivalent to, say, that given that appliances such as refrigerators account for only a small portion of output in the Electric machinery and instrument sector, is it possible to estimate an implicit consumption price index for Electric machinery and instrument sector, p^{uc}, that is consistent with our estimated p^{uc} for Appliances and furniture category? The answer is positive, and the estimation is made as follows.

Given the price vector ph^{uc} and a set of real consumption expenditures by consumer category, which is known in historical period and estimated in the forecasting period, we multiply the real consumption by its price index to get consumption in current prices. Given the bridge matrix for the consumption categories, we convert consumption from household categories into the I-O sectors and obtained two vectors of consumption expenditures on I-O products, one in current prices and the other in constant prices. Dividing, element by element, the nominal consumption vector by the real consumption vector, we obtain a vector of prices by I-O sector, which is named as p^{uc} and used as our estimate of the vector of consumption prices by I-O sector. A similar procedure is used for rural consumption and a similar price vector p^{rc} can be computed for rural consumption based on the ph^{rc} vector.

5 User Prices

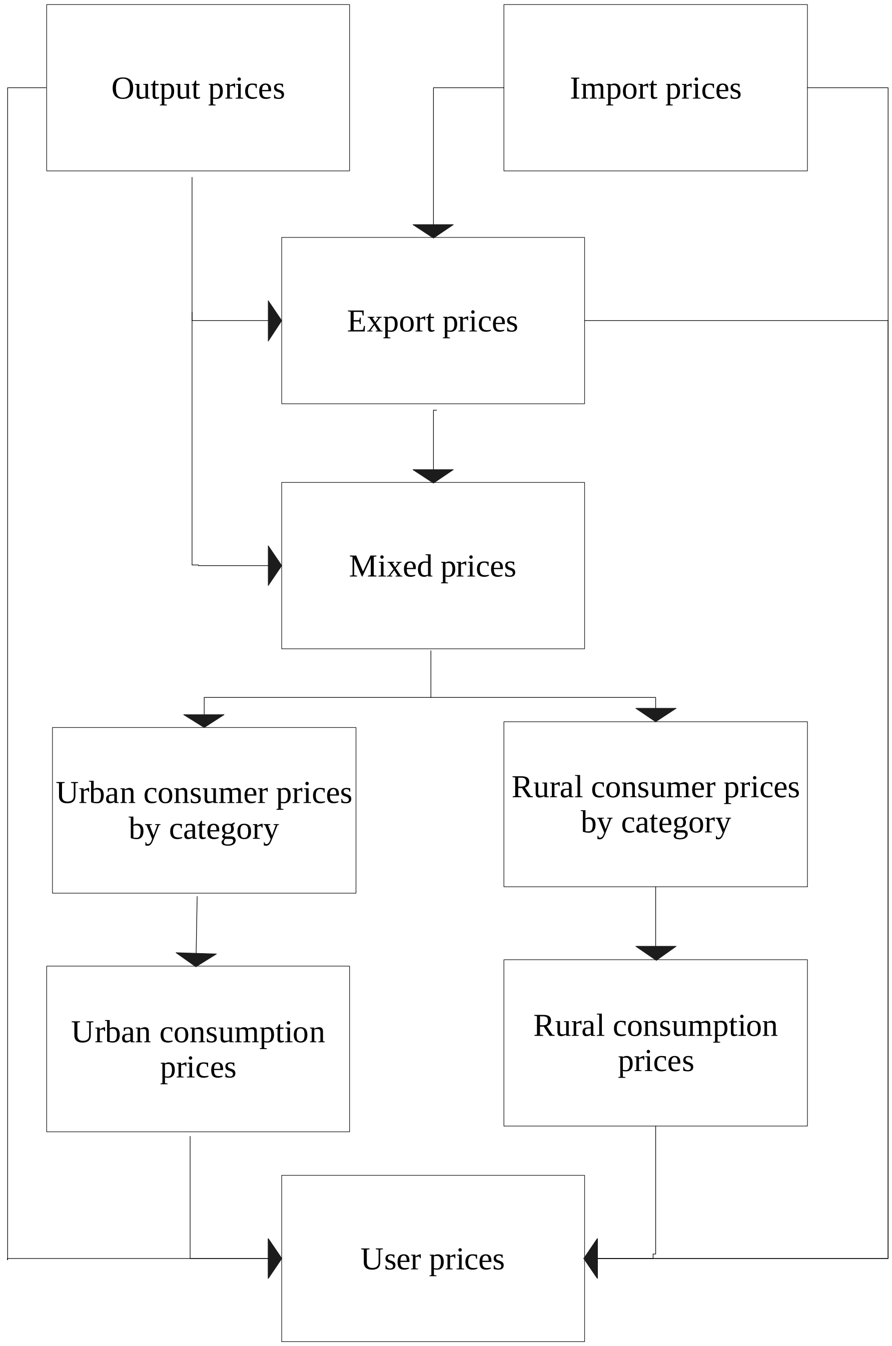
The last vector of prices is what I call the user prices, p^o, which measures the average price of a product that is used in investment, intermediate consumption, government consumption, and other final demand. The user price is introduced for accounting purposes. Because, in MuDan, output is deflated by output prices that are solved from Eq. (2). Urban consumption, rural consumption, exports, and imports are deflated by p^{uc}, p^{rc},p^x, and p^m, respectively. The remaining final demands and intermediate inputs are lumped together and deflated by a single price vector, which is the user price p^o. To satisfy the I-O accounting identity of Eq. (4), which holds in both current and constant prices, we compute p^o as

$$p_{it}^{o} = \frac{q_{it} * p_{it} + m_{it} * p_{it}^{m} - x_{it} * p_{it}^{x} - c_{it}^{u} * p_{it}^{uc} - c_{it}^{rc}}{q_{it} + m_{it} - x_{it} - c_{it}}, \quad i = 1, \ldots, 59 \qquad \textbf{(11)}$$

where q, m, x, c^u, and c^r are vectors of output, imports, exports, urban consumption, and rural consumption, all by I-O sector in constant prices. It can be easily verified that Eq.(4) holds if the column vectors in the I-O table are deflated respectively by p^{uc}, p^{rc},p^x, and p^m and p^o.

The computation of overall deflators is straightforward once all price vectors are computed. The GDP deflator *gdpD* is computed as the ratio of nominal and real

GDP, with the nominal GDP computed as the sum of all final demand components in current prices and the real GDP the sum of final demands in constant prices. For the overall consumption deflator *cD*, we compute the sums of consumption expenditures for all residents, one in constant price and the other in current prices. Then *cD* is simply the ratio of the current sum to the constant sum. Other overall deflators are similarly computed. The computing order of price indexes and deflators is summarized in Figure 3.



All Prices are by IO sector unless specified otherwise

Figure 3 - Computation of Price Indexes in MuDan

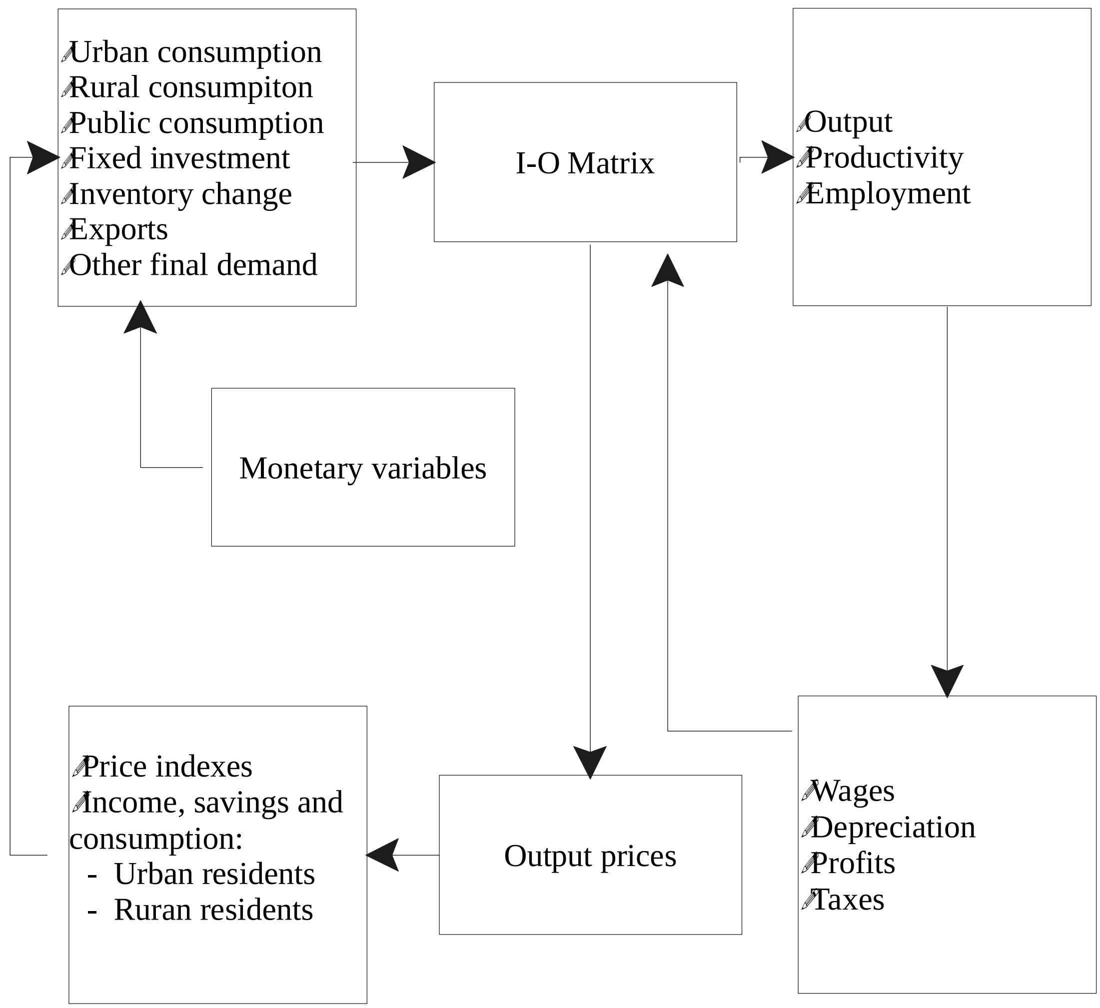


Figure 4 - Solution Process of MuDan

CHAPTER IV :

PERSONAL CONSUMPTION EXPENDITURES

Personal Consumption Expenditures in China: An Overview

Personal consumption expenditure (PCE) is the most significant component of final demand. While PCE accounts for 60-70% of GDP in many market economies, PCE in China accounts for only 50 percent of GDP on average. The ratio of PCE to GDP in China has shown a declining trend in the last decade. It reached its peak of 53 percent in 1981, fell to its trough of 45 percent in 1994, and is on a recovery path since 1994. This is displayed in Figure 5. As the Chinese economy becomes more market-oriented, consumer demand is certain to play an even more important role in determining economic activities.

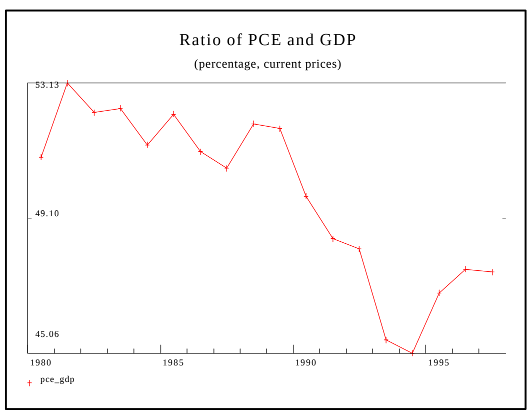


Figure 5 - Ratio of PCE and GDP

Given the large size of PCE, it is obvious that determining aggregate consumer demand is crucial in building any economic model. Equally important for a disaggregated long-term growth model such as MuDan are the commodity composition and the asymptotic properties of the consumption equations. In this chapter, I will first give a brief survey of the existing empirical studies on private consumption, and comment on the applicability of these studies to modeling MuDan. I then describe the functional form that is used in MuDan. Finally, estimation results based on this form are discussed. Since consumption expenditures by rural and urban residents are modeled separately, the compelling reasons for doing so will be given at once.

The official distinction between a rural resident and an urban resident is his residential registration status or *hukou*. Every Chinese has either a rural *hukou*, in which case he is classified as a rural resident, or an urban *hukou*, in which case he is an urban resident. Changes from one status to the other involve government approval, and there are strict rules regarding the change of *hukou*. In the old system, urban residents were entitled many preferential benefits, such as guaranteed employment, subsidized housing, and quotas for grain, edible oil, and other rationed commodities, that their rural counterparts were not. Economic reform has eliminated many subsidies to urban residents, and China's drive toward a market economy has allowed limited labor mobility from rural areas to cities. However, China still maintains the *hukou* system, and urban residents still enjoy certain privileges in areas such as welfare benefits, education, and employment.

Personal consumption illustrates sharp differences between recent economic growth and economic development prior to 1979. Before economic reforms began in 1979, rapid industrialization was the only goal for economic development, and huge investment was made at the cost of consumption. Economic reforms have re-focused economic development toward improving the standard of living. Consequently, the Chinese have enjoyed a significantly improved standard of living since reforms began. In the twenty-two years from 1956 to 1978, the personal consumption per capita in real terms increased by only 47%, about 2% per year. In the fifteen years from 1979 to

1996, however, personal consumption per capita increased by 241%, an average growth of 7% per year. The successful rural reforms in the early 1980's substantially raised the income of rural residents and narrowed the income gap between rural and urban residents. The per capita consumption of urban residents was 3.2 times higher than that of rural residents in 1978. It was reduced to 2.4 times higher in 1985. Unfortunately, that gap has widened again since 1985. Figure 6 contrasts per capita consumption for rural and urban residents.

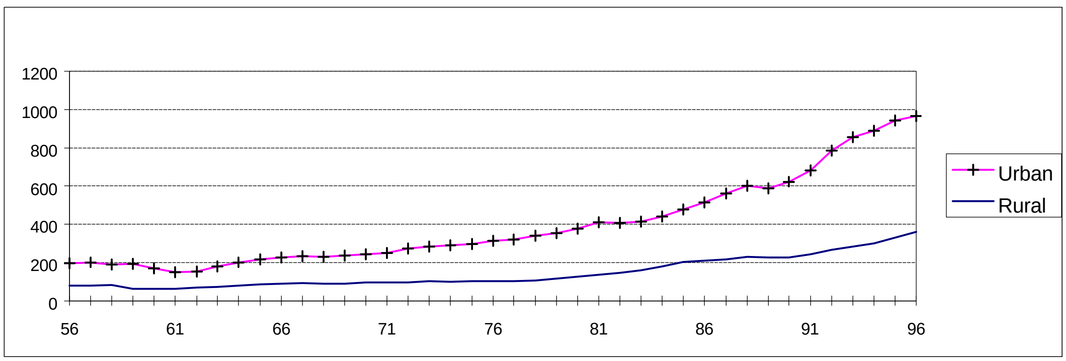


Figure 6 - Personal Consumption Per Capita

(yuan in 1956 prices)

Empirical Studies on Chinese Private Consumption: A Brief Review

Before economic reform, Chinese were faced with chronic shortage of consumer goods, which were produced by central planning and often distributed through rationing. As China continues economic reform, the rationing system has been gradually replaced with a competitive market system. In the late 1980's, grain, edible oil, and housing were still subject to rationing. As income has risen, however, urban residents have increasingly chosen to purchase grain and edible oil from free markets, which are better quality, leaving rationed quotas unused. By the end of 1992, rationing on grains and edible oils had been lifted. The only remaining legacy of the rationing system is probably subsidized housing, which has been subject to significant changes and is scheduled to be abolished by the end of 1998. (People's Daily, March 20, 1998)

Most previous studies on consumption focused on urban residents, presumably because urban consumption data are more readily available. Equally important, though, is that the consumption behavior of urban residents can be actually observed in the market because urban residents earn money income and purchase consumption goods and services from the market. The consumption behavior of rural residents, in contrast, is not easily observed from market activities because a substantial part of their consumption bundle is self-produced, not purchased from the market. Because rationing was common even in the early 1980's, many previous empirical studies had to consider explicitly the impact of the rationing system on consumer behavior and make specific adjustments in estimating demand systems.

The Linear Expenditure Systems (LES) or the Almost-Idea Demand Systems (AIDS), and several of their variations are the primary forms used in the published studies on Chinese consumption. (Van der Gaag 1987; Wang and Chern, 1992; Chern and Wang, 1994; Wang et al. 1996; Gao et al. 1996.) Van der Gaag (1984) used LES to estimate a consumption system for food, clothing, housing and services with pooled household consumption data from Hebei and Beijing for both rural and urban residents in 1981 and 1982. The effect of rationing is not specifically considered. Wang et al. employed several forms, including AIDS, LES, and QES, the Quadratic Expenditure System of Houthakker and Taylor, to estimate urban consumption under rationing. (Wang and Chern, 1992; Chern and Wang, 1994.) Time series and cross-sectional data by income group from household expenditure surveys were pooled in the study. They found that rationing of housing and grain had significant impacts on the demand for non-rationed goods. Both QES and LES forms were found to yield similar results.

The marginal propensity to consume (MPC) on food was estimated as 0.42. Among food items, pork, poultry, and fish have higher MPC while grain, oil, and beef had lower MPC.

Wang et al. (1996) used a non-nested test to examine the relative explanatory power of the AIDS and translog demand system based on Chinese urban household data. They found that these two demand systems were not significantly different in explanatory power and elasticity estimates. Fan et al. (1995) estimated a demand system of Chinese rural households using a two-stage LES-AIDS model and pooled provincial and time-series data from 1982 to 1990. Demand for commodity groups, including food, clothing, fuel, housing, and other commodities, was found to be price inelastic. Housing and other commodities were found luxury goods while clothing and food were necessities. Within the food group, price elasticities were estimated ranging from -0.005 to -0.63. Expenditure elasticities were lower for grains and higher for meat, tobacco, and alcohol.

Gao et al. (1996) evaluated economic and demographic effects on China's rural household demand for nine food commodities and five nonfood commodity groups. A two-stage budgeting allocation procedure was used to obtain an empirically tractable demand system for food commodities. An upper-level AIDS model was combined with a lower-level GLES as a modeling framework. They found that the slow growth of food consumption in China during the latter half of the 1980s was a result of income stagnation rather than consumption saturation. Growth in the demand for better food and shelter by Chinese rural households would continue to be a major concern.

Wang and Kinsey (1994) examined the effect of strictly rationed housing and partially rationed food grains on consumption and saving behavior for urban households during 1981 and 1987. By incorporating compensated income, savings, and parallel markets for partially rationed goods, complete demand system models with strict rationing were extended. They found that strictly rationed housing had a positive spillover effect on household savings. The estimated expenditure and price elasticities showed that partially rationed food grains had become an inferior good. Policy simulation results further demonstrated that removing grain rationing would have no important influence on the demand for other goods in urban China; however, increasing the level of rationed housing would increase income available for other purposes and thus induce more forced savings.

The popularity of AIDS and LES in empirical studies of private consumption behavior is gained through their elegant theoretical derivations from utility maximization. However, such ancestry is no assurance of the goodness of a form. In fact, shortcomings of these forms have been well documented. Deaton (1974), for example, pointed out that because the LES form is derived from an additive utility function, the specification of the income elasticities and one price elasticity are sufficient to determine all price elasticities. For a fairly detailed disaggregation of commodities, even for eight or ten commodities in practice, the assumption of additivity is likely to yield Pigous's Law of approximate proportionality of expenditure and price elasticities. That is, all products' own price elasticities will all stand in the same ratio to the income elasticities of the same product. Unless we have grounds for believing that elasticities should be proportional, and there is good deal of evidence against such a position, LES is believed too restrictive to be useful in more general models. A main drawback for the AIDS form is that it fails to deal with significant income growth. Increasing real income must ultimately drive the consumption of one or more goods negative unless it has no effect at all on budget shares (Almon 1996). Using French data for 1959 to 1979, Gauyacq (1985) estimated several forms of consumption systems, among which are the forms of LES, AIDS, QES, and a form proposed by Almon (1979). His conclusion was that only the Almon model offered a system that satisfied approximately theoretical expectations and was of real interest for the econometric study of detailed demand functions. In a recent survey of consumption demand systems, Pollak and Wales (1992) conclude that alternative specifications always involve restrictions, and the important thing is to use a functional form appropriate to a particular application.

MuDan is a long-term, multisectoral growth model. Therefore, it requires a demand system that is capable of analyzing consumer expenditures on disaggregated products, that is able to deal with substantial real income growth, and that satisfies certain “adequate” criteria. Both AIDS and LES appear to be inadequate for use in such type of models, for AIDS does not easily accommodate significant income growth while LES is too restrictive for detailed analysis. What is used in MuDan is a demand system that is suggested by Almon (1996). The form is modestly named as PADS, A Perhaps Adequate Demand System. Its specification is described in the next section, which follows closely Almon (1996).

PADS: A Perhaps Adequate Demand System

PADS is a system of market demand functions that describe consumer demand for a collection of goods and services. It is not derived from any utility maximization problem. Instead, PADS is designed to satisfy certain adequacy requirements that should be met with any demand system regardless of its derivation. As been argued by Almon (1979, 1996), a derivation by utility maximization is neither necessary nor sufficient for the usefulness of a system. The criteria for an adequate demand system are meant to portray the world as we expect it to be and include at least the following:

1. It should allow the possibility of expressing either substitution or complementarity between goods, and permit some goods to have close

substitutes and high price elasticities while other goods, with no close substitutes, have low elasticities.

2. It should be homogeneous of degree zero in all prices and income.
3. It should add up. That is, sum of expenditures on all goods must equal the amount spent on all goods, or total income less saving.
4. It should be possible to use the assumption of Slutsky symmetry. While this symmetry is by no means necessary for market demand functions, it is plausible that it should hold closely enough to help us economize on parameters.
5. As income increases, any asymptotic proportions of amounts consumed or of the budget shares should depend on prices, or at least this dependence should not be ruled out a priori.
6. Marginal propensities to consume as income rises must be capable of being different for different goods, and should depend on prices in a way to be estimated.
7. It should be easy to include effects of variables other than prices and income, such as time trends and demographic variables.
8. The parameters of the system should not be difficult to estimate, and reasonable degrees of freedom should be maintained.
9. Price changes should alter the effect of income and non-income determinants of demand in approximately equal proportions.

PADS is constructed based on these criteria. Before the functional form of PADS is presented, however, it is necessary to introduce the concept of groups and subgroups of commodities in PADS because the division of goods into groups and subgroups is essential in PADS to reduce the number of parameters to be estimated while keeping the possibility of complementarity and substitution between goods.

A group in PADS contains at least two products that are closely related while a subgroup includes at least two products that are even more closely related. A product is not required to join a group, nor can it be included in more than one group or in more than one subgroup. Elements of a subgroup usually are, but do not have to be, from a same group. The closeness of two related products is usually measured by the sensitivity of the demand for one product to the price of the other. For example, various food categories form a natural group for they are all related to satisfying appetites. Dress-related products may form another group. Meat and Fish are both protein-rich foods within the food group. The demand for one, Meat or Fish, is probably more sensitive to the price of the other than to the price of others in the food group. Therefore, Meat and Fish seem naturally to form a subgroup. Similarly, Liquor, beverages and tobacco products appear to be more closely related food items and therefore a natural candidate for a subgroup. As an example, Table 9 lists groups and subgroups in MuDan, including 24 consumption categories for urban residents and 10 categories for rural residents.

Table 9 - Groups and Subgroups of Consumption Categories in MuDan

	Urban consumption categories		Rural consumption categories
I	Food group	I	Food group
	A. Protein source subgroup		A. Unprepared food subgroup
	2. Meat, poultry, and fats		1. Grain and products
	3. Fish & aquatic products		2. Meat & vegetables
	B. Tobacco, liquor and beverages		3. Other food
	6. Tobacco		
	7. Liquor and beverag II		
	8. Fresh and dried fruits		
	C. Prepared food		
	9. Cake & dairy products		
	10. Dining out		
	1. Grain		
	4. Vegetables		
	5. Flavorings and sugar		
II	Clothing group	II	Clothing & housing
	D. Ready-to-wear subgroup		4. Clothing
	11. Garments		5. Housing
	13. Shoes, hats & socks		6. Household facilities
	E. Other clothing		
	12. Cloth and tailoring		
III	Durables group		
	14. Appliances & furniture		
	15. Other household articles		
	19. TV, VCR and Piano		
IV	Culture and education group		
	20. Education & child care		
	21. Sports & entertainment		
V	Ungrouped categories	III	Ungrouped categories
	16. Medicine & medical equipment		7. Medicines & med. equip.
	17. Transportation		8. Transportation
	18. Post and telecom.		9. Culture and education
	22. Housing		10. Other goods & services
	23. Utilities		
	24. Jewelry, make-up & others		

As shown in Table 9, the 24 urban categories are divided into 4 groups and several categories that are not in any group. Similarly, the 10 rural categories are divided into 2 groups and several ungrouped categories. In general, we would expect to find substitution between groups; within a group, we may find either substitution or complementarity. It should be emphasized, however, that PADS allows any two goods to be complements or substitutes. The division of groups and subgroups does not constrain the goods within a group or subgroup to be complements or substitutes with each other. However, the way that a particular group or subgroup is formed does influence the values of the cross price elasticities, as we will see later in Eq. (5).

We are now ready to introduce the functional form of PADS. Assume that there is a consumption demand system of n commodities, which are divided into groups and subgroups of closely related commodities. Let G denote a group and g a subgroup. Then the consumption demand per capita of product i, x_i, a member of group G and subgroup g, may be estimated as

$$x_i = (a_i + b_i(y/P) + c_i \Delta y + d_i t)\left(\frac{p_i}{P}\right)^{-l_0} \prod_{k \neq i}^{n} \left(\frac{p_i}{P_G}\right)^{-l_k s_k} \left(\frac{p_i}{P_G}\right)^{-m_G} \left(\frac{p_i}{P_g}\right)^{-n_g} \qquad \textbf{(1)}$$

where y is nominal income per capita,

p_k is the price index for product k,

a_i, b_i, c_i, d_i, λ_i, μ_G and ν_g are parameters to be estimated,

and P, P_G , P_g are overall price, overall group price, and overall subgroup price levels, respectively, defined by

$$P = \prod_{k=1}^{n} p_k^{s_k}, P_G = \left(\prod_{k \in G} p_k^{s_k}\right)^{1/\sum_{k \in G} s_k} \; and \; P_g = \left(\prod_{k \in g} p_k^{s_k}\right)^{1/\sum_{k \in g} s_k} \qquad \textbf{(2)}$$

where s_k is the budget share of product k in the period in which the price indexes are all ones.

It is useful in judging the reasonableness of regression results to be able to calculate the compensated own and the cross price elasticities. “Compensated” here means that y has been changed in order to keep the real spending y/P constant. Their derivation is straightforward. If we introduce

u_{ij}	=	The share of in the base year of product j in the group which contains product i, or 0 if i is not in a group with j.
w_{ij}	=	The share in the base year of product j in the subgroup which contains product i or 0 if i is not in a subgroup with j
μ_i	=	μ_G if product i is in group G, 0 otherwise
ν_i	=	ν_g if product is in subgroup g, 0 otherwise
L	=	the share-weighted average of the λ_i

$$L = \sum_{k=1}^{n} l_k s_k \tag{3}$$

The compensated own price elasticity of product i is then

$$h_{ii} = -l_i(1-s_k) - L + l_i s_i - m_i(1-u_{ii}) - n_i(1-w_{ii}) \tag{4}$$

while the cross price elasticity, the elasticity of demand for good i with respect to the price of good j, is

$$h_{ij} = l_i s_j + l_j s_j + m_{ij} m_i + w_{ij} n_i \tag{5}$$

Estimation of PADS is through a program written in C++. The description of the estimation algorithm can be found in Almon (1996). The program allows soft constraints on coefficients on income, the change in income, the time trend, and parameters λ_i, μ_G and ν_g.

Estimation Results

MuDan is probably the only INFORUM model at present that has two consumption equation systems in one model: one for rural and the other for urban household. Each system is estimated independently by using PADS. Since the primary data source for estimating PADS in MuDan is from China's household surveys, which are conducted separately with different sets of categories for rural and urban residents, it is natural that two consumption systems are estimated. While that is indeed an important consideration, it is not the only reason. For instance, there are significant inequalities between rural and urban residents in terms of their income and consumption expenditures. A typical Chinese living in urban area earns and consumes 2.5 to 3 times as much as one in rural area. Furthermore, rural and urban residents are faced with different consumption choices. For example, urban residents are often entitled to subsidized housing, education and medical insurance while their rural counterparts are not. Clearly, we need more than one consumption system to properly account for the significant differences among rural and urban consumers.

The variables used in estimating PADS in MuDan are fairly standard: income per capita, a time trend and price indexes of the consumption categories. The only extension is that a dummy variable has been added to the income term. Each category uses only one dummy variable. For most categories, I have used a dummy variable that equals –1 in 1989 and zero otherwise. This dummy is intended to capture the negative interruption of the TianAnMen incident of June 4, 1989 on private consumption patterns. Several additional dummy variables are also used. The exact content of and reasons for these other dummies are explained along with regression results.

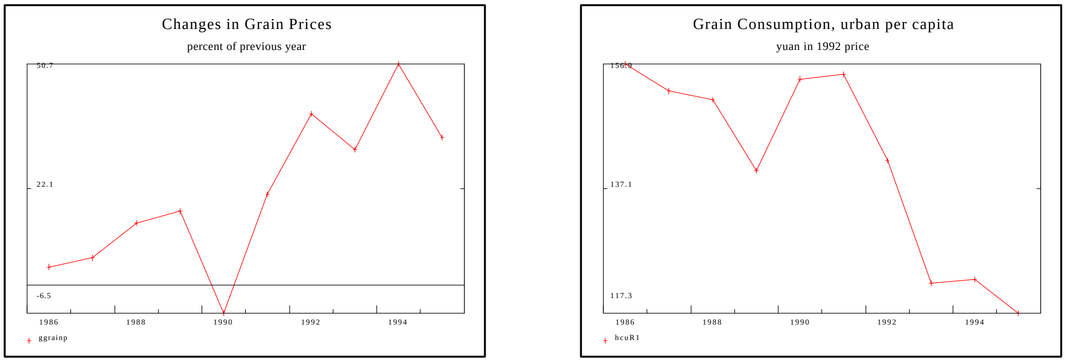


Figure 7 - Grain Price Indexes and Consumption

The impact of rationing is not explicitly estimated in MuDan. This is probably not a serious limitation, for our estimation period is from 1985 to 1994 and most consumer goods were no longer distributed by rationing during that period. Grain and housing are the two major categories subjected to rationing during that period. However, it appears that ignoring their impacts on the demand system might not be a big problem for the following two reasons.

While grain was indeed subject to rationing until 1992, the following evidences suggest that the rationing had not been binding after 1985. First, our estimation is based on the household survey data that showed consumers' actual consumption expenditures. As shown in Figure 7, the data indicate that the grain price that consumers actually paid has shown significant changes, particularly since the late 1980s, while the first increase of the price of the rationed grain did not occur until 1991. This implies that a certain quantity of grain must have been purchased from the free market. Secondly, consumption of grain has shown a declining trend since the late 1980s, as also shown in Figure 7. It may be partly true that the declining demand for grain is a result of rising prices, but it is also plausible that grain is an inferior good, (Wang and Kinsey, 1994), and is price and expenditure inelastic (Wang et al. 1996). While rationing of grain officially remained in effect before 1992, consumers seemed to have chosen to forfeit the quotas and purchased grain from the free market at higher prices. The primary reasons for their opting for the higher priced products included considerations in quality and variety that government grain stores did not provide. Quota-priced grain was generally of lower quality because grain producers often sold lower quality grain to the government to fulfill the procurement requirement at guaranteed procurement prices while keeping higher quality product for sale in the free market at higher prices. Furthermore, stocks of procured grain were held as a reserve, and sales from the reserve were the oldest grain. The quota-priced retail grain was thus often from previous harvests and therefore further degraded. The open market vendors, on the other hand, bought fresh grain and retailed it immediately (Crook, 1995).

Housing is another major commodity that is still subject to rationing. There has been evidence to suggest that housing rationing encourages consumption of other non-rationed goods such as consumer durable goods (Wang and Chern, 1992), although the extent of distortion is not clear. Given that housing consumption is only a small portion (2% in 1992) of the per capita consumption expenditures of rural residents, the distortional effect does not appear to be significant, and therefore, I did not pursue this issue any further.

We now turn to the discussion of our estimation results of rural and urban consumption from PADS.

Urban Consumption

Urban consumption of 24 categories is divided into four groups and five subgroups in the estimation of urban PADS, as shown in Table 9. Soft constraints[5] are

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[5] Soft constraints have sometimes been called stochastic constraints, or Theil's mixed estimation, or Bayesian regression. The estimation program of PADS allows the

applied in the estimation to obtain reasonable values or correct signs of the coefficients in PADS. In particular, own price elasticities are constrained to be negative, income price elasticities are constrained to be positive, and coefficients on the time trend have been deliberately kept small to allow more explanatory power for income and price variables. Statistical results of the estimation are listed in Table 10, and own and cross price elasticities that are estimated by PADS are displayed in Table 11.

Three dummy variables are used in the estimation. Dummy 1 equals 1 before 1993 and 0 since 1993, and is used in Post and telecommunication. Consumption expenditures on Post and communication equipment, including cellule phones, pagers, and regular telephones, have shown extraordinary growth since 1992. The per capita real spending by urban residents on Post and communication, which is still subject to state monopoly, increased from 3.25 yuan in 1980 to 6.27 in 1991. It surged, however, from 11.56 yuan in 1992 to 95.66 yuan in 1996. Surprisingly, this surge of demand coincided with sharp price increases, 47.8%, 61.4% and 18.7% increases in 1990, 1991 and 1993, respectively. Prices were almost unchanged in other years. Clearly, it will be impossible for the consumption demand system to explain this kind of unusual consumer behavior with regular variables such as income and prices. Therefore, dummy 1 is used as a last resort to allow the system to work.

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user to specify the desired value of any parameters except the constant term. For each specified desired value, the user must specify a “trade-off parameter” to express the user’s trade-off between closeness of fit and conformity with the desired value of the parameter. If the trade-off parameter is 0, the desired value has no effect on the estimation. A value of 1.0 for the trade-off parameter gives about equal weight to the constraint and to the data.

Table 10 - Estimation Statistics of Urban PADS

Sec#	Title	G	S	D	lamb	share	IncEl	DInc	time%	PrEl	Err%	rho
1	Grain	1	0	1	0.49	0.078	0.16	-4.07	-0.95	-0.34	2.65	-0.29
2	Meat, poultry, and fats	1	1	1	0.52	0.167	0.92	-0.09	0.00	-0.58	1.44	0.51
3	Fish & aquatic products	1	1	1	0.45	0.035	0.84	0.01	0.04	-1.26	3.57	0.38
4	Vegetables	1	0	1	0.57	0.060	0.84	-0.11	0.02	-0.41	4.04	0.68
5	Flavorings and sugar	1	0	1	0.66	0.016	0.81	-0.70	0.35	-0.50	5.27	0.60
6	Tobacco	1	2	1	0.47	0.032	1.01	-0.21	2.10	-0.12	3.51	0.43
7	Liquor and beverages	1	2	1	0.51	0.027	1.05	-0.32	1.11	-0.13	2.40	0.43
8	Fresh and dried fruits	1	3	1	0.49	0.043	1.00	-0.29	0.05	-0.45	2.50	0.60
9	Cake & dairy products	1	3	1	0.53	0.027	0.99	-0.79	0.07	-0.51	2.66	0.17
10	Dining out	1	3	1	0.56	0.042	1.27	-0.45	-0.01	-0.51	2.43	-0.34
11	Garments	2	4	1	0.54	0.079	1.21	-0.34	-0.01	-0.50	2.46	0.20
12	Cloths & tailoring	2	0	1	0.57	0.028	0.65	-0.53	0.13	-0.57	5.10	0.27
13	Shoes, hats & socks	2	4	1	0.63	0.033	0.89	-0.45	-0.03	-0.19	3.70	0.11
14	Appliances & furniture	3	5	3	0.48	0.045	0.28	-0.44	-2.04	-2.29	14.39	0.47
15	Other household articles	3	5	3	0.52	0.040	1.18	-0.51	1.01	-2.53	2.77	-0.47
16	Medicine & medical eq.	0	0	1	0.57	0.025	2.16	0.34	0.04	-1.01	3.46	0.08
17	Transportation	0	0	1	0.03	0.020	2.24	0.01	-0.18	-0.49	9.91	0.41
18	Post and telecom.	0	0	4	0.76	0.006	2.69	-0.19	0.67	-1.21	35.67	-0.23
19	TV, VCR and Piano	3	0	3	-0.06	0.030	0.49	-1.88	-0.19	-0.10	6.09	0.66
20	Education & child care	4	0	1	0.23	0.038	1.64	-0.20	0.99	-0.72	4.16	0.14
21	Sports & entertainment	4	0	1	-0.01	0.020	0.49	-0.82	-1.07	-0.54	7.10	0.06
22	Housing	0	0	1	0.04	0.021	1.27	-2.86	-0.17	-0.50	9.05	0.06
23	Utilities	0	0	1	0.44	0.038	1.76	-0.22	0.03	-0.87	4.98	0.34
24	Jewelry, make-up & others	0	0	1	0.51	0.047	1.07	-0.42	0.03	-0.92	4.54	0.40

Note: G: group number; S: subgroup number; D: which dummy variable: D1 = -1 in 1989, 0 otherwise; D3 = 1 in 1988, 0 otherwise;
D4 = 1 before 1992, 0 since 1992; lamb: the lambda for each sector; share: expenditure share in base year;
IncEl: the income elasticity in base year; Dinc: the coefficient on the change in income divided by income coefficient;
time%:the annual change due to the time trend expressed as a percentage of the base year value; PrEl: the own price elasticity
Err%1 the standard error of estimate as a percentage of the base year value; rho: the autocorrelation coefficient of the residuals.
The per capita income, the change in income, and a common time trend are used in every equation.

Table 11 - Price Elasticities of Urban Consumption Categories

(The number in row i and column j is the elasticity of product i with respect to the price of product j, Consumption Categories and Groups are shown in Table 9)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	-0.34	0.06	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
2	0.02	-0.58	0.23	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
3	0.02	1.10	-1.26	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.03	0.05
4	0.03	0.07	0.01	-0.41	0.01	0.01	0.01	0.02	0.01	0.02	0.09	0.03	0.04	0.05	0.04	0.03	0.01	0.01	0.02	0.03	0.01	0.01	0.04	0.05
5	0.04	0.08	0.01	0.04	-0.50	0.01	0.01	0.02	0.01	0.03	0.10	0.03	0.04	0.05	0.05	0.03	0.01	0.01	0.02	0.03	0.01	0.02	0.04	0.06
6	0.02	0.05	0.01	0.02	0.01	-0.12	-0.16	0.01	0.01	0.02	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.03	0.05
7	0.02	0.06	0.01	0.03	0.01	-0.19	-0.13	0.01	0.01	0.02	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
8	0.02	0.06	0.01	0.03	0.01	0.01	0.01	-0.45	0.07	0.11	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
9	0.03	0.06	0.01	0.03	0.01	0.01	0.01	0.10	-0.51	0.11	0.09	0.03	0.04	0.05	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
10	0.03	0.07	0.01	0.03	0.01	0.01	0.01	0.11	0.07	-0.51	0.09	0.03	0.04	0.05	0.04	0.03	0.01	0.01	0.02	0.03	0.01	0.01	0.04	0.05
11	0.08	0.18	0.04	0.07	0.02	0.03	0.03	0.04	0.03	0.05	-0.50	-0.06	-0.24	0.05	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	0.05
12	0.08	0.18	0.04	0.07	0.02	0.03	0.03	0.05	0.03	0.05	-0.17	-0.57	-0.07	0.05	0.04	0.03	0.01	0.01	0.02	0.03	0.01	0.01	0.04	0.05
13	0.09	0.19	0.04	0.07	0.02	0.04	0.03	0.05	0.03	0.05	-0.58	-0.06	-0.19	0.05	0.05	0.03	0.01	0.01	0.02	0.03	0.01	0.01	0.04	0.05
14	0.08	0.17	0.03	0.06	0.02	0.03	0.03	0.04	0.03	0.04	0.08	0.03	0.04	-2.29	1.58	0.03	0.01	0.01	-0.10	0.03	0.01	0.01	0.04	0.05
15	0.08	0.17	0.03	0.06	0.02	0.03	0.03	0.04	0.03	0.05	0.08	0.03	0.04	1.79	-2.53	0.03	0.01	0.01	-0.10	0.03	0.01	0.01	0.04	0.05
16	0.08	0.18	0.04	0.07	0.02	0.03	0.03	0.05	0.03	0.05	0.09	0.03	0.04	0.05	0.04	-1.01	0.01	0.01	0.02	0.03	0.01	0.01	0.04	0.05
17	0.04	0.09	0.02	0.04	0.01	0.02	0.01	0.02	0.02	0.02	0.05	0.02	0.02	0.02	0.02	0.01	-0.49	0.00	0.00	0.01	0.00	0.00	0.02	0.03
18	0.10	0.21	0.04	0.08	0.02	0.04	0.03	0.05	0.04	0.06	0.10	0.04	0.05	0.06	0.05	0.03	0.02	-1.21	0.02	0.04	0.01	0.02	0.05	0.06
19	0.03	0.08	0.01	0.03	0.01	0.01	0.01	0.02	0.01	0.02	0.04	0.01	0.02	-0.13	-0.11	0.01	0.00	0.00	-0.10	0.01	0.00	0.00	0.01	0.02
20	0.06	0.13	0.02	0.05	0.01	0.02	0.02	0.03	0.02	0.03	0.06	0.02	0.03	0.03	0.03	0.02	0.01	0.01	0.01	-0.72	0.05	0.01	0.03	0.04
21	0.04	0.09	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.02	0.04	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.10	-0.54	0.00	0.02	0.02
22	0.04	0.09	0.02	0.04	0.01	0.02	0.02	0.02	0.02	0.03	0.05	0.02	0.02	0.02	0.02	0.02	0.00	0.01	0.00	0.01	0.00	-0.50	0.02	0.03
23	0.07	0.16	0.03	0.06	0.02	0.03	0.03	0.04	0.03	0.04	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	-0.87	0.05
24	0.08	0.17	0.03	0.06	0.02	0.03	0.03	0.04	0.03	0.05	0.08	0.03	0.04	0.04	0.04	0.03	0.01	0.01	0.01	0.03	0.01	0.01	0.04	-0.92

Dummy 2 equals 1 in 1988 and 0 otherwise, and is used in the following three categories: Appliances and furniture, Other household goods, and TV, VCR and piano. It is intended to capture the panic shopping, induced by the first serious inflation since economic reform started, of household appliances and other durable goods by consumers during 1988. Dummy 3, the TianAnMen[6] dummy, equals –1 in 1989 and 0 otherwise and is used for the remaining categories.

Standard errors of the estimation can be found in Table 10 in the column marked as “Err%”. They are computed as a percentage of the base year, 1992 in MuDan, value for each category. Naturally, equations for durable goods have higher standard errors than the ones for non-durable goods because expenditures on durable goods are more volatile than the ones on non-durable goods. The largest error is 36% in the equation for Post and telecommunication, followed by 14% for Appliances and furniture. Standard errors for the rest are all less than 10%.

Since total expenditures are used in lieu of total income in estimating PADS, income and expenditure elasticities are the same in this context, and I will use them interchangeably in this section. The estimated income elasticities are listed in the column marked as “IncEl” in Table 10, with values ranging from 0.16 for Grain to 2.69 for Post and telecommunication. These values appear fairly close to what we would expect. In the first group, the food related categories, we find that grain and other

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[6] In 1988, China planned an overhaul of the price system, which caused nation wide panic shopping for consumer goods that included everything from bath tissues, garments, cloths, shoes to home appliances and other durable goods. The panic shopping was evident based on the significant dropping of expenditures on these storable goods while spending on non-storable goods and services such as food items and utilities did not have much fluctuation. Therefore, it seems more plausible to contribute the drop in consumption expenditures in 1989 to the panic shopping in 1988 rather than to the TianAnMen incident of June 4 even though the two coincided.

unprepared food items are necessities, all of which have income elasticities less than one. Dining out, Liquor, beverages, and Tobacco products are luxury goods with income elasticities over one. In the clothing group, Garments is found to be a luxury while Clothing materials, Shoes and hats are necessities. Medicine and medical equipment, Transportation, and Post and telecommunication have the strongest expenditure elasticities with values above two. What I find surprising is the durable good group. Weak income elasticities are found in Household appliances and furniture, and in TV, VCR and piano. Given high prices of these products and the relatively low income of Chinese consumers, I expected to see stronger income elasticities. However, the weak elasticities appear surprising but not inconceivable, and may have been caused at least partly by the durable good rush of the early 1980s, the premature popularization of TV, tape recorder and other durable goods. As reported in a CASS (1988) study, by the end of 1986, the per capita GNP of China was only 465 dollars. However, the number of durable goods possessed by Chinese urban consumers had reached or even surpassed the levels of Japan and South Korea when their per capita GDP were 1000 dollars. The early 1980s was a period when China just opened its door to the outside world and consumer durable goods such as TV, refrigerators, and tape recorders were just introduced to ordinary people. The durable goods rush resulted from the combination of rising personal income, generous welfare of subsidized housing, medical insurance, and education, and the enthusiasm of embracing modern life by the Chinese urban consumers. Another important factor is related to the "resembling the neighbor" consumption pattern. Many Chinese consumers seem to like to follow fads, particularly in consumption of durable goods. For example, the products to buy for the 1980's were TV, refrigerators and washing machines; for the 1990's, they are telephones, cellular phones, and automobiles. Therefore, the low expenditure elasticities may simply indicate that these durable goods are temporally out of fashion.

Own price elasticities can be found in Table 10 in the column marked as “PrEl”. The estimation results suggest that, in most categories, urban consumers are not highly price sensitive. Although all own price elasticities show desired negative values, only five categories have own price elasticities larger than one in absolute value.

Cross price elasticities are more interesting, as shown in Table 11. Each off-diagonal element, e_{ij}, in the table shows the elasticity of product i with respect to the price of product j while the diagonal elements show own price elasticities. A positive e_{ij} indicates product i and j are substitutes while a negative indicates complements. In general, cross elasticities seem very small, whether they are within groups or between groups, and most products are shown as weak substitutes. The second column shows larger positive values than other columns, indicating relatively strong substitution effect of the change in price of Meat, poultry and fats on consumption of other categories. In particular, meat and fish seem to be strong substitutes. According to the estimates, if the meat price increases by 1%, consumption of fish will increase by 1.10% while if fish price increase by 1%, consumption of meat will pick up only 0.23%.

The off-diagonal negative elements, which are highlighted in boxes, of Table 11 reveal several interesting and important results from the group and subgroup structure of the demand system. The upper left box shows the complementarity between categories 6 Tobacco and 7 Liquor and beverages, which are in the second subgroup of the food group. The 3×3 box in the middle shows complementarities among a group of three categories, Categories 11 Garments, 12 Cloths and tailoring, and 13 Shoes, hats and socks. The remaining boxes can be thought of as in one box containing Categories 14 Appliances and furniture, 15 Other household articles, and 19 TV, VCR and Piano. The three are formed as one group while the first two are specified as a subgroup in estimating PADS. The estimation results exemplify how flexible and useful groups and subgroups can be in the specification of PADS. From the estimation, we find strong substitutions between categories 14 and 15, and complementarities between categories 14 and 19, and between 15 and 19. By allowing complementarities and substitutabilities among consumer categories, we can expect MuDan to provide richer simulation results and the results to be more realistic.

MuDan's estimation results are broadly comparable to other studies. For example, in the study of Wang and Kinsey (1994), which explicitly modeled the effect of strictly rationed housing and partially rationed food grains on consumption for urban households during 1981-1987, the following expenditure and own price elasticities were reported:

Table 12 - Estimated Price and Expenditure Elasticities

Elasticity	Grain	Nonstaple Food	Tea, tobacco & liquor	Clothing	Articles for daily use	Saving	Services
Expenditure	-0.074	0.955	1.075	1.356	1.534	1.255	0.90
Own prices	-0.104	-0.632	-1.015	-0.656	-2.113	-.070	-3.867

Note: All elasticities are calculated at sample means.
Source: Table 6 in Wang and Kinsey (1994).

A comparison of between the estimated price and income elasticities in Wang and Kinsey's study and those in this study reveals comparable results. The expenditure and price elasticities in Table 12 are comparable to income and price elasticities of IncEl and PrEl in Table 10 of our estimates. A noticeable difference is on the elasticities of Grain. While both show relatively low price elasticity, their estimate of the expenditure elasticity is a negative of –0.074 while our estimate shows a positive of

0.16. However, our estimate of the coefficient on the change in income is –4 times the coefficient on income, as indicated by the coefficient on Dinc, so that in our equation also the immediate effect of a one percent increase in income is a drop in consumption of grain by –0.48 percent (0.16 – 4.07*0.16= –0.48.) However, in the next year after the income increase, consumption of grain would rise. The Nonstaple food category in Table 12 is comparable to the categories 2 to 5 and 8 to 10 in Table 10. As evident from the tables, both find income elasticities to be close to one and price elasticities around –0.5. For tobacco, liquor and beverages (categories 6 and 7 in MuDan), both find income elasticities to be close to unit although there are marked differences in price elasticities. Both income and price elasticities for Closing are fairly close to our estimates for Garments (category 11), although we also include two separate categories of Cloths and tailoring, and Shoes, hats and socks. The remaining categories are difficult to compare because the groups do not match well. Broadly speaking, their category of Articles for daily use includes MuDan's categories 14, 15, 17, 19, and 24 although it also includes part of categories 16 and 21. Through a causal examination, it appears that the results are still comparable. For services, the main categories in MuDan include categories 16, 17, 18, 20, 21, and 23. Again, our estimates show diversities in income elasticities, and relatively low price elasticities compared with the results in their results.

Figure 8 displays graphically the actual and fitted values for all 24 categories.

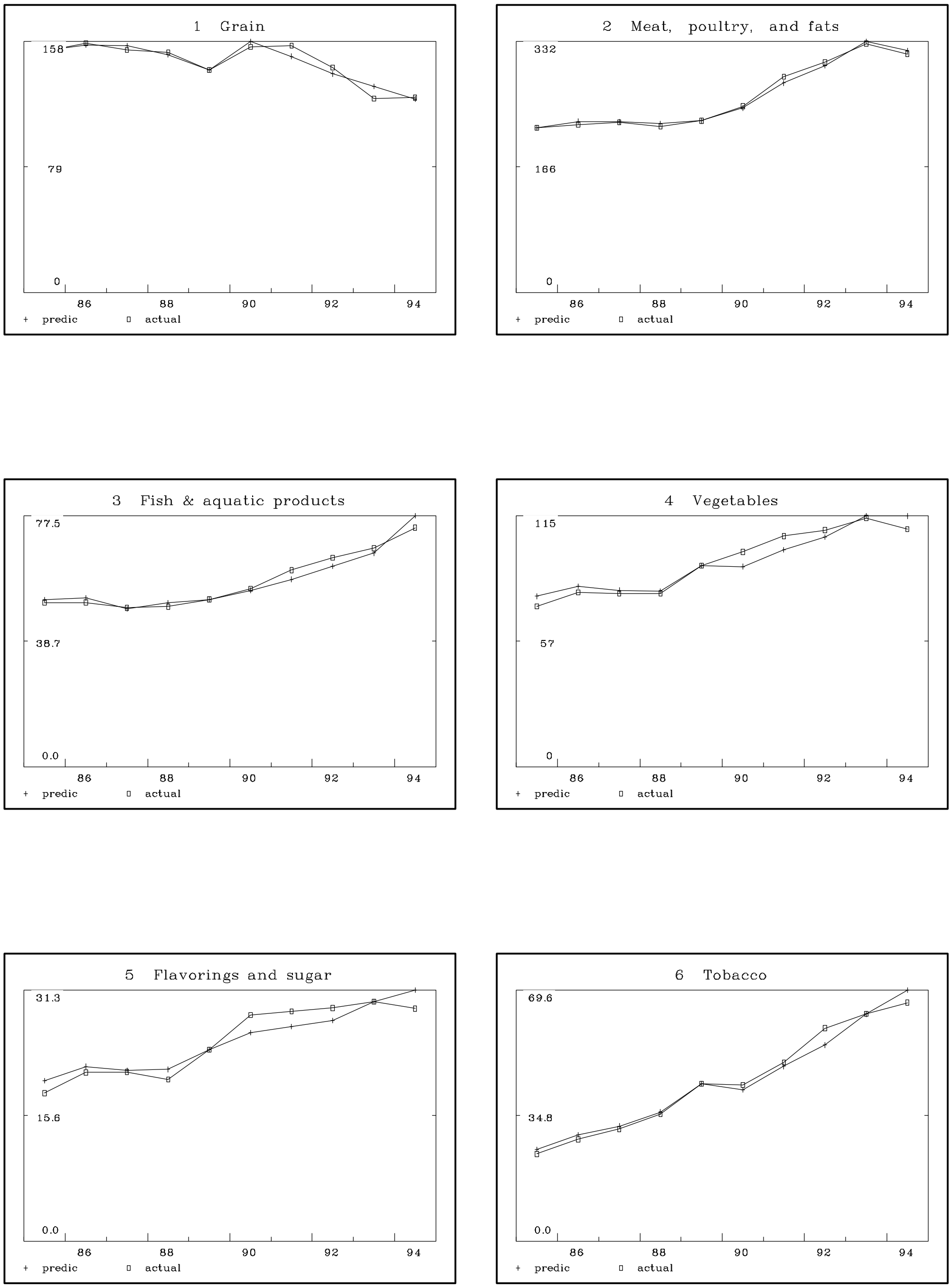

Figure 8 - Urban Consumption Per Capita

(yuan in 1992 prices, household consumption category)

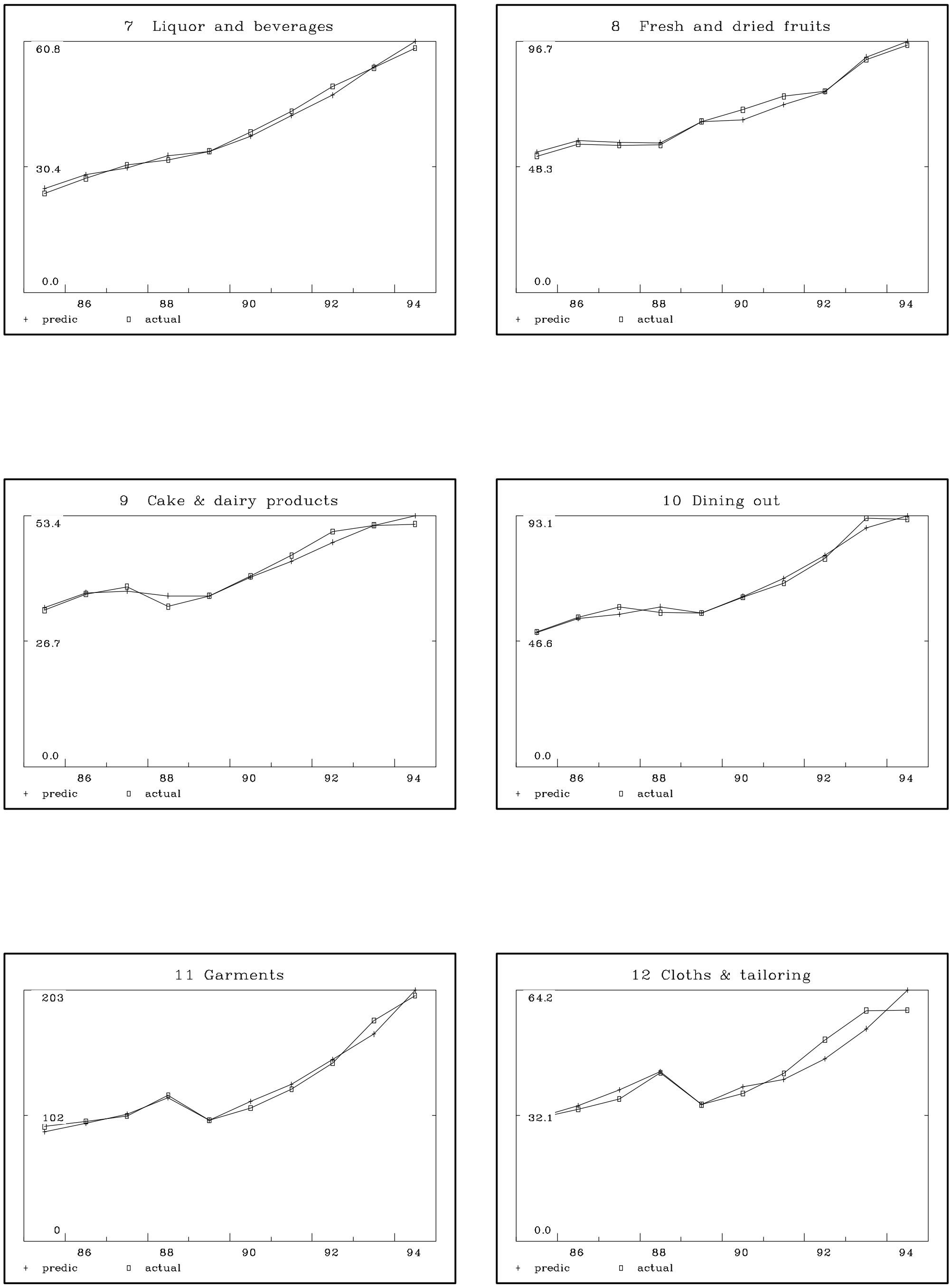

Figure 8 - **Urban consumption per capita (cont.)**

(yuan in 1992 prices, household consumption category)

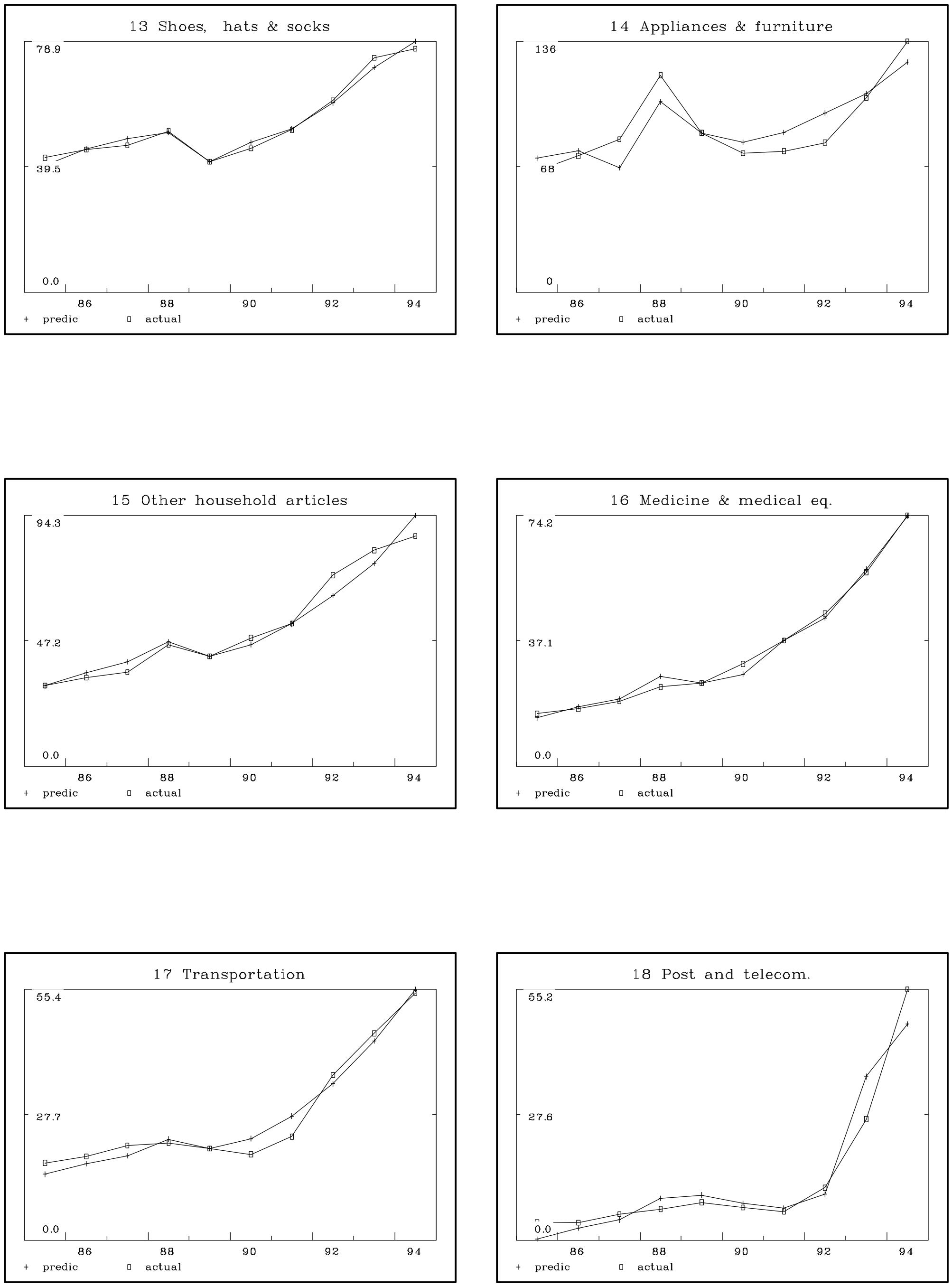

Figure 8 - **Urban consumption per capita (cont.)**

(yuan in 1992 prices, household consumption category)

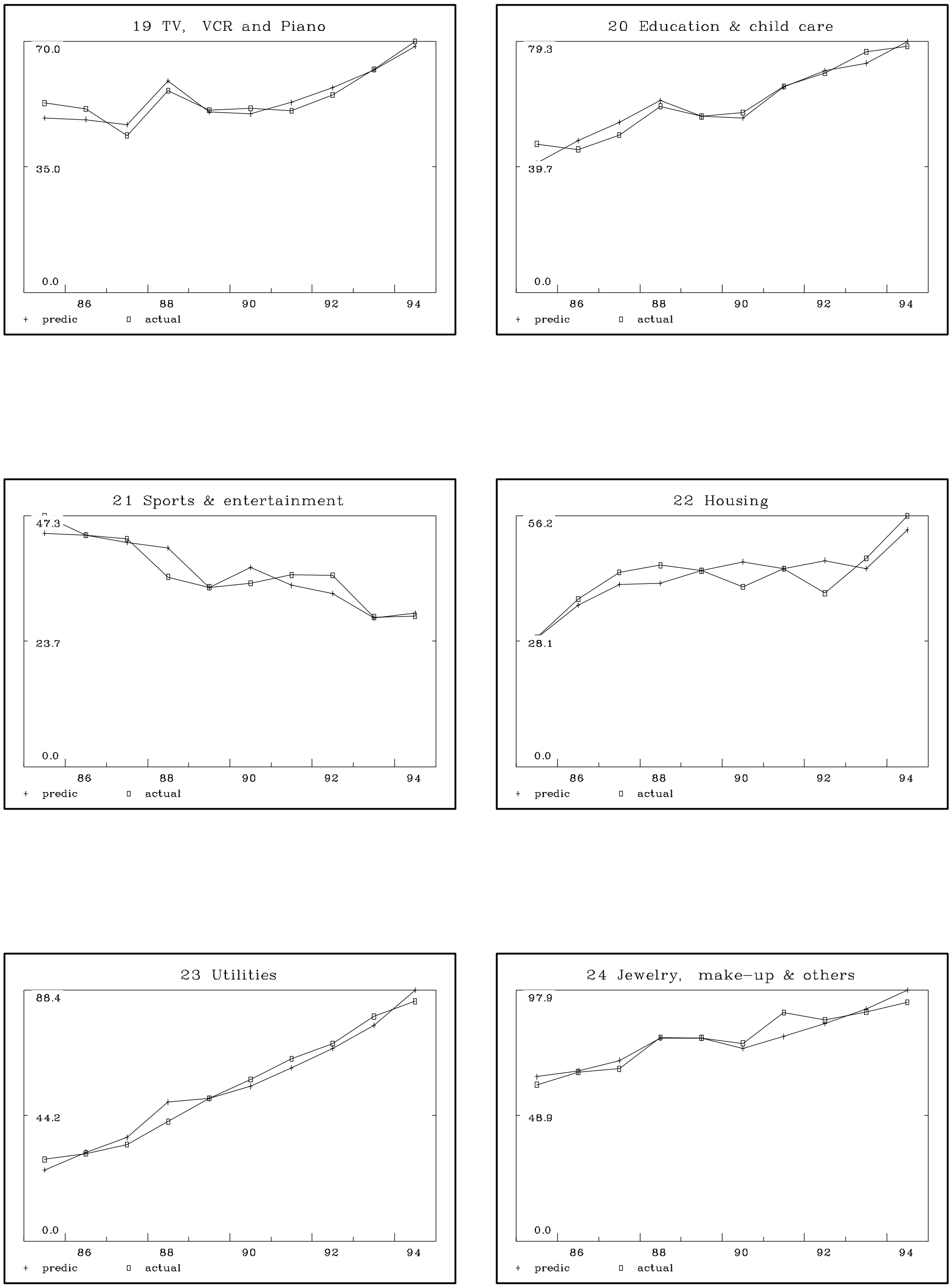

Figure 8 - Urban consumption per capita (cont.)

(yuan in 1992 prices, household consumption category)

Rural Consumption

Rural consumption of 10 categories is divided into two groups with one subgroup as shown in Table 9 on page 85. Soft constraints are applied to obtain the desired sign and magnitude of parameters. Two types of dummy variables are used in the estimation. Dummy 1, the same TianAnMen dummy as in urban PADS, is used for all but the last category, Other goods and services, which uses a dummy that equals 1 before 1992 and 0 since 1992. There appears to be a disruption in the trend between 1991 and 1992 for the last category, a miscellaneous category whose coverage may have changed. With no further information on the exact cause for the disruption, dummy 2 is used to adjust for ignorance on that matter. Estimated coefficients and statistics are shown in Table 13 and Table 14.

Estimation statistics in Table 13 show that standard errors of estimate are reasonably small for all but the last category. Because the objective function of PADS is to minimize the unweighted sum of standard errors of estimate in the system, larger categories often have significant influence on the parameters of smaller categories. Since the last category is the smallest of all the 10 categories and accounts for less than 1% of total expenditures in 1992, its parameters may have been heavily influenced by other categories in a simultaneous estimation process such as the PADS.

The estimated expenditure elasticities, in Table 13, suggest that 5 of the 10 categories are necessities, including two food categories, Clothing, Medicine, and Culture and education. Grain has the smallest expenditure elasticity at 0.32. For all the remaining categories, expenditure elasticities are significantly larger than 1, but the expenditure elasticity for category 10 appears to be a bit too strong.

Table 13 - Estimation Statistics of Rural PADS

Sec#	Title	G	S	D	lamb	share	IncEl	DInc	time%	PrEl	Err%	rho
1	Grains and products	1	1	1	0.72	0.152	0.32	-3.19	-2.02	-1.69	6.78	0.09
2	Meat and vegetables	1	1	1	-0.83	0.273	0.65	0.90	0.72	-0.55	1.15	-0.04
3	Other food	1	0	1	0.22	0.119	1.41	-0.25	0.08	-0.84	6.08	0.72
4	Clothing	2	0	1	0.61	0.086	0.97	0.64	0.00	-0.39	3.20	0.21
5	Housing	2	0	1	2.48	0.171	1.25	0.30	0.09	-1.76	2.66	-0.04
6	Household facilities	2	0	1	0.83	0.060	1.98	-0.41	0.03	-0.53	4.44	0.00
7	Medicines & med. eqp.	0	0	1	0.09	0.039	0.84	-0.18	2.74	-0.63	4.56	0.45
8	Transportation	0	0	1	0.64	0.020	2.30	0.40	1.33	-1.17	7.02	0.26
9	Culture and education	0	0	1	1.25	0.071	0.80	0.65	1.98	-1.63	4.04	0.08
10	Other goods and services	0	0	2	1.32	0.009	6.66	-0.21	0.05	-1.85	24.08	0.19

Note: G: group number; S: subgroup number; D: which dummy variable: D1 = -1 in 1989, 0 otherwise; D2 = 1 before 1991, 0 since 1991;
lamb: the lambda for each sector; share: expenditure share in base year;
IncEl: the income elasticity in base year; Dinc: the coefficient on the change in income divided by income coefficient;
time%:the annual change due to the time trend expressed as a percentage of the base year value; PrEl: the own price elasticity
Err%1 the standard error of estimate as a percentage of the base year value; rho: the autocorrelation coefficient of the residuals.
The per capita income, the change in income, and a common time trend are used in every equation.

Table 14 - Price Elasticities of Rural Consumption Categories

(The number in row i and column j is the elasticity
of product i with respect to the price of product j,
Consumption Categories and Groups are shown in Table 9)

	1	2	3	4	5	6	7	8	9	10
1	-1.69	0.12	0.17	0.11	0.55	0.09	0.03	0.03	0.14	0.02
2	0.54	-0.55	-0.01	-0.02	0.28	0.00	-0.03	0.00	0.03	0.00
3	0.29	-0.32	-0.84	0.07	0.46	0.06	0.01	0.02	0.11	0.01
4	0.20	-0.06	0.10	-0.39	0.45	-0.04	0.03	0.02	0.13	0.02
5	0.49	0.45	0.32	0.07	-1.76	0.07	0.10	0.06	0.27	0.03
6	0.24	0.00	0.12	-0.07	0.49	-0.53	0.04	0.03	0.15	0.02
7	0.12	-0.20	0.04	0.06	0.44	0.05	-0.63	0.01	0.10	0.01
8	0.21	-0.05	0.10	0.11	0.53	0.09	0.03	-1.17	0.14	0.02
9	0.30	0.12	0.18	0.16	0.64	0.12	0.05	0.04	-1.63	0.02
10	0.31	0.13	0.18	0.17	0.65	0.13	0.06	0.04	0.18	-1.85

Estimates of own price elasticities can be found in Table 13. For most sectors, they are comparable to the results for urban categories. In contrast to urban residents that are found insensitive to grain prices, rural residents appear to be very price sensitive to grain prices, with own price elasticity of –1.69.

Cross price elasticities are shown in Table 14 and appear problematic. Like urban categories, most rural categories are shown as substitutes with positive cross elasticities. A change in the grain price is found to have significant impacts on every other category, as suggested by positive off-diagonal elements in the first column in Table 14. Since rural residents are also suppliers of grain, this may imply that as grain prices rise, income of rural residents rises so that they will buy more other goods. The fifth column, Housing, also shows relatively strong substitution with other categories. Since Housing is the largest "luxury" and the second largest category overall, and it happens to be also very price sensitive, it is not surprising that a change in housing prices will have large impacts on other consumption expenditures.

Figure 9 displays graphically the actual and fitted values for the 10 rural consumption categories.

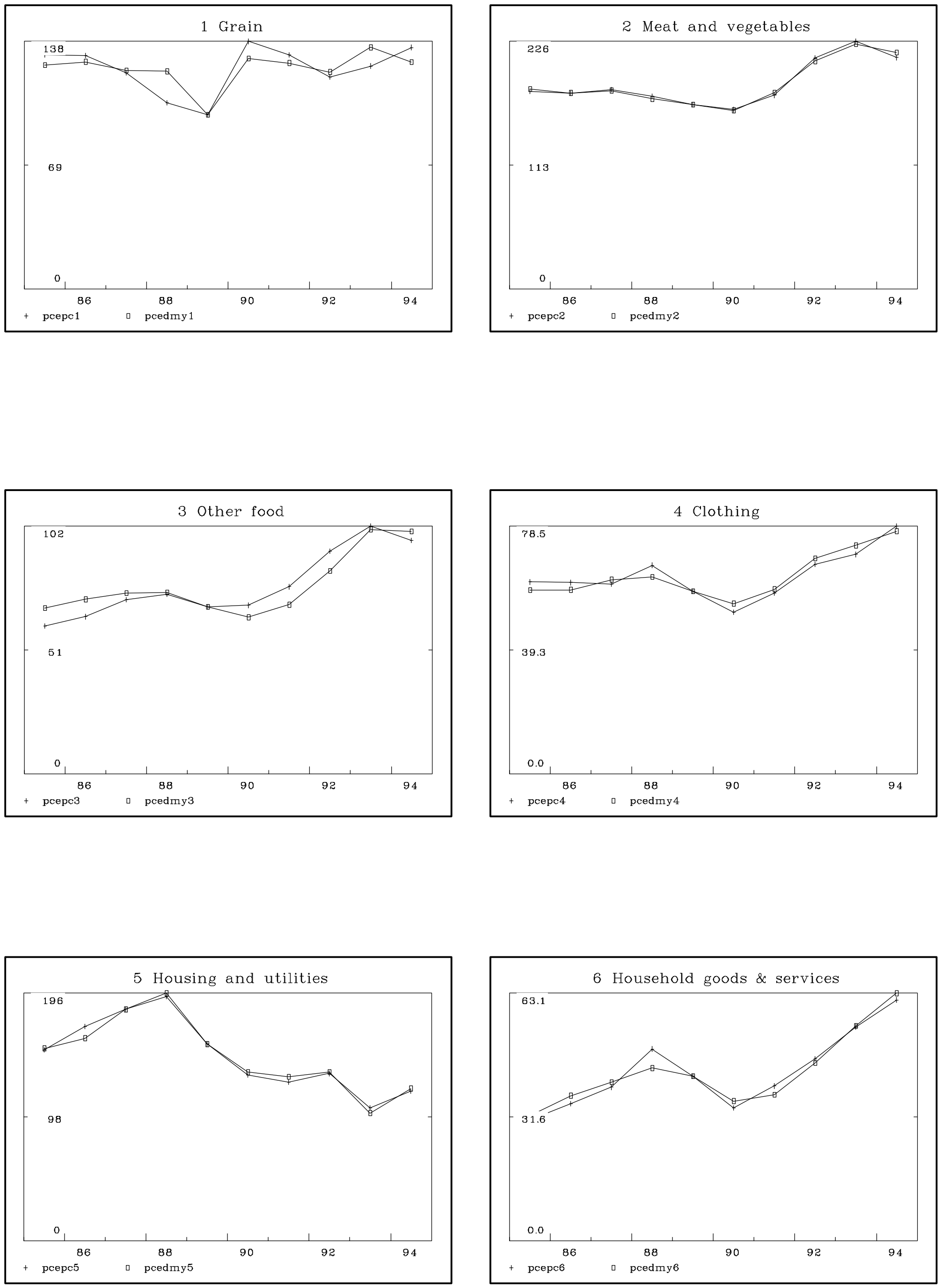

Figure 9 - Rural Consumption Per Capita

(yuan in 1992 prices, household consumption category)

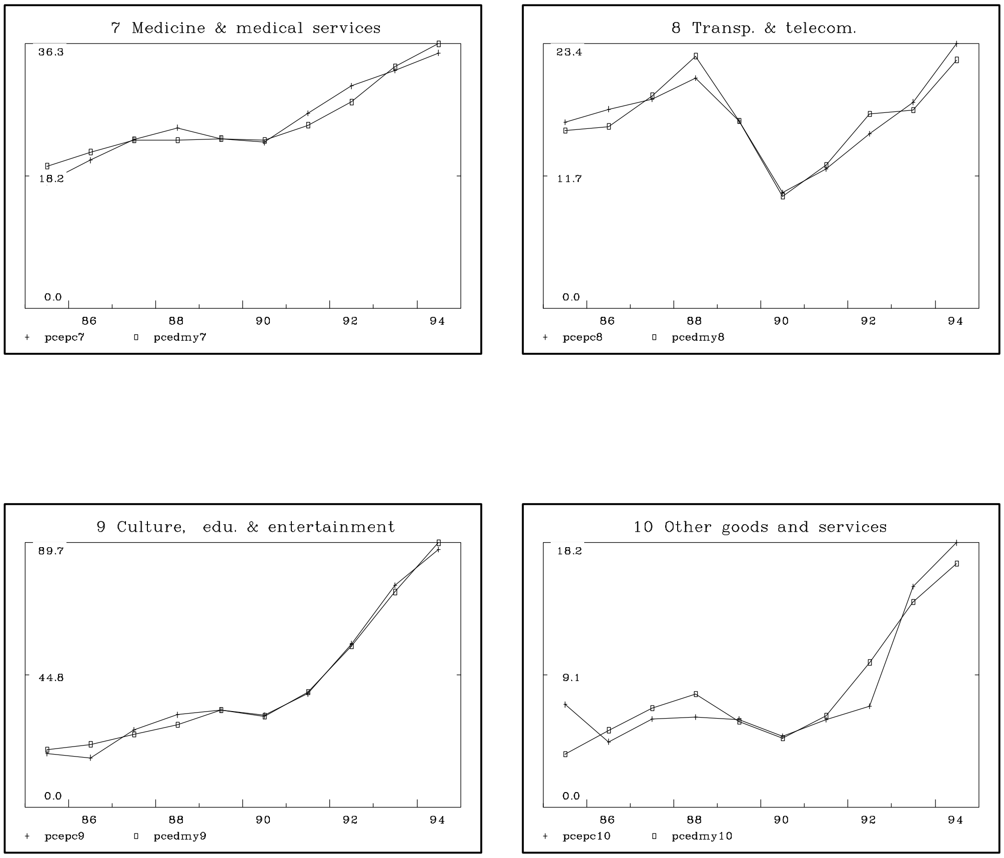

Figure 9 - Rural Consumption Per Capita (Cont.)

(yuan in 1992 prices, household consumption category)

CHAPTER V :

INVESTMENT

Introduction

Although fixed investment is a smaller part of final demand than private consumption, accounting for about 30% percent of GDP on average in China, it plays a very important role in economic analysis for at least two main reasons. First, it is one of the prime determinants of an economy's long term growth and productive performance. Therefore, anyone concerned with the long-term growth perspective of an economy will inevitably have to be concerned with investment. Second, investment fluctuates much more than consumption and other final demand, and is often associated with inflation and business cycles. Therefore, it is of particular interest in understanding economic dynamics.

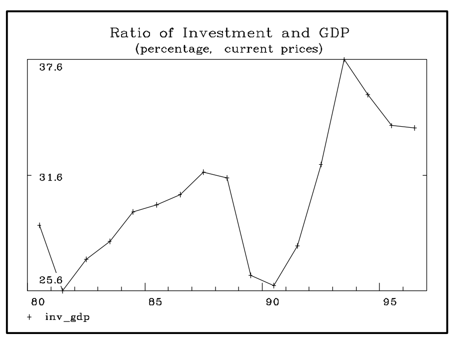

Figure 10 - Ratio of Investment and GDP

Economists have devoted much energy to understanding and explaining the determinants of investment, and there are many alternative investment models in the literature. In spite of economists' best efforts, investment is still one of the most difficult components to model and forecast. Because the majority of investment in China is accounted for by the government and state enterprises, whose behavior does not usually fit in the investment theory that is based on a market economy, the difficulty in modeling the investment behavior in the Chinese economy has been further aggravated.

There have been very few published studies on Chinese investment, particularly empirical studies. This scarcity of empirical studies on Chinese investment is certainly not an indication of researchers' lack of interest in that subject. Rather, it reflects the difficulties, theoretical and practical, that researchers have to deal with when studying Chinese investment. On the practical side, the lack of adequate data is probably the biggest obstacle for researchers to conduct empirical studies on Chinese investment. Although total investment data has been made available in recent years, there are only fragments of investment details. Most investment statistics in China cover only investment by the state-owned units (SOUs). Investment data for collective-owned units (COUs), private enterprises and individuals are scarce and only available for some aggregate totals without industrial details. The only exception is urban COU investment between 1985-91 for which there are data on investment by industry. Furthermore, frequent changes in coverage, severe inconsistencies among statistics, and deficiencies in other data such as gross output and output prices have aggravated the difficulty to conduct any meaningful time series analysis on sectoral investment in China. On the theoretical side, the biggest obstacle comes from the lack of adequate investment theory. While Janos Kornai's theory of investment of centrally planned economies appears very popular and applicable to pre-reform or the early stages of post-reform China, theories on the investment behavior in the transitional Chinese economy are yet to emerge.

Progress has been made in recent years in developing theories to explain the investment behavior of individual firms during the transitional period, (see Huang, 1996, for example.) But empirical studies have yet to catch up. As a result, most published studies on Chinese investment have used the conventional wisdom suggested by Kornai (for example, Imai, 1994.) Since the Chinese economy is in transition from central planning to a market economy, old fashioned macroeconomic controls and newly established market system are struggling to co-exist. Therefore, investment theories of both socialist and market economies appear to contribute some understanding on investment, but probably neither alone can explain it satisfactorily.

I have experimented with various specifications of investment function, and selected the accelerator model for this study. During the estimation of the accelerator model, an interesting and important aspect of the investment behavior in the Chinese economy emerged: the existence of a number of priority industries for investment in the Chinese economy. Throughout China's economic development, the government has attempted to identify and determine certain sectors of the economy as priorities for development. Once a sector is placed on the selected list of priority industries, the government will mobilize various resources, including financial investment, to support the development of the sector. Since the literature on modeling this type of investment behavior has been silent, I will propose an econometric approach that quantifies the information regarding priority industries and can then easily be applied to simulations.

The primary focus of the investment study in MuDan is not to propose any new investment theory. Instead, it is aimed to tackle the data problem by constructing a consistent time series of fixed investment by sector, and then to incorporate the data with a properly selected investment model to explain the determinants and make forecasts of investment. The function specification and estimation results of investment in MuDan are reported in this section.

Empirical Investment Modeling

There have been many investment models proposed by numerous authors, and there are several comprehensive surveys on empirical investment studies. (For example, Jorgenson, 1971; Meade, 1990; Serven, 1992; Kopcke, 1993; and Chirinko, 1993.) Simpler models such as the autoregressive and accelerator models use fewer variables such as lagged investment, output, and capital stock as explanatory variables. More elaborated models such as Cobb-Douglas, CES, generalized Leontief putty-putty and putty-clay, and Tobin's q usually include additional variables such as output prices and cost of capital under neoclassical market equilibrium conditions.

Among the alternative investment functions, the accelerator model is chosen for MuDan. This choice is made based on several considerations. First, the accelerator model appears the most flexible and capable of accommodating investment under both market and planning economies while many other investment models are more geared toward explaining investment in market economies. The investment response to output is particularly appealing to explain investment in the Chinese economy because it has often been argued that state-owned enterprises act to maximize output or employment, not profits (Huang, 1996, for example) while the cost of capital is often ignored in making investment decisions. Therefore, the accelerator variable of the change in output appears to be a more important factor in determining investment than other factors such as the cost of capital. Second, the accelerator model is simple to estimate. This is particularly important for MuDan because lack of statistical data has been a major problem for developing a China model. Third, all explanatory variables are readily produced within MuDan, making investment easily forecasted in the model. Fourth, the contemporaneous and lagged response of investment to output adds dynamic flavor to the investment demand and makes the model more attractive. Last but not least, the model fits historical data fairly well and it has a fairly good track record, not only in INFORUM type models, but also in other studies. (For example, Kopcke, 1993; Cortes et al., 1993; Werling, 1992; Ford and Poret, 1991; and Meade, 1990.) Meade (1990) provides a survey of investment models and, by using the US industrial investment data from 1953 to 1985, estimates eight alternative specifications, including autoregressive, accelerator, Jorgenson Cobb-Douglas, CES, generalized Leontief putty-putty and putty-clay, and dynamic factor demand models. These alternative specifications were applied in LIFT, an INFORUM macroeconomic and multisectoral model of the US economy. Based on out-of-sample simulation, he finds that in general the Generalized Leontief, the Cobb-Douglas, and the Accelerator models perform better than the other models.

Cortes et al (1993) compares the explanatory power of five theories of business fixed investment, including accelerator, accelerator-cash flow, q, standard neoclassical, and modified neoclassical, for each of 104 manufacturing firms for the 1960-84 period. Their main finding is that no single theory provides a generally better explanation of the historical investment behavior of the firms than others. The results show that the accelerator-cash flow model explains investment behavior for more firms than any other model but it accounts for only a third of the firms. The standard and modified neoclassical models explain the least number of firms while the q and accelerator models rank in between. Findings from non-nested tests generally support the previous results. The accelerator model in Kopcke (1993) also appears consistently among the better ones among five alternatives, including q, neoclassical, cash flow, and autoregressions with or without output.

The Accelerator Model in MuDan

There are many versions of accelerator models. While exact specifications are different, they all share the same two basic assumptions. The first is the capital stock adjustment assumption. Firms have a desired capital stock, which is not necessarily the same as the capital stock they have actually had. They invest to close a certain fraction of the gap, if exists, between the desired capital stock and the actual stock. The second is the output response assumption. A firm's desired stock of capital is assumed to be directly dependent on its level of output, and the output is assumed and often found to be more important in explaining investment expenditures than relative prices or other variables such as wages, taxes and interest rates (Meade, 1990). While some specification assumes an "ideal" capital-output ratio, others specify that investment respond to the changes in output. The accelerator model in MuDan uses the later assumption.

Under the two basic assumptions, an accelerator model can determine net fixed investment. To determine gross investment, a replacement investment term has to be added to the basic accelerator model. The accelerator model that MuDan uses is:

$$I_{it} = a_0 + a_1 * dq_{it} + a_2 * dq_{i,t-1} + a_3 * dq_{i,t-2} + a_4 * w_{i,t-1} + a_5 * D \qquad (1)$$

where I_{it} = gross investment expenditure of sector i at time t,

dq_{it} = difference between real output of sector i at t and its lagged value,

$w_{i,t-1}$ = "wear-out" of the physical capital stock of sector at the end of t-1,

D = a dummy variable.

All coefficients are sector-specific, therefore should be thought of having a sector subscript *i*. Coefficients of *dq*'s are expected to be non-negative. The coefficient of the "wear" w_{it}, which is calculated as the depreciation spilling out of the first "bucket[7]" of capital stock as described in the following paragraphs, is expected to be close to 1 because it represents replacement investment. The dummy variable *D* is used to account for the unusual investment behavior observed around 1989 and it has three forms, which will be indicated along with the simulation results. Because the dummy is constructed as having non-positive values, the coefficient of *D* is expected to be positive. A description of the dummy variables that are used in the estimation is provided along with the estimation results at the end of this section.

The depreciation or the "wear-out" variable is calculated based on the computed capital stock in MuDan. Because there is not enough information available on the service lives of physical capital in China, a depreciation rate of 8 percent per year is assumed for all sectors. This rate is probably a bit too high for buildings and low for computing equipment and motor vehicles. As an intuitive estimate, it seems to have fit the data fairly well. Principally, capital stock K_{it} can be computed as

$$K_{it} = (1 - d_{it}) * K_{i,t-1} + I_{i,t} \tag{2}$$

where K_{it} = capital stock of sector i at the end of time t;

d_{it} = depreciation rate for sector i at t, uniformly chosen as 0.08 in MuDan.

However, because the investment series in MuDan is very short and starts only in 1981 prior to which time we do not have any capital stock data, we can't simply use Eq. (2) to compute K_{it}. If we do use Eq. (2) to compute K_{it} with $K_{i,1980}$ set to zero, K_{it} will increase very rapidly at the beginning and then slow down. The K_{it} computed in such a way is far from realistic and can't be used in the model. This initial "filling problem" is illustrated by imagining filling water into an empty bucket (with a hole in it)

[7] The calculation of capital stock and replacement in the context of "bucket" and "spills" is developed in more detail in Almon (1994).

under a water faucet in Almon (1994). At first, the water level rises rapidly, but gradually the outflow through the hole increases, the rate of rise diminishes and, if the inflow is steady, the bucket fills to an equilibrium level. If the time series on investment is so long that nearly all of the investment in the initial period will have "spilled out" by the time that we want to use the stock series, we need not worry about this "filling problem." However, if the investment series is very short, we cannot ignore the initial filling problem. This is exactly the problem we have. Therefore, the capital stock as computed in Eq. (2) must be adjusted to be useful. In MuDan, the capital stock K_{it} is adjusted by a "unit" bucket, which is simply one into which the input is 1.0 each period. In the case of Eq. (2), a unit bucket, K_t^1, is computed as K_{it} according to Eq. (2) with $d_{it} = 0.08$, $I_{it} = 1$, and $K^1_{1980} = 0$. The adjusted capital stock, K_{it}, that is actually used in MuDan is computed by

$$K_{it} = [(1-d_{it})*K_{i,t-1} + I_{i,t}]/(d_{it}*K_t^1) \tag{3}$$

And the depreciation or wear-out w_{it} , or $d_{it}*K_{it}$, is computed by

$$w_{it} = [(1-d_{it})*K_{i,t-1} + I_{i,t}]/K_t^1 \tag{4}$$

The accelerator terms in the basic form include the change in industry output variable dq_{it} at time t and its two lagged values. However, the dq_{it} or the $dq_{i,t-2}$ term is dropped from the equation if its coefficient does not have the desired positive sign. For two sectors, the sectors of 39 Railway transportation and 51 Scientific research and polytechnic services, I have been unable to obtain meaningful coefficients to fit the data with the basic version of Eq. (1). As an alternative, I have used the differences of real GDP in the place of sectoral output, and obtained very good fits. This seems fairly reasonable. Investment in railways is typically of long term forward looking, and certainly beyond our specification of two or three years. Therefore, the poor fit from using Eq. (1) to forecast railway transportation investment should not be surprising. Since the output of sector 51 Scientific research and polytechnic services is probably not well defined and investment in scientific research does not necessarily respond to changes in output, the poor fit in that sector also seems understandable.

The sectoral equations have been estimated for several variations of the basic form. When necessary, the Almon lag is applied to smooth the coefficients on the accelerator variables, and the coefficients on the wear-out variable are softly constrained to equal one. As evident from the estimation results in Table 15, the coefficients on the accelerator variables still jump around quite a bit for some sectors. The coefficients on the wear-out variables are close to one for most sectors; for some other sectors, they are significantly larger than one. This appears an indication that there are factors that cannot be explained by our simple specification. For example, it might be that expected output is growing faster than what could be explained as a distributed lag of past changes in output. It might also be some other factors that are important in determine investment and are missing in our specification. Obviously, additional efforts are need to remedy the deficiencies of the specification.

Table 15 - Regression Results of the Sectoral Investment Equations

Sec#	Title	Const.	Dummy	dqR	dqR[1]	dqR[2]	WearOut	Rbsq
1	Agriculture	-105.40	8.84	0.049	0.275		0.951	0.64
2	Coal mining	27.23	27.02		0.118	0.118	0.925	0.68
3	Crude petroleum and natural gas production	93.74	42.33	0.026	0.059	0.092	0.951	0.49
4	Ferrous ore mining	-4.93	7.76	0.629	0.688	0.318	0.921	0.78
5	Non-ferrous ore mining	1.85	9.46	0.043	0.058	0.537	1.006	0.33
6	Non-metal minerals, and mining n.e.c.	7.94	6.35	0.037	0.020	0.013	1.066	0.77
7	Logging and transport of timber and bamboo	-3.81	5.34		0.036	0.024	0.793	0.23
8	Food process & manufacturing	1.79	56.72	0.025	0.108	0.129	1.036	0.97
9	Beverages	23.05	38.62	0.030	0.098		0.923	0.78
10	Tobacco manufacture	-6.73	8.03	0.075	0.063	0.027	2.071	0.90
11	Textiles	20.71	67.04	0.025	0.086	0.025	1.151	0.81
12	Wearing apparel	11.46	26.12	0.072	0.065	0.063	1.080	0.91
13	Leather, fur and their products	3.10	7.61	0.063	0.031	0.040	1.051	0.85
14	Sawmills and bamboo etc. products	2.27	2.12	0.114	0.079	0.040	1.130	0.88
15	Furniture	2.79	4.81	0.025	0.026		1.105	0.82
16	Paper and paper products	14.46	10.53	0.145	0.013		1.143	0.81
17	Printing industries	-3.11	6.12	0.164	0.168	0.078	1.043	0.98
18	Cultural, education, sports articles	-0.49	2.66	0.099	0.104	0.074	1.061	0.87
19	Petroleum refineries and coking products	0.76	20.12	0.012	0.035	0.505	1.280	0.96
20	Chemical industries	52.35	56.97	0.106	0.128	0.059	1.026	0.87
21	Medicines	2.96	2.06	0.105	0.112	0.035	1.138	0.82
22	Chemical fibres	-16.75	12.99	0.265	0.472	0.367	1.161	0.82
23	Rubber products	1.88	8.88	0.064	0.197	0.083	1.160	0.75
24	Plastic products	-4.73	13.60	0.120	0.135	0.128	0.992	0.88
25	Building materials and other non-metallic mineral	-16.84	60.00	0.169	0.252		1.206	0.92
26	Primary iron and steel manufacturing	-2.37	49.64	0.123	0.130	0.168	1.167	0.83
27	Primary non-ferrous metals manufacturing	3.78	37.77		0.033	0.075	1.677	0.67
28	Metal products	-12.15	16.96	0.107	0.111		1.635	0.81
29	Machinery	33.15	40.90	0.069	0.059	0.024	0.992	0.97
30	Transportation equipment	17.84	26.30	0.061	0.095	0.069	1.070	0.95
31	Electric machinery and instrument	5.48	34.67	0.064	0.115		1.075	0.91
32	Electronic and communication equipment	0.65	29.16	0.077	0.118	0.179	1.047	0.85
33	Instrument, meters and other measuring equipment	2.47	4.63	0.048	0.044	0.108	0.996	0.98
34	Industries n.e.c	-4.53	6.76	0.055	0.087		0.953	0.86
35	Electricity, steam and hot water production and s	-111.60	133.90	0.098	0.071		2.389	0.86
36	Gas production and supply	13.50	14.43	0.093	0.096	0.106	1.013	0.43
37	Production and supply of water	2.74	0.73	0.860	0.763	0.973	1.092	0.92
38	Construction	-31.93	11.69	0.046	0.044		1.352	0.74

Table 15 - Regression Results of the Sectoral Investment Equations (Cont.)

Sec#	Title	Const.	Dummy	dqR	dqR[1]	dqR[2]	WearOut	Rbsq
39*	Railway transportation	-32.98	126.60		0.032	0.037	1.015	0.93
40	Highway transportation	-182.80	89.17		0.311	0.211	3.581	0.92
41	Water transportation	-122.80	65.85	0.537	0.087	0.194	2.996	0.76
42	Air transportation	-5.64	14.40	0.752	0.699	0.277	1.647	0.71
43	Pipeline transportation	0.15	5.21	0.932	1.042	1.039	0.691	0.54
44	Communications	-55.05		1.156	1.002	0.814	2.264	0.96
45	Commerce	187.10	524.10	0.058	0.093	0.446	1.336	0.91
46	Restaurants	0.30	2.04	0.016	0.008		0.998	0.80
47	Finance and insurance	-47.93		0.154	0.159	0.142	1.344	0.87
48	Real estate and social services	502.40	169.70	0.135	0.211		1.082	0.94
49	Health care, sports and social welfare	42.66	30.62	0.202	0.159		0.958	0.61
50	Education, culture, arts, radio, film and televis	54.18	37.04	0.164	0.239		0.846	0.37
51*	Scientific research and polytechnical services	7.16	28.95		0.011		0.996	0.88
52	Public administration and others	220.30	232.20	0.325	0.134	0.219	1.091	0.95

Notes: * Sectors 39 and 51 use the difference of real GDP and its lagged value as the accelerator variable
Following four dummy variables are used in the estimation:
Dummy 1: It equals -1 in 1989, and zero otherwise.
Dummy 1 is used in sectors 3, 32, 36-38, 42, 43, 48, and 51.
Dummy 2: It equals -1 in 1989-90, and zero otherwise.
Dummy 2 is used in sectors 1, 6, 8, 10, 13, 17, 19-21, 24-26, 28-31, 33, 34, 39 and 40.
Dummy 3: It equals -1 in 1989-91, and zero otherwise.
Dummy 3 is used in sectors 4, 5, 9, 11, 12, 14-16, 18, 22, 23, 27, 35, 41 and 50.
Dummy 4: It equals -1 in 1981-90, and zero otherwise.
Dummy 4 is used in sectors 2, 7, 45, 46, 49 and 52.
Dummy 4 is used to accout for two obviously distinct trends in the data.

Modeling Priority Investment Sectors

A close examination of the sectors that have coefficients on w_{it} significantly larger than one reveals some similarities of these sectors. Table 16 lists eight sectors that display the largest coefficients on $w_{i,t-1}$, all greater than 1.6. Seven of the eight sectors are in energy, transportation, communication, and raw material production sectors, the sectors with the highest priority in investment by the government. The development of these infrastructure sectors is the key to the future development of the

Chinese economy, and investment in these sectors is apparently beyond the explaining power of the accelerator variables and the simple replacement of capital stock. While these seven sectors are certainly the ones for the future, the only exception in that group is the tobacco industry, a rather unfortunate appearance in this group. The tobacco industry has been a cash cow, at least on the surface, for the government in recent years. For example, Table 17 compares Tobacco with Textile, a traditional industry that employs a lot of people, and all industrial sectors in 1996. It is apparent from the table that Tobacco is a very small industry that requires very few resources, 1.2% of investment and 0.4% of employment of all industries, but it generates almost 40% of sales taxes and extra charges that are levied by the government.

Table 16 - Regression Results of Key Investment Sectors

Sec#	Title	Const.	Dummy	dqR	dqR[1]	dqR[2]	WearOut	Rbsq
40	Highway transportation	-182.80	89.17		0.311	0.211	3.581	0.92
41	Water transportation	-122.80	65.85	0.537	0.087	0.194	2.996	0.76
35	Electricity, steam and hot water production and s	-111.60	133.90	0.098	0.071		2.389	0.86
44	Communications	-55.05		1.156	1.002	0.814	2.264	0.96
10	Tobacco manufacture	-6.73	8.03	0.075	0.063	0.027	2.071	0.90
27	Primary non-ferrous metals manufacturing	3.78	37.77		0.033	0.075	1.677	0.67
42	Air transportation	-5.64	14.40	0.752	0.699	0.277	1.647	0.71
28	Metal products	-12.15	16.96	0.107	0.111		1.635	0.81

This observation brings us to an important modeling issue in MuDan. It is obvious that the government still plays an important role in fixed investment in China. For a model to be useful and flexible, it seems necessary to introduce additional policy variables in order to reflect the government's priority of investment in the future. For example, while the extra investment in Tobacco has happened in the past, it may not, and better not, continue in the future. There are projects such as the construction of the Three-Gorge Dam that is undoubtedly beyond the model's ability to forecast simply based on history. Obviously, these special situations require special attention by a model.

Table 17 – A Comparison of Tobacco and Textile Industries

(For Industrial Enterprises with Independent Accounting System, 1996)

	Employment		Investment		Gross Output		Gross Profits		Sales Taxes	
	000s	% of Total	Bil. Yuan	% of Total	Bil. Yuan	% of Total	Bil. Yuan	% of Total	Bil. Yuan	% of Total
Total, All industries	81,870	100.0	605.7	100.0	6,274.0	100.0	514.7	100.0	118.1	100.0
Tobacco	309	0.4	7.3	1.2	120.2	1.9	69.0	13.4	46.2	39.2
Textiles	8,104	9.9	12.7	2.1	472.2	7.5	1.9	0.4	7.8	6.6

In order to model investment priorities, MuDan has introduced a vector of 52 investment policy variables, which is formed in terms of replacement needs. By default, the value of the policy variable for each sector in the forecast period is set to equal the difference between the coefficient of the wear-out variable in the investment equation and 1. Therefore, the default value of the investment policy variable for sector *i* is zero if the coefficient of $w_{i,t-1}$ for investment in sector *i* is exactly one, or that replacement investment in sector i is exactly 8 percent of existing capital stock. If the coefficient of $w_{i,t-1}$ is estimated as greater than one, the default value of the policy variable for sector i is positive, an indication that the sector incurred some priority treatment in investment in the past.

The advantages of using such a policy variable are obvious. Firstly, because the policy variable contains clear economic meaning, it can be easily explained. Secondly, since the information regarding priority investment is built naturally in the investment function through the policy variable, exogenous assumptions on investment policies such as priority industries can be easily incorporated into the model. Thirdly, because of the dynamic nature of investment in MuDan, an investment policy change modeled through a change in the value of the policy variable can have profound impact on the simulation results of the model.

The use of the policy variable is simply and intuitive. If no change on investment policy is foreseen, the policy variables can be set to equal the historical values. If a historically important sector is foreseen to become a normal or less important industry, such as the Tobacco industry, the positive values of the policy variables can be reduced in simulations. To investigate the impact of increasing the priority of investment in an industry, on the other hand, the value of the policy variable can be set to above the historical values. Since the values of the policy variables can be set for any particular year for each industry, the experiment of policy changes can be very flexible. Therefore, the introduction of such a vector of investment policy variables provides convenience to conduct policy simulation on investment.

Aggregate Investment Function

In addition to the sectoral investment functions, MuDan also has an aggregate investment equation that is estimated separately from the sectoral investment functions. During a simulation, the use of the aggregate investment function is optional. When the aggregate investment function is used, sectoral investment expenditures that are estimated in sectoral investment functions will be scaled to match the aggregate investment that is estimated from the aggregate investment function. When the aggregate investment function is not used, however, sector investment will be determined by the sectoral investment functions and the aggregate investment will be computed as the sum of the estimated sectoral investment.

There are three primary reasons to allow the possibility of letting aggregate investment determine sectoral investment. First, because reform of public ownership has lagged behind overall economic reform, SOUs and many COUs are still subject to soft budget constraints. An investment rush emerges whenever government loosens the money supply. Therefore, there is no strong market force that keeps investment in check. Consequently, government intervention or control over investment decisions remains one of the major forces that prevent investment from over-expanding. Second, the government in China maintains investment controls at the aggregate level. It is also directly or indirectly involved in business decision making of enterprises, SOUs and COUs in particular. For example, investment projects need government approval and are subject to government planning or macro control. When the economy overheats, the government can apply the brakes by disapproving certain projects or forcing some investment projects to stop. The government can also influence investment indirectly through monetary policies. In the past, it maintained planning of the size of the funds that could be issued as loans by banks. More recently, the interest rate and the reserve requirement of banking institutions have become the tools to exercise its desire of influencing the national economic activities since the central bank of China does not have the power to conduct independent monetary policies and has to follow the government's directives. Because the aggregate investment equation is influenced by the monetary variables while the sectoral equations do not, scaling sectoral investment by an aggregate total is intended to be an imitation of these kinds of processes. Third, it is easier for the aggregate investment to respond to the macroeconomic conditions such as inflation and money supply whose impact on sectoral investment may not easily be caught by the sectoral investment functions.

The aggregate investment function also uses the specification of an accelerator model in which the difference between total gross output is used as the accelerator variable. Total real investment spending is explained by the accelerator variable *dqRtot* and its two lagged values, a wear-out variable *w1k*, the two-year moving average of the M2 and nominal GDP ratio *rmgma*, and the TianAnMen dummy *d89*, which equals –1 in 1989 and 0 otherwise. The wear-out variable *w1k* is computed as the sum of sectoral wear-outs. The results of the estimated aggregate investment equation are presented in Table 18 and Figure 11.

There are two soft constraints applied to the estimation of the aggregate investment function. For the accelerator variable *dqRtot* and its two lagged values, their coefficients are constrained to lie in a second-degree polynomial. The coefficient of the wear-out variable is constrained to be one. Therefore, the coefficients on all the explanatory variables have desired signs and reasonable magnitude, and, based on the significant adjusted R^2 value of 0.985, the equation has a reasonable fit even after the soft constraints are applied. As suggested by the equation, the reduction in investment in 1989 was approximately 74 billion yuan.

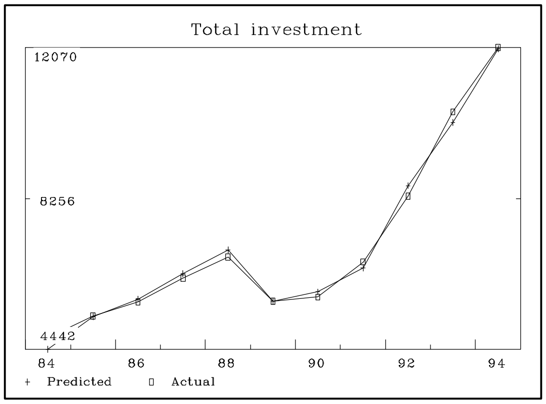

Figure 11 – Estimation of Aggregate Investment

Table 18 - Regression Results for Aggregate Investment

Aggregate Investment

SEE = 170.56 RSQ = 0.9940 RHO = -0.15 Obser = 11 from 1984
SEE+1 = 165.36 RBSQ = 0.9850 DW = 2.29 DoFree = 4 to 1994
MAPE = 2.08

Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0 invtot	- - - - - - -	- - - -	- - - -	- - -	- - - -	7052.75
1 intercept	-1965.109	51.5	-2.972	-0.28	118.01	1.00
2 dqRtot	0.193	***	***	0.15	50.16	5485.84
3 dqRtot[1]	0.189	***	***	0.12	45.02	4431.25
4 dqRtot[2]	0.061	***	***	0.03	44.76	3882.88
5 w1k[1]	0.979	***	***	0.63	2.95	4519.89
6 rmgma	3857.714	54.4	3.071	0.36	1.61	0.65
7 d89	739.104	26.8	2.033	-0.01	1.00	-0.09

Note: *** indicates the variables are soft constrained.

CHAPTER VI :

FOREIGN TRADE AND OTHER FINAL DEMAND

Foreign Trade

The Chinese economy has achieved spectacular growth in foreign trade since the 1980s, and the growth in the foreign trade sector has brought positive changes in the national economy. From 1979 to 1997, the total value of imports and exports grew from $29.3 billion to $325.1 billion with an average annul growth of 14.3%. During the period, China maintained trade balances or surpluses for the most of the time. Strong exports accompanied by an influx of foreign investment has resulted accumulation of a sizable foreign exchange reserve, which in 1997 reached $140 billion from a mere $2 billion in 1979. Furthermore, strong exports have become a main growth engine of the Chinese economy, as the ratio of export to GDP measured in current prices was almost tripled from 13% in 1979 to 35% in 1996. In addition, the transition from autarky to an open economy has helped improve the efficiency and competitiveness of the Chinese economy.

The foreign trade segment in the MuDan model is represented by a set of import share equations, which attempts to estimate the behavior of domestic demand on foreign products. MuDan does not include a foreign demand equation system. Foreign demand on Chinese products is derived from the INFORUM international model system, and is therefore exogenous to MuDan but endogenous to the INFORUM international system, which includes MuDan as a member model. In this section, I first describe the relationship between MuDan and the International System, and then present the functional form and estimation results of the import functions that are used in MuDan.

The INFORUM International Model System and MuDan

The INFORUM International Model System is composed of a group of national interindustry macroeconomic models, most of which are constructed and maintained by INFORUM's partner groups in the respective countries. All national models share a structure similar to MuDan and use a common software package, called InterDyme, which has been developed by INFORUM. At present, the active national models include those of Austria, Belgium, Canada, China, France, Germany, Italy, Japan, Mexico, Spain, South Korea, the United Kingdom, and the United States. Several other national models are expected to join in the system soon. The new partner groups, which include those from Denmark, the Netherlands, Hungary, Poland, Russia, and Switzerland, are actively involved in developing their national models.

The heart of the INFORUM International Model System that links national models is a multisectoral bilateral trade model, the Bilateral World Trade Model (BTM), which provides trade linkages among the national models and ensures strict accounting consistency of trade forecasts from country to country. Specifically, BTM takes the sectoral export prices and capital investment from the national models in the national sectoring schemes and converts them into the trade model classification. Based on the national projections, BTM forecasts, for 120 commodity categories that are aggregated from 5-digit SITC classes, 120 trade-share matrices, each of which shows the import shares of a product in the columns by country or region. The International System then takes as given each national model's import projection in the national sectoring schemes, converts it into the BTM commodity classification, and then allocates them through the trade-share matrix to their source countries. Summing the allocations to each exporter across importers gives exports by product by exporter in the BTM nomenclature, which are then translated into respective national classification schemes for use in the national models. The process is repeated until an equilibrium solution is achieved. A complete description of BTM is found in Ma (1996).

MuDan maintains a close relationship with the INFORUM International Model System through the information exchange on imports and exports. Chinese imports by product are endogenously determined in MuDan. Exports from China, however, are determined in the INFORUM International Model System, therefore exogenous to MuDan. When MuDan is run with the international model system, MuDan's imports and exports are simultaneously determined. When MuDan is run independent of the international system, MuDan's exports are exogenously determined, usually by a previous run of the international system.

Imports and Exports Data

Assembling a coherent time series data set on China's foreign trade statistics proves to be quite a challenge. Because China's official publications on foreign trade statistics are incomplete, I have to rely on additional sources to construct the time series for MuDan. In constructing the data set, two major difficulties were encountered. The first was to find a reliable source for imports and exports, and the second was to maintain the consistency between the constructed imports and exports series and the published national accounts and I-O accounts. This section describes the primary source for MuDan's imports and exports by sector, and the procedures that were undertaken to construct the time series foreign trade data for MuDan.

Finding a reliable source for imports and exports turns out to be relatively easy. As a member of the United Nations, China is obligated to provide detailed trade statistics to the United Nations every year. Based on the United Nations trade statistics, Statistics Canada has constructed a world trade database (WTD), which provides all international trade flows between UN members. The trade statistics in the

WTD is broken down by commodity by the Standard International Trade Classification, Revision 2 (SITC Rev. 2). The highly disaggregated details and long time period (1980 to 1994) on China's imports and exports in the WTD are desirable for constructing the time series data for the MuDan model. Therefore, the 1997 version of the WTD was selected as the principal source for constructing the import and export series for MuDan, covering annual data for the period from 1980 to 1995 and 600 commodities.

Constructing the time series of imports and exports by sector for MuDan based on the WTD trade data was a more difficult task than locating the data source. Because trade data in the WTD are classified by the SITC, which is very different from China's Standard Industry Classification and Codes (SICC) for National Economic Activities on which the I-O tables and the MuDan model are based, a conversion of the WTD data from the SITC to MuDan sectors is necessary. In most cases, the conversion from the SITC to MuDan is a one-to-one mapping, although it is not always clear whether a SITC code should belong to a particular MuDan sector. In some other cases, however, the conversion involves a one-to-many mapping in which a SITC code must be split into several MuDan sectors. For example, the SITC code 8510 Footwear covers footwear of any materials. In the SICC system and therefore the MuDan sectoring scheme, however, shoes are classified according to the materials that they are made of. Therefore, leather shoes are included in Leather Products (MuDan sector 16); rubber or plastic based shoes are in Rubber (MuDan sector 26) or Plastic products (MuDan sector 27). The one-to-many conversions from SITC to MuDan can be very troubling, involving a specific breakdown of exports and imports in the SITC code. Such a breakdown can introduce errors, especially if the trade volume classified by the SITC code is significant, such as in the case of Footwear.

Complicating the conversion process, however, is the fact that the control totals for exports and imports are not separately available. In China's national accounts, foreign trade is published in terms of net exports, and there is no separate account on imports or exports.[8] In China's input-output accounts, the foreign trade column also is given in terms of net exports rather than separate imports and exports columns. This peculiar presentation of net imports without exports and import details is often thought to be deliberate, designed to avoid revealing state subsidies on exports. Because exports and imports are presented as net exports, there lacks information for us to verify whether a particular conversion is appropriate. In general, the net exports from the constructed exports and imports for a particular MuDan sector are always different from the net exports as published in the I-O table. The lack of exports and imports published separately means that one can't identify whether the problem lies in the exports or imports or both[9].

Converting exports and imports from the SITC into MuDan sectors was an experiment process. At the outset of the conversion, exports by the SITC in the WTD were scaled so that, for each year, the sum of exports equals the total exports as published in the yearbook. Imports from the WTD were also scaled to ensure that the sum of imports equals the total imports in the yearbook. A mapping scheme was then devised from the SITC to the SICC or the MuDan sectors. The 1992 imports and exports from the WTD were then converted, according to the mapping scheme, into

[8] China does publish the total values of merchandize exports and imports. However, exports and imports of services are not available. Therefore, one cannot compute total imports or exports based on published sources.

[9] In theory, the conversion from SITC to SICC for exports can be different from the one for imports because of the existence of the one-to-many mappings. For example, the proportion of leather shoe exports in total exports of footwear can be different from the proportion of leather shoe imports in total imports of footwear. In practice, however, I used the same mapping scheme for both exports and imports due to a lack of information that may be used to identify the different proportions for imports and exports.

MuDan sectors and the net exports were computed and were compared with the net exports from the 1992 I-O table. For sectors with significant differences, the mapping was revised. The revision of the mapping scheme involves correcting possible mismatches and, in cases where a SITC code is mapped to several MuDan sectors, the assumed proportions of the SITC code to each MuDan sector were adjusted. In revising the mapping scheme, publications such as the statistical yearbooks, when applicable, were consulted to verify the reasonableness of the WTD figures. After the data were verified, corrected if necessary[10], and the mapping scheme was revised, the conversion of the WTD data was repeated.

The final version of the SITC to MuDan conversion was reached as a result of close collaboration with several Chinese experts on the subject[11]. The conversion scheme for exports and imports as used in MuDan is shown in Table B.1 in Appendix B. Table 19 shows the estimated exports and imports by sector in 1992.

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[10] I was not able to find any apparent errors for the 1992 figures. However, when the SITC to MuDan conversion mapping was finalized, and the WTD data were converted into MuDan sectors, erroneous import figures for MuDan sectors 15 for 1991 and 37 for 1984 to 97, and export figures for MuDan sector 34 for 1988, 1990 and 1991 were observed. In all these cases, unreasonably huge deviations from adjacent years in the magnitude of hundreds of percent occurred. Cross checking the figures tended to suggest that they were errors rather than what happened to the sectors during the years. These numbers were replaced by the linearly interpolated figures.

[11] In finalizing the conversion scheme, I benefited from discussions with Professor Shantong Li and Dr. Fang Zhai of the Development Research Center of China State Council, and Professor Shengchu Pan of the Central University of Finance and Economics of China.

Table 19 - Estimated Exports and Imports in 1992 from the WTD

(100 Mil. Yuan)

	MuDan Sector	Exports in WTD	Imports in WTD	Estimated Net Exports	Net Exports as in I-O
1	Farming	180.0	107.5	72.5	49.2
2	Forestry	3.9	17.5	-13.6	-12.5
3	Livestock	42.5	19.2	23.3	19.4
4	Fishing	20.3	1.5	18.8	19.6
5	Coal mining	40.4	1.9	38.5	40.9
6	Crude petroleum and natural gas production	136.2	52.2	84.0	-44.5
7	Ferrous ore mining	0.4	38.3	-37.9	-51.0
8	Non-ferrous ore mining	10.9	8.5	2.4	6.6
9	Non-metal minerals, and mining n.e.c.	30.1	7.4	22.7	13.8
10	Logging and transport of timber and bamboo	3.8	24.2	-20.4	-23.7
11	Food process & manufacturing	268.5	93.4	175.1	154.3
12	Beverages	37.2	13.4	23.8	40.6
13	Tobacco manufacture	21.5	15.6	5.9	7.5
14	Textiles	759.4	477.0	282.4	366.8
15	Wearing apparel	587.4	16.6	570.8	609.3
16	Leather, fur and their products	303.1	103.0	200.1	208.9
17	Sawmills and bamboo etc. products	9.4	44.3	-34.9	-39.8
18	Furniture	86.0	16.1	69.9	96.0
19	Paper and paper products	74.3	123.6	-49.3	-64.4
20	Printing industries	5.0	10.6	-5.6	-5.7
21	Cultural, education, sports articles	91.2	19.9	71.3	73.0
22	Petroleum refineries and coking products	77.0	98.9	-21.9	-30.2
23	Chemical industries	190.5	569.8	-379.3	-377.5
24	Medicines	49.3	33.4	15.9	26.5
25	Chemical fibres	0.4	44.5	-44.1	-51.2
26	Rubber products	26.9	7.4	19.5	10.5
27	Plastic products	88.0	2.2	85.8	86.2
28	Building materials and other non-metallic mineral	92.8	34.2	58.6	107.8
29	Primary iron and steel manufacturing	63.5	234.6	-171.1	-178.5
30	Primary non-ferrous metals manufacturing	40.7	122.4	-81.7	-97.9
31	Metal products	131.1	45.2	85.9	105.1
32	Machinery	194.7	771.1	-576.4	-623.7
33	Manufacturing and repair of railroad equipment	10.8	2.8	8.0	15.4
34	Manufacturing and repair of motor vehicles	12.4	233.2	-220.8	-246.5
35	Shipbuilding and repair of ships	20.6	12.3	8.3	3.0
36	Manufacturing and repair of aircraft	14.3	104.9	-90.6	-91.0
37	Manufacturing and repair of transportation equipm	25.6	10.9	14.7	27.0
38	Electric machinery and instrument	227.5	197.2	30.3	19.7
39	Electronic and communication equipment	285.4	386.7	-101.3	-74.8
40	Instrument, meters and other measuring equipmen	51.0	118.0	-67.0	-45.6
41	Industries n.e.c	310.1	168.0	142.1	163.8
42	Electricity, steam and hot water production and su	0.4	13.2	-12.8	-15.3

In Table 19, the first two columns of numbers show the estimated exports and imports based on the WTD data and the SITC to MuDan sector conversion table shown in Appendix B.1. The third column is the estimated net exports, which are compared with the net exports as published in the 1992 I-O table. The total net exports as estimated from the WTD data are 201.9 million yuan, and are very close to the total net exports of 196.9 million yuan in the I-O table. This is not surprising because I have scaled the total exports and imports from the WTD so that they equal the total exports and imports, respectively, as published in the yearbooks. Therefore, the difference in the two net exports figures really reflected the difference between the yearbook figure and the I-O figure. However, a close look at the net exports reveals significant differences at the sectoral level for several sectors. One notable example is the crude oil (MuDan sector 6.) The WTD shows Chinese exports and imports of crude oil of 13.6 billion yuan and 5.2 billion yuan, respectively, in 1992, resulting net exports of 8.4 billion yuan. By contrast, the net exports of crude oil in the I-O table show net exports of –4.5 billion yuan. Not only the two have different signs, the difference in magnitude also is very significant. I have checked with other published trade statistics such as the yearbook, and they seem to support the figures in the WTD. Informal discussions with several Chinese experts on the subject also tended to confirm that the net exports of crude oil in the 1992 I-O table were questionable. Therefore, the net exports as computed from the WTD were retained in the MuDan model.[12]

For many sectors, such as Crude Petroleum (Sector 6), the mining sectors (7 to 10), Beverage (12), and Railroad equipment (33), the differences between the

[12] The difference between the estimated net exports and the published I-O figure was added to the Other Final Demand column in the I-O table so that total output of the sector in the MuDan model remained the same as in the I-O table.

estimated net exports and the I-O figures are significant, and they appear to be attributable to the different sources that were used, as the conversion from the SITC code to the SICC or MuDan sectors consists primarily one-to-one mappings. For many other sectors, the significant difference between the estimated figures and the published net exports may be due as much to the different sources being used as to the particular mapping scheme that was used for the MuDan model. It is conceivable that much more disaggregated imports and exports data were used in compiling the I-O table. Therefore, by using the WTD data to construct the export and import series, discrepancies in net exports between the WTD-based figures and the published I-O figures seem unavoidable. However, since we are relying on the same source for the exports and imports series, it is reasonable to expect that there exists a certain degree of consistency in coverage of the exports and imports over the years in the covered period.

The Specification of Import Equations

Import equations in MuDan are estimated in terms of the shares of sectoral imports to domestic supply. All equations use the following functional form:

$$\log(shimp_{it}) = a_0 + a_1 * imptime_{it} + a_2 * \log(rpma_{it}) \qquad (1)$$

where $shimp_{it}$ = import share of product i at year t,

$imptime_{it}$ = a special import-share weighted time trend[13] that is computed as:

$$imptime_{it} = imptime_{i,t-1} + (1 - shimp_{i,t-1})$$

$rpma_{it}$ = 3-year moving average of relative foreign-domestic prices,

[13] This import-share weighted time trend was first formulated by Nyhus (1975), and has been used by several INFORUM models. Within the INFORUM circle, this special time trend is also called a Nyhus trend (for example, in Ma, 1996).

$rpma_{i,t} = .25 * rp_{i,t} + 0.5 * rp_{i,t-1} + 0.25 * rp_{i,t-2}$ with $rp_{i,t} = priceimp_{i,t} / prices_{i,t}$

and a_0, a_1, and a_2 are parameters to be estimated.

The trend variable in the specification has used the special, import-share weighted time trend, the Nyhus trend, instead of normal calendar time. This special trend has a "slow-down" feature that is particularly appealing to estimate share-type variables compared with normal time trend with fixed increments each period. Because MuDan is a long-term model, if the coefficient of the time trend term is large enough in absolute value, the time trend may in the long run force the import share to be larger than 1 or less than 0 depending on the sign of the coefficient. This is of course nonsense and should be avoided. Although it can't eliminate the possibility of nonsense shares of larger than 1 or less than 0, the import-share weighted time trend has a desirable feature that will at least alleviate the potential problem. The Nyhus trend is incremented by (1- $shimp_i$), which varies as $shimp_{it}$ changes. As the share $shimp_{it}$ gets larger, each increment to time variable becomes smaller, thus slowing down the "time" variable.

The use of the Nyhus trend should not cause the concern over the lagged dependent variable problem[14]. The Nyhus trend is by no mean a lagged dependent variable, not even a linear combination of the lagged dependent variable, the logarithm of $shimp_{it}$, even though it is constructed as a linear combination of the lagged value of $shimp_{it}$.

The import share equations are estimated in a Bayesian fashion. Because our specification only includes the relative price and a trend variable, other important

[14] Almon (1994) shows that a regression equation with the lagged value of the dependent variable as an explanatory variable can be a dangerous and deceptive practice, leading to very erratic estimates of the coefficients on the other variables.

factors affecting imports such as quotas, subsidies, and discounts are left out due to lack of data. The absence of these factors will inevitably cause specification problems, which can result in nonsensical regression results, positive price elasticities in particular, and may eventually render the underlying model unusable. To avoid positive price elasticities, soft constraints are used on the price term to force the coefficient to equal to an *a-priori* value. Since there is no information on the specific value *a priori* of the elasticity of any a sector, the *a-priori* elasticity is chosen to be –1.

The price variable is computed as a moving average of current and two lagged relative prices, with *a-priori* weights of the three prices chosen subjectively as 0.25, 0.5, and 0.25 for all sectors. The moving average of relative prices instead of the current or the lagged value of the relative price is used in the specification to account for the *J-curve* effect of trade balance in response to changed relative prices. Discussions of the *J-curve* effect can be found in Meade (1988), Bryant et al. (1988), and Krugman (1989). The following is an intuitive example. Suppose the Chinese yuan is devalued but foreign and domestic prices remain unchanged in terms of their respective currencies. Then the relative foreign to domestic prices in terms of yuan rises. This leads to two effects. One is the price effect: if the physical *volume* of imports does not change, their *value* measured in yuan unambiguously increases because of the higher import prices, therefore a worsening of the trade balance. There is also an opposite volume effect of substitution in response to changed relative prices. The increased relative price of imports makes Chinese goods more competitive and shifts demand in volume terms toward domestic goods. There is strong empirical evidence (Meade 1988, for example) to suggest that in the short-term of within a year or so, the volume effects are quite small and outweighed by the price effect. In the long-term, however, the volume effects are strong enough to offset the price effect and make the trade balance respond in the normal fashion to a relative price change. This pattern of the trade balance responding to currency depreciation or devaluation looks diagrammatically like a J and is therefore termed as the J-curve effect.

We now turn to estimation results for the import equation.

Estimation Results of the Import Equation

Table 20 displays the regression results of the 42 import equations in MuDan. All price elasticities are negative as desired because we have used soft constraints when necessary. The fits are fair, but not great. Of the 42 import equations, the median $\overline{R}^2$ is 0.46 and the median R^2 is around 0.58. As mentioned earlier, many factors may have contributed to the poor fitting, including inadequate data on import volume and prices, lack of data on factors such as quotas, subsidies, and discounts, and consequently the oversimplified specification. However, since price elasticities have been constrained to some *a-priori* values, the import equations overall should behave as expectedly reasonable.

In terms of price elasticities, there are significant discrepancies among the 42 import sectors. According to the estimates, 12 out of the 42 sectors have price elasticities significantly larger than 1 in absolute values, including Wearing apparel (-2.0, the price elasticity), Rubber products (-1.5), Plastic products (-1.5), Iron and Steel (-1.9), Primary non-ferrous metals (-2.1), Motor vehicles (-2.0), Ships and boats (-2.0) and Transportation equipment n.e.c. (-2.0). On the other hand, 11 sectors have price elasticities of no greater than 0.25 in absolute values, including Elasticity, steam and hot water, Paper and paper products, Chemicals, Food processing and manufacturing, Medicine, Livestock, Non-ferrous mining, Non-metal mineral mining, and Forestry. In most cases, they show positive elasticities in the unrestricted regression, and have to be constrained to have negative ones.

Most sectors show modest trends according to the estimates. Although the coefficients of the time trend variable range from –0.28 for Railway equipment to 0.58 for Crude oil, 29 out of 41 sectors have coefficients between –0.1 to 0.1 and additional 6 sectors have coefficients of the trend variables between 0.1 and 0.2 in absolute values. The coefficients of the trend variables of remaining seven sectors seem far too large although all these sectors have fairly good fits as seen from their reasonably significant $\bar{R}^2$ values. These sectors include Railway equipment (the coefficient of the trend to be -0.28), Other transportation equipment (-0.22), Petroleum refineries (0.24), Plastic products (0.24), Wearing apparel (0.25), Fishing (0.33), and Crude petroleum (0.55). Apparently, special attention should be paid to these sectors in simulation to avoid nonsensical forecasts.

Table 20 - Regression Results of Import Share Equations

	Sector number and title	const	imptime	log(rpma)	RBSQ	RSQ
1	Farming	-3.8074	-0.022	-0.5713		
		(1.06)	(0.08)	(0.06)	-0.203	0.0644
2	Forestry	-2.8135	-0.0264	-0.2496		
		(6.60)	(0.58)	**	-0.1924	0.0726
3	Livestock	-4.1438	-0.0798	-0.2477		
		(6.42)	(1.21)	**	-0.045	0.1872
4	Fishing	-9.857	0.3344	-0.4994		
		(14.86)	(5.00)	**	0.6962	0.7637
5	Coal mining	-3.6866	-0.1737	-0.4992		
		(15.52)	(7.22)	**	0.839	0.8748
6	Crude petroleum and natural gas	-9.1568	0.5703	-1.5014		
		(6.47)	(3.93)	**	0.6691	0.7426
7	Ferrous ore mining	-1.6506	0.0368	-0.4407		
		(7.08)	(1.30)	(0.68)	0.0089	0.2292
8	Non-ferrous ore mining	-1.7727	-0.1224	-0.2489		
		(5.67)	(3.56)	**	0.5672	0.6634
9	Non-metal minerals mining	-3.6677	-0.0252	-0.2491		
		(8.52)	(0.76)	(0.35)	0.1496	0.3385
10	Timber and bamboo	-1.9853	0.0047	-1.1129		
		(5.81)	(0.14)	(1.29)	-0.0177	0.2085
11	Food processing and manufacturing	-3.3865	0.0173	-0.2498		
		(12.24)	(0.60)	**	-0.2997	-0.01
12	Beverages	-4.6652	0.0582	-0.8282		
		(4.78)	(0.76)	(1.04)	-0.064	0.1724
13	Tobacco manufacture	-2.8935	-0.0688	-0.9995		
		(10.50)	(2.39)	**	0.6651	0.7395
14	Textiles	-3.0412	0.0937	-0.4461		
		(19.75)	(6.65)	(2.63)	0.8841	0.9099
15	Wearing apparel	-6.8042	0.2466	-2		
		(26.08)	(9.33)	**	0.9027	0.9243
16	Leather, fur and their products	-3.4341	0.1934	-0.8348		
		(4.74)	(2.66)	(0.98)	0.5647	0.6614
17	Sawmills and bamboo etc. products	-1.0221	-0.0619	-0.2494		
		(5.73)	(2.80)	**	0.4829	0.5978
18	Furniture	-3.6167	0.0683	-0.5		
		(12.69)	(2.29)	**	-0.0037	0.2193
19	Paper and paper products	-2.2746	0.0315	-0.2499		
		(17.51)	(2.12)	**	-0.0534	0.1807
20	Printing industries	-3.8361	0.0038	-0.9858		
		(5.62)	(0.07)	(1.63)	0.6961	0.7636
21	Culture, education, and sports articles	-2.8556	0.0849	-1.0002		
		(8.11)	(2.10)	**	-0.0788	0.1609

** soft constraints.

Table 20 - Regression Results of Import Share Equations (Cont.)

	Sector number and title	const	imptime	log(rpma)	RBSQ	RSQ
22	Petroleum refineries & coking products	-4.8313	0.2361	-0.4994		
		(7.95)	(3.71)	**	0.5743	0.6689
23	Chemical industries	-1.6602	-0.0056	-0.2499		
		(11.64)	(0.32)	**	-0.0859	0.1554
24	Medicines	-3.3502	0.0351	-0.2495		
		(17.11)	(1.72)	**	-0.2526	0.0258
25	Chemical fibers	-1.5268	-0.0673	-0.6681		
		(3.74)	(1.61)	(1.14)	0.7314	0.7911
26	Rubber products	-5.4893	0.1168	-1.4786		
		(15.25)	(3.90)	(3.34)	0.5951	0.6851
27	Plastic products	-8.9292	0.2398	-1.501		
		(4.50)	(1.53)	(0.72)	0.2653	0.4286
28	Building materials	-4.6157	0.0232	-0.8909		
		(14.65)	(0.91)	(2.15)	0.3688	0.509
29	Primary iron and steel manufacturing	-1.6599	-0.0578	-1.8583		
		(4.85)	(1.47)	(2.88)	0.611	0.6975
30	Primary non-ferrous metals	-2.4439	0.008	-2.1059		
		(6.65)	(0.20)	(3.07)	0.4523	0.574
31	Metal products	-3.3634	0.0055	-0.7949		
		(15.44)	(0.26)	(2.18)	0.2744	0.4356
32	Machinery	-2.4273	0.0768	-0.9494		
		(7.75)	(2.55)	(3.59)	0.6298	0.712
33	Railway Equipment	-0.1692	-0.2776	-0.2468		
		(0.24)	(3.44)	(3.94)	0.5521	0.6516
34	Motor vehicles	-3.0289	0.0961	-2.0003		
		(10.73)	(2.84)	**	0.4806	0.5961
35	Ships, boats	-3.3212	0.1282	-2.0014		
		(11.45)	(3.35)	**	0.6193	0.7039
36	Aerospace	-1.7417	0.1221	-0.7484		
		(2.02)	(1.23)	(0.78)	0.0078	0.2283
37	Transportation equipment, n.e.c.	-1.1239	-0.2225	-2.0001		
		(1.39)	(2.56)	**	0.3358	0.4834
38	Electric machinery and equipment	-3.0572	0.0878	-0.9362		
		(10.90)	(3.53)	(3.27)	0.5382	0.6408
39	Electronic & communication equip.	-2.0498	0.0996	-1.4888		
		(6.58)	(2.87)	(3.09)	0.4613	0.581
40	Instrument, meters & office mach.	-1.6412	0.028	-1.4635		
		(6.05)	(0.90)	(4.31)	0.8556	0.8877
41	Manufacture, n.e.c.	-2.4982	0.0483	-0.719		
		(5.46)	(1.10)	(1.26)	-0.0492	0.184
42	Electricity, steam and hot water	-4.9262	-0.0085	-0.2519		
		(5.44)	(0.11)	(0.37)	-0.1789	0.0831

** soft constraints.

Note: Numbers in parenthesis are t-statistics.

Government Expenditures and Other Final Demand

So far, all major components of final demand in MuDan have been introduced. The remaining final demand components include inventory change, government expenditures, and other final demand. Because only very limited data on these subjects are available, including time series of national totals, the sectoral details in the I-O tables, and sectoral inventories in industrial sectors in industrial census years, our modeling efforts are very restricted. In balancing historical data to make historical time series of I-O tables in MuDan, time series of final demand by sector are produced and become the basis for future forecasts. The details of the balancing procedure can be found in Yu (1998).

Inventory Change

Although inventory change is a fairly small component in final demand and is relatively unimportant in the long run, it is very important in the short run to estimate changes in output properly. Since it is impossible to econometrically estimate inventory change equations without knowing historical data, I have postulated the inventory change equation based on a stock adjustment model, with parameters being chosen rather than econometrically estimated. There are two assumptions to the so postulated inventory change equations.

First, firms have a desired inventory stock, ivn^d, which is not necessarily the same as the inventory stock they have actually kept, *ivn*. If there is a gap between the desired inventory stock and the actual inventory stock, firms will plan to get rid of a certain fraction α of this gap each period. This gives the following equation to determine the inventory change $Dinv_{i,t}$ for sector i at time t,

$$\Delta ivn_{i,t} = a_i (ivn^{d}_{i,t} - ivn_{i,t-1}) \qquad (2)$$

Notice that the lagged actual inventory is used in Eq. (2) because when firms decide what proportion of the gap to be got rid of, they only observe the inventory stock at the end of last period.

Second, firms are assumed to have a desired, probably cost minimizing, level of inventory that is a fixed proportion β to output.

$$ivn^{d}_{i,t} = b_i * out_{i,t} \qquad (3)$$

Combining the two equations, we have

$$\Delta ivn_{i,t} = a_i * b_i * out_{i,t} - a_i * ivn_{i,t-1} \qquad (4)$$

The adjustment factor α is assumed to be 0.8 for all sectors in MuDan, and the inventory/output ratio β is determined as described below.[15]

The inventory/output ratios for industrial sectors are assumed to be time-invariant and equal to the 1995 values, the ones that can be calculated from the only know data from the third National Industrial Census. The ratio for Commerce of 0.76 is assumed based on the inventory value for commercial firms of 418.41 billion yuan from TJNJ (1997, T15-1) and gross output of 552.3 billion yuan from the 1992 I-O table. This ratio is very high, and may be an indication of how insensitive to demands the state enterprises were in determining production. Without any helpful information on inventory stocks of the remaining sectors, I have chosen to postulate the inventory/output ratios for them as seen in Table 21.

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[15] Nyhus (1993) reported that an adjustment factor of 0.6 worked fairly satisfactorily for a Japanese model in a similar specification. When the same factor of 0.6 is used in MuDan for 1991, some of the inventory figures become negative. If the factor is raised to 0.8, the inventory series look more plausible and therefore is chosen for MuDan.

Table 21 – Inventory, Change in Inventory and Output

(100 million yuan in 1992 prices, with adjustment = 0.8)

	Sector number and title	Inventory/ Output Ratio	Computed Inventory in 1991	Inventory Change in 1992	Gross Output in 1992
1	Farming	0.500	2648.6	116.3	5588.0
2	Forestry	0.300	119.8	5.6	422.6
3	Livestock	0.800	1948.2	16.2	2460.5
4	Fishing	0.200	105.0	14.2	613.6
5	Coal mining	0.155	74.2	30.5	725.7
6	Crude petroleum and natural gas	0.121	39.8	27.4	610.0
7	Ferrous ore mining	0.213	5.1	11.2	90.1
8	Non-ferrous ore mining	0.166	35.9	-10.0	140.1
9	Non-metal minerals mining	0.157	12.6	44.0	430.9
10	Timber and bamboo	0.287	94.0	-47.4	121.2
11	Food processing and manufacturing	0.175	551.6	-66.0	2685.6
12	Beverages	0.266	174.9	10.9	709.7
13	Tobacco manufacture	0.241	45.3	92.7	668.0
14	Textiles	0.200	492.9	214.0	3799.1
15	Wearing apparel	0.193	169.6	25.5	1042.6
16	Leather, fur and their products	0.230	48.2	48.0	471.2
17	Sawmills and bamboo etc. products	0.232	53.1	-12.9	159.5
18	Furniture	0.266	101.3	-11.4	327.2
19	Paper and paper products	0.169	55.3	54.1	726.3
20	Printing industries	0.198	47.3	20.9	370.7
21	Culture, education and sports articles	0.201	111.1	18.4	667.1
22	Petroleum refineries and coking	0.109	109.8	-6.4	931.2
23	Chemical industries	0.163	266.0	119.1	2538.9
24	Medicines	0.243	124.1	24.2	636.2
25	Chemical fibers	0.159	75.0	-16.4	343.1
26	Rubber products	0.193	110.5	-17.6	457.0
27	Plastic products	0.195	131.2	32.5	881.4
28	Building materials	0.187	407.5	54.1	2535.5
29	Primary iron and steel	0.232	930.6	-315.1	2313.9
30	Primary non-ferrous metals	0.187	90.6	56.4	859.9
31	Metal products	0.248	329.7	19.7	1427.8
32	Machinery	0.328	973.9	214.1	3788.5
33	Railway Equipment	0.266	26.4	-2.6	86.7
34	Motor vehicles	0.247	127.5	121.8	1134.3
35	Ships, boats	0.471	51.0	-1.8	103.4

Table 21 - Inventory, Change in Inventory and Output (cont.)

(100 million yuan in 1992 prices, with adjustment = 0.8)

	Sector number and title	Inventory/ Output Ratio	Computed Inventory in 1991	Inventory Change in 1992	Gross Output in 1992
36	Aerospace	0.506	30.5	-2.2	54.8
37	Transportation equipment, n.e.c.	0.204	13.1	16.1	162.3
38	Electric machinery and equipment	0.255	310.3	65.5	1539.5
39	Electronic & communication equip.	0.237	114.6	104.6	1035.8
40	Instrument, meters & office mach.	0.350	70.8	-0.2	201.5
41	Industries, n.e.c.	0.213	222.2	44.2	1299.7
42	Electricity, steam and hot water	0.000	0.0	0.0	1178.0
43	Gas utility	0.167	4.0	7.1	77.4
44	Tap water	0.000	0.0	0.0	87.2
45	Construction	0.00	0.0	0.0	5203.0
46	Railway transportation	0.100	59.7	-1.2	581.8
47	Highway transportation	0.100	125.2	1.0	1264.3
48	Water transportation	0.100	40.4	-0.6	396.1
49	Air transportation	0.100	12.4	2.0	149.6
50	Pipeline transportation	0.100	2.0	0.0	20.2
51	Post and communications	0.100	30.9	-4.4	254.1
52	Commerce	0.758	3910.8	218.6	5522.6
53	Restaurants	0.00	0.0	0.0	826.3
54	Finance and insurance	0.00	0.0	0.0	1713.2
55	Real estate, and social services	0.00	0.0	0.0	2053.2
56	Health care, sports and social welfare	0.00	0.0	0.0	625.9
57	Education, culture, entertainment	0.00	0.0	0.0	844.5
58	Scientific research	0.00	0.0	0.0	802.7
59	Public administration and others	0.00	0.0	0.0	1909.7

Note: 1. Inventory/output ratios

The ratios for industrial sectors are computed based on inventory and output data for enterprises township and above with independent accounting units.

The ratio for Commerce is based on inventory values in commercial firms in 1992 from TJNJ and output in 1992 from the 1992 I-O table.

The ratios for other sectors are by postulation.

2. The level of inventory in 1991 is computed as

inventory ratio * output in 1992 - inventory change in 1992 / inventory adjustment factor (=0.8).

3. Inventory and output in 1992 are from the 1992 I-O table.

Sources: The Data of The Third National Industrial Census in 1995, National and Industry Volume, pp46-197.

TJNJ 1997, T15-1.

Once adjustment factors and inventory/output ratios are determined, inventory stocks by sector $ivn_{i,t-1}$ of 1991, the year prior to the base year, can be computed according to Eq. (4). The computed inventory stocks and the assumed inventory to output ratios are displayed in Table 21.

Government Expenditures and Other Final Demand

Government expenditures are exogenous to the model and used as policy variables in simulation. If only the total of government expenditures is specified, it will be distributed into sectoral demand in proportion to the 1992 values in the I-O table. If government expenditures are specified by sector, the sectoral values are used in the simulation.

The Other final demand in MuDan is a statistical discrepancy term. In the forecasting period, the sectoral values in the forecasting period are held at the levels of the last year for which there are data.

CHAPTER VII :

THE INCOME SIDE OF MUDAN

The income side of MuDan describes income distribution among factors of production and the government. MuDan includes all four types of income that are distinguishable from China's I-O tables, including labor income or wages, the depreciation allowance of fixed assets, net indirect business taxes, and operating surplus or profits. Behavioral equations for each of these income categories are estimated and used for projection in the model. A description of these behavioral equations and their estimations is presented in this chapter.

China's input-output tables generally include four categories of income or value-added components: depreciation, wages, taxes, and profits. Except in the I-O tables however, income data by these categories are not publicly available. Due to lack of adequate data, development of the income side of MuDan has lagged behind other parts of the model. A recent official publication on provincial income, however, provides useful details that can be used to construct time series of national income and, therefore, makes it possible to advance the development of the income side of MuDan. The recently published data set (DNEA, 1997a) includes historical series of the same four income categories, by province, for 13 aggregated industries for the 1980-95 period. However, additional work is necessary to make the data usable in equation estimation for MuDan. For example, the data is presented in the national income account framework, which differs from the input-output account framework on which MuDan is based. Therefore, adjustments are needed in order for the data to be consistent with I-O accounts and usable in MuDan. Also, the data set includes only provincial data and does not even include the sums of provincial income for the four categories. Consequently, various assumptions and adjustments are needed to construct corresponding time series of national account data that are consistent with the published national aggregates such as GDP. Despite its deficiencies, the provincial data set provides valuable information on which a set of national income data with reasonably good quality can be constructed. More detailed information on the procedures and assumptions of constructing the national income data set are described in Yu (1997a). In this Chapter, I will describe the estimation of the behavioral equations for the four income categories based on the constructed national income data.

Wages

Wages in MuDan include all labor income of both agricultural and nonagricultural workers. This labor income includes imputed income from direct consumption of own production for farmers as well as income in kind received from employers and fringe benefits for non-agricultural employees. The wage rate in MuDan is computed simply as total wages divided by total employment, representing the annual average of gross labor income per worker. Behavioral equations are estimated based on historical wage rates for two broad segments of the economy, agriculture and non-agriculture, as well as for individual sectors, whose wage rate equations are explained by the wage rates of the two broad sectors as primary explanatory variables. Before introducing the wage equations, however, a brief description of wage setting institutions of the Chinese economy is in order.

The wage setting mechanism before economic reform started was very simple, when the economy was under central planning. The agriculture sector was in the commune system in which the government set production plans and procured products at prices set by government. Employment was guaranteed by the commune in which a rural resident lived. Revenues from production, after deducting production costs and capital accumulation, were distributed to agricultural workers based on the hours they worked. The non-agriculture sector was characterized by a system of lifetime employment and centrally fixed wages. The government assigned jobs for urban resident to state and collective owned enterprises. Firms neither had the right to make decisions on how many workers or which specific individual to employ, nor were they allowed to dismiss employees. Individuals were paid according to a uniform grade wage system, derived from the Soviet model, that consisted of eight grades for factory workers and 28 grades for government and factory administrative personnel. Each individual's wage grade was generally based on his personal endowments such as education level and work experience as well as his official ranking. Wage raises were infrequent and subject to quotas that were allocated by government (Meng and Kidd, 1997; Korzec, 1992). Performance-based compensations such as commissions and bonuses were prohibited. Since the grade wage system was uniformly administrated, individual firms had little right to give wages raises other than following the regulations stipulated by government.

Economic reform since the late 1970s has fundamentally changed the Chinese labor markets and wage systems. In the agricultural sector, the commune system was replaced with a household responsibility system. Rural households rent a piece of land from government and become the basic unit in making production decisions. The contracted households are responsible for delivering a given quantity of certain product to fulfill the procurement quota, but otherwise are free to make decisions on how to organize inputs and production more efficiently in order to maximize profits. Since prices of an increasing share of agricultural products are competitively determined by the market rather by government, farmers behave not unlike their profit maximizing peers in market economies. Labor income they receive is determined by the residual between the revenues their products generate and the costs of production after taking out taxes and capital allowance as well as return on capital.

The non-agricultural sector displays heterogeneity in terms of employment and wage setting mechanisms. On the one hand, there is the relatively capitalist segment of the private and foreign enterprises. On the other hand, there is the relatively socialist segment of the state enterprises. In between, there are collective enterprises, joint ventures and other companies with a hybrid type of ownership. The employment and wage decisions in a particular enterprise are largely influenced by which ownership is the controlling party in the company.

Private and foreign ownership has been generally accepted by the society and is rapidly expanding its share in the economy. In general, private and foreign firms are free to make employment decisions and less vulnerable to government's intervention than state enterprises are. Wages are competitively set and the employees' right to quit is guaranteed. In addition, workers in these companies generally are not unionized, and even if they are, their bargaining power with management in setting wage and ensuring job security is very limited. Therefore, it appears that the determination of employment and wages in this segment of enterprises is not very different from that in a typical market economy. Ironically, for a society in which workers should, in theory, enjoy a dominant position, lack of independent labor unions has placed workers in a disadvantageous position in wage determination; and there is little bargaining between workers and employers.

State enterprises have gained much autonomy in deciding whom to hire and how much to pay. However, they are still subject to the control of government on wage rates and the number of formal employees, and dismissing state employees remains a difficult task and requires government approval. The wage structure of state employees is very similar across industries, including basic salaries, bonuses, and subsidies and allowances that sometimes include a small seniority premium. The basic salary of a particular employee is determined by the administrative, management, or technical level of the position and the skill level he holds, and it varies across industries. In 1995, the basic salary accounted for about 60% of total wage for state employees. While industrial wage differentials are determined mostly by the differences in basic salaries, the bonus payment is the most versatile components of wages in determining the wage differentials between companies.

The government's control on wage increases, particularly on the amount of bonus payment, had helped to maintain a steady income growth across industries while keeping the sectoral wage difference in check in the 1980s. Two major wage reforms were conducted by the government that raised the basic salary for all state employees. For less well performing sectors, however, the increase in labor costs meant an increase in losses or government subsidies, neither of which could be sustained for long. As the government loosens the control on wages and reform of state enterprises intensifies, sectoral wage differentials widen. Figure 12 displays the non-agricultural wage differential that is expressed as the ratio of the standard deviation of sectoral wage rates to the mean during the 1984-94 period. As shown in Figure 12, the ratio declined from 1984 to 1990, indicating a convergence of wage rates toward the mean. Since 1991, however, the ratio has been rapidly increasing, suggesting that the market forces are taking over in wage setting as industries with good performance are rewarding workers with high wages while struggling sectors are no longer able to sustain the wage increases.

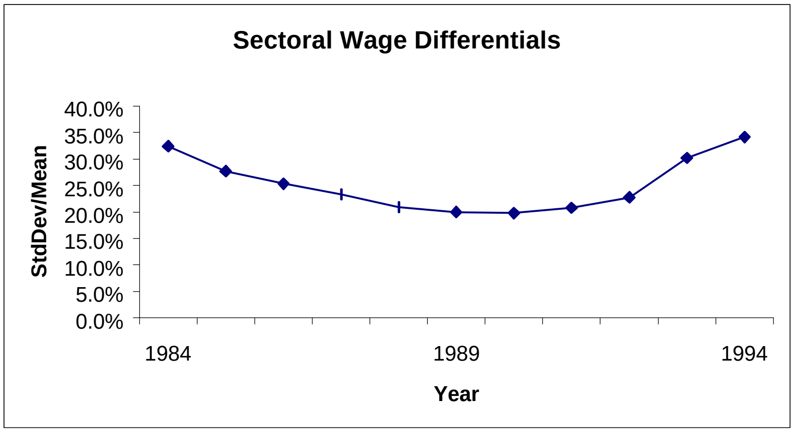

Figure 12 - Wage Differentials for Non-agricultural Sectors

(Expressed as the ratio of the standard deviation to the mean)

Table 22 displays the wage rates by industry for 1985, 1990 and 1994 and average annual growth rates, and it is ranked in the descending order of the 1994 wage rates. There are two apparent observations from Table 22. First, there is an apparent gap between the agricultural and non-agricultural wages. One of the primary factors for such a gap to exist is China's segmented labor markets, in which barriers for labor to flow from the rural to urban labor market are high. As a result, there is evidence to suggest that industrial wage rates may have been well above market-clearing levels (Fleisher et al., 1997). Second, substantial wage differentials exist among non-agricultural sectors, with the average wage in the Communication sector being as much as almost four times the average wage in the Sawmills and bamboo product industry in 1994. In general, service industries are better paid than manufacturing industries, and capital intensive industries tend to pay higher wages than labor intensive industries.

Table 22 - Average Annual Wage and Growth by Industry

(Levels in current yuan, growth in percentage)

Sec#	Industry	1985	1990	1994	1985-90	1990-94	1985-94
44	Communications	570	1,847	9,137	23.5%	40.0%	30.8%
42	Air transportation	863	2,445	8,912	20.8%	32.3%	25.9%
10	Tobacco manufacture	1,510	2,850	9,134	12.7%	29.1%	20.0%
51	Scientific research and polytechnical services	857	2,194	6,906	18.8%	28.7%	23.2%
49	Health care, sports and social welfare	900	2,157	6,533	17.5%	27.7%	22.0%
48	Real estate management and social services	1,214	2,225	6,141	12.1%	25.4%	18.0%
52	Public administration and others	853	2,210	5,725	19.0%	23.8%	21.2%
47	Finance and insurance	1,087	2,633	6,443	17.7%	22.4%	19.8%
50	Education, culture, arts, radio, film and television	1,023	2,118	5,083	14.6%	21.9%	17.8%
3	Crude petroleum and natural gas production	1,432	2,801	6,648	13.4%	21.6%	17.1%
35	Electricity, steam and hot water production and supply	1,381	2,892	6,778	14.8%	21.3%	17.7%
37	Production and supply of water	1,360	2,714	6,255	13.8%	20.9%	17.0%
26	Primary iron and steel manufacturing	1,277	2,637	6,071	14.5%	20.8%	17.3%
22	Chemical fibres	1,226	2,482	5,574	14.1%	20.2%	16.8%
19	Petroleum refineries and coking products	1,365	2,541	5,688	12.4%	20.1%	15.9%
36	Gas production and supply	1,516	3,114	6,890	14.4%	19.9%	16.8%
40	Highway transportation	852	2,026	4,298	17.3%	18.8%	18.0%
45	Commerce	1,013	1,716	3,636	10.5%	18.8%	14.2%
38	Construction	1,754	2,635	5,567	8.1%	18.7%	12.8%
32	Electronic and communication equipment	1,384	2,770	5,766	13.9%	18.3%	15.9%
41	Water transportation	1,171	2,194	4,487	12.6%	17.9%	14.9%
30	Transportation equipment	1,362	2,747	5,596	14.0%	17.8%	15.7%
46	Restaurants	733	1,867	3,775	18.7%	17.6%	18.2%
27	Primary non-ferrous metals manufacturing	1,411	2,659	5,301	12.7%	17.2%	14.7%
25	Building materials and other non-metallic mineral produ	971	1,708	3,355	11.3%	16.9%	13.8%
43	Pipeline transportation	2,603	3,884	7,537	8.0%	16.6%	11.8%
4	Ferrous ore mining	930	1,782	3,381	13.0%	16.0%	14.3%
33	Instrument, meters and other measuring equipment	1,745	3,199	6,065	12.1%	16.0%	13.8%
1	Agriculture	718	1,272	2,408	11.4%	16.0%	13.4%
21	Medicines	1,278	2,577	4,871	14.0%	15.9%	14.9%
13	Leather, fur and their products	1,347	2,367	4,399	11.3%	15.5%	13.1%
29	Machinery	1,156	2,161	4,008	12.5%	15.4%	13.8%
31	Electric machinery and instrument	1,237	2,470	4,544	13.8%	15.2%	14.5%
18	Cultural, education, sports articles	1,046	2,043	3,655	13.4%	14.5%	13.9%
20	Chemical industries	1,126	2,315	4,131	14.4%	14.5%	14.4%
12	Wearing apparel	1,034	2,002	3,556	13.2%	14.4%	13.7%
9	Beverages	924	1,744	3,061	12.7%	14.1%	13.3%
8	Food process & manufacturing	923	1,743	3,054	12.7%	14.0%	13.3%
17	Printing industries	1,189	2,171	3,778	12.0%	13.9%	12.8%
23	Rubber products	1,161	2,280	3,935	13.5%	13.6%	13.6%
24	Plastic products	856	1,668	2,766	13.3%	12.6%	13.0%
28	Metal products	1,163	2,202	3,621	12.8%	12.4%	12.6%
16	Paper and paper products	925	1,666	2,691	11.8%	12.0%	11.9%
5	Non-ferrous ore mining	1,083	2,115	3,410	13.4%	11.9%	12.7%
11	Textiles	982	1,944	3,126	13.7%	11.9%	12.9%
34	Industries n.e.c	1,501	2,861	4,594	12.9%	11.8%	12.4%
15	Furniture	1,354	2,282	3,602	10.4%	11.4%	10.9%
2	Coal mining	1,163	2,400	3,681	14.5%	10.7%	12.8%
14	Sawmills and bamboo etc. products	1,049	1,730	2,457	10.0%	8.8%	9.5%
7	Logging and transport of timber and bamboo	1,380	2,288	3,207	10.1%	8.4%	9.4%
39	Railway transportation	1,899	3,123	4,300	9.9%	8.0%	9.1%
6	Non-metal minerals, and mining n.e.c.	1,320	2,738	3,615	14.6%	6.9%	11.2%

The presence and persistence of substantial interindustry wage differentials are a universal phenomenon that has been well documented for many other countries (for example, Krueger and Summers, 1988; and Gera and Grenier, 1994). However, there have been no conclusive explanations as to why there exist such persistent interindustry wage differentials. Some suggest that the wage differentials can be traced back to the differences in human capital accumulation. They argue that, in a competitive labor market, the normal functioning of the market forces tends to reward workers with larger accumulation of human capital. Therefore, industrial wage differences can be traced back to individual characteristics such as level of educational attainment, age, length of job tenure as well as characteristics of firms such as firm size (Brown and Medoff, 1989). Some attribute the wage differentials to institutional influences, primarily as a result of the presence or absence of a labor union. However, a widely used theory is the efficiency wage theory (Akerlof and Yellen, and Katz, 1986), which has been used extensively in labor economics. Many empirical studies seem to have found support for such theory (for example, Krueger and Summers, 1987; Gera and Grenier, 1994). The basic argument of the efficiency theory is that, for some industries, firms may find it profitable to pay above workers' reservation wages or the competitive wages. However, the motives for such action vary, ranging from reducing turnover costs and shirking, increasing work effort and loyalty of employees, to suggesting that the higher wages serve as a signal to attract higher quality job applicants.

Many of the arguments seem to apply well to explaining the wage differentials for Chinese industries. For example, a worker's basic salary generally is tied directly to his or her education level, which is often served as a significant signal in indicating a person's capability. With respect to industries, capital intensive industries tend to hire people with more education and require a higher level of accumulation of human capital than labor-intensive industries. State monopolized industries such as telecommunication, air transportation, and tobacco products generally are paying high wages because they can relatively easily shift the labor cost to consumers by exercising the monopoly power to charge high prices and still remain profitable. Industries with high productivity levels can afford to pay high wages simply because the labor cost is not as significant a portion of products as it is in low productivity industries. Eventually, however, only profitability dictates. Whether through monopoly power or competitive strength, a company can afford to pay high wage only if it can make enough profits to support high wage. While this seems so simple in a market economy, it is a fundamental lesson that has taken China a long time to grasp. As China continues the effort of establishing a market economy, one can reasonably expect that the profit maximization motive of enterprises will play a more important role in wage determination.

Aggregate Wage Rate Equations

MuDan includes two aggregate wage equations, one for agriculture and the other for non-agriculture sectors. Both are estimated in terms of average wage rates. During the forecasting period, the aggregate wage rates are projected first and subsequently used as a primary explanatory variable in the sectoral wage rate equations. Such estimated sectoral wage rates combined with sectoral employment implicitly determine another set of aggregate wage rates that may not be the same as the one predicted by the aggregate wage equations. To maintain the consistency, the estimated sectoral wage rates are scaled to ensure that the consistency between the equation forecasted aggregate wage rates and the implicit wage rates is maintained. Obviously, the aggregate wage equations play pivotal roles in determining wages and prices.

Both aggregate wage rate equations are postulated in MuDan as following a form of the Phillips curves, and are expressed as a function of labor productivity, expectation of inflation, and the unemployment rate. Coefficients are softly constrained so that they have desired magnitudes and / or signs in order for the equations to have desirable long-run properties.

The selection of the Phillips curve for MuDan is based on its empirical tractability and robustness. The Phillips curve depicts an empirical relationship between inflation and unemployment, and it is used in a good number of widely used macro econometric models. Although its validity has often been challenged, the Phillips curve has been found extremely robust (Fulrer, 1995). Furthermore, while several forms of wage equations have been suggested in the literature, they often suffer from identification problems. It has been argued that if one confines attention to models of wage bargaining that are commonly used, the most appropriate form of an aggregate wage equation should be a Phillips curve (Manning, 1993).

1 Aggregate Wage Rate for Non-agricultural Sectors

The aggregate wage rate for non-agriculture sectors is postulated as a function of the average labor productivity of these sectors, the lagged value of urban consumption price index, and the unemployment rate. The following functional form is used in estimation:

$$\ln wpcnoag_t = a_0 + a_1 * \ln prtnoag_t + a_2 \ln cuD_{t-1} + a_3 (uunemp_t - u^*) \tag{1}$$

where *wpcnoag* = the average annual labor income for non-agriculture worker,

prtnoag = the average labor productivity for all non-agricultural sectors,

cuD = the urban consumption price index,

uunemp = the urban unemployment rate,

u^* = the natural rate of unemployment, assumed constant, and

α_0, α_1, α_2, and α_3 are coefficients.

The appearance of labor productivity in the equation suggests that productivity growth is both a source and a constraint of wage increases. Although wage growth in a particular industry may not necessarily be linked to productivity growth, real wage growth in the long run and economy wide has to be based on growth in productivity. It is simply unsustainable in the long run to have real wage growth that is faster than productivity growth. Therefore, we expect the coefficient on the productivity variable to be positive and its magnitude to be less than 1.0.

A simple adaptive expectation of inflation is assumed for the expected inflation variable, which is assumed to equal the lagged value of the urban consumption price index. As pointed out in Chapter I, the use of adaptive expectations may cause problems for structural modeling. Therefore, alternative formations of inflation expectation such the forwarding looking rational expectation technique should be explored whenever possible. However, there are problems. The implementation of such forward looking techniques in large macroeconomic models, while feasible, requires the adoption of computational algorithms more complicated than those used by the MuDan model. Furthermore, even proponents of rational expectation techniques acknowledged that the benefits of using rational expectation in forecasting are not always obvious (Poret, 1990). In addition, much empirical evidence has supported the stability of the Phillips curve even though adaptive expectation formations are used (Fuhrer, 1995). Therefore, although it might be beneficial to build alternative expectation formations such as forward looking rational expectations into the model, the benefits of using forward-looking expectations may be difficult to justify.

The urban unemployment rate is used in the equation because overall unemployment rate data is not available. In a more standard specification of the Phillips curve type wage equations, unemployment is usually specified as the deviation from the “natural” unemployment rate. When the unemployment rate falls below the “natural” unemployment rate, inflation in wages tends to rise; when the unemployment rate rises above the natural rate, inflation tends to fall. In the Chinese statistics, however, urban unemployment is the only available official unemployment data, and overall unemployment rate has never been officially published. In addition, there has been no published study on the estimation of the natural unemployment rate, nor is there adequate data to estimate one in this study. Therefore, I simply use the urban unemployment rate as a proxy for the overall unemployment rate, and further assume that the natural unemployment rate equals some unknown constant. A constant term is present in the specification to account for any other exogenous trend in wage growth. By assuming the natural rate to be constant, therefore $-\alpha_3 * u^*$ to be constant, the specification in Eq. (1) can be simplified to Eq. (2), which is actually estimated as follows:

$$\lg wpcnoag_t = a_0 + a_1 * \lg prtnoag_t + a_2 * \lg cuD_{t-1} + a_3 * uunemp_t \qquad (2)$$

The equation is first estimated unconstrained and the estimation results are shown in the top panel of Table 23. All coefficients are statistically significant and have desired signs. However, the magnitudes of the coefficients on the productivity and inflation variables appear less than desirable. Both coefficients have shown magnitudes greater than one, which can not be sustained in the long run. To maintain desirable long-term properties, these coefficients are softly constrained and the equation is re-estimated. The coefficient on productivity is softly constrained to be 0.7, a value that should be reasonably close to the share of labor in a typical production function. The coefficient on the inflation variable is softly constrained to be 1.0, so that price inflation can be passed proportionally to wage inflation. In addition, the coefficient on the unemployment variable is constrained to –0.2, its unconstrained estimate. The constrained estimation results are shown in the bottom panel of Table 23. Compared with the unconstrained estimates, the MAPE increases from 0.20 to 0.72, indicating the worsening of fit. However, R-squared is still respectable at 0.971. Therefore, we seem to have a more desirable specification without sacrificing much of the good fit. The results are graphed in Figure 13.

Table 23 - Regression Results of the Non-agriculture Wage Rate

```
                    Wage Rate, Non-agriculture
                    Coefficients Unconstrained

SEE   = 0.02 RSQ  = 0.9985 RHO =  -0.57 Obser  =   11 from 1984
SEE+1 = 0.01 RBSQ = 0.9978 DW  =   3.13 DoFree =    7 to   1994  MAPE
= 0.20
  Variable name   Reg-Coef  Mexval t-value  Elas   NorRes     Mean
0 lgwpcnoag     - - - - - - - - - - - - - - - - - - - - -      7.60
1 intercept       -2.78732    41.9  -2.664  -0.37  652.36      1.00
2 lgprtnoag        1.12054   327.5  10.995   1.47   42.01     10.00
3 lgcuD[1]         1.13681   462.3  14.639  -0.05    2.77     -0.34
4 uunemp          -0.18923    66.4  -3.518  -0.06    1.00      2.25

                    Wage Rate, Non-agriculture
                     Coefficients Constrained

SEE   = 0.07 RSQ  = 0.9799 RHO =   0.84 Obser  =   11 from 1984.000
SEE+1 = 0.05 RBSQ = 0.9713 DW  =   0.32 DoFree =    7 to   1994.000
MAPE  = 0.72
  Variable name   Reg-Coef  Mexval t-value  Elas   NorRes     Mean
0 lgwpcnoag     - - - - - - - - - - - - - - - - - - - - -      7.60
1 intercept        0.75666     7.9   1.399   0.10   70.59      1.00
2 lgprtnoag        0.75446     *       *     0.99   43.13     10.00
3 lgcuD[1]         1.08880     *       *    -0.05    2.04     -0.34
4 uunemp          -0.14511     *       *    -0.04    1.00      2.25
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Note: * Coefficients are soft-constrained.

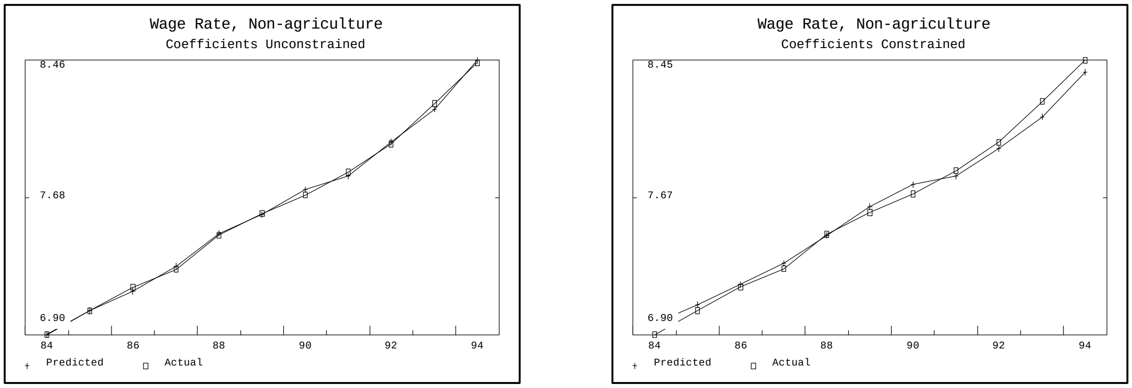


Figure 13 - Estimation of the Non-agricultural Wage Rate

2 Agriculture Wage Rate Equation

The wage rate for the agriculture sector is postulated in a similar fashion as for non-agriculture sectors, as a function of labor productivity of the agriculture sector, the lagged value of rural consumption price index, and the unemployment rate. It has the following form:

$$\ln wpcag_t = a_0 + a_1 * \ln prtag_t + a_2 * \ln crD_{t-1} + a_3 * uunemp_t \qquad (3)$$

where *wpcag* = the average annual labor income per agricultural worker,

prtag = the labor productivity in agriculture,

crD = the rural consumption price index,

uunemp = the unemployment rate, and

α_0, α_1, α_2, and α_3 are coefficients.

Although the two aggregate wage rate equations have similar forms, the interpretation of the inflation variable is slightly different. Ideally, one would like to use the lagged value of the producer prices index of agricultural products in the place of consumption price index because labor income for farmers is determined in a different way than for non-agricultural workers. For non-agricultural workers, wages are usually adjusted for inflation, often in the form of temporary inflation subsidies in the short run and permanent wage increases in the long run; for farmers, however, inflation subsidies are not available. Therefore, the only way to increase wages is to raise prices. Using producer prices to determine wages, however, poses a serious simultaneity problem since wages are used to determine prices in the model. If the lagged producer prices were used, we would likely to have an unstable price equation since, given the expectation that the coefficient of the inflation variable is close to one, the prices would be predicted by the lagged dependent variables. Given the potential problems associated with the producer price index, I did not pursue further the producer prices and use the rural inflation rate instead.

The urban unemployment rate is used in the equation because neither the rural nor the overall unemployment rate has ever been published. In fact, the rural unemployment rate may be impossible to build. Therefore, I have to rely on the only available unemployment rate and implicitly assume that the overall unemployment rate is proportional to the urban unemployment rate, with the interpretation that the urban rate may indicate opportunity costs for rural workers.

Table 24 displays the estimation results. The top panel of Table 24 shows the estimation without soft constraints on coefficients. Coefficients on all three explanatory variables of productivity, inflation, and unemployment have desired signs and, except the one on unemployment, they are statistically significant. However, these coefficients do not seem to have desired magnitudes. The coefficient on the productivity variable shows a value of greater than one. There are several possible explanations for that. It is plausible that agricultural labor income grew faster than productivity changes during the estimation period because farmers may have been gaining a larger share of agricultural value-added. Prior to economic reform, personal consumption and income had been depressed by the government to support its industrialization drive. Economic reform allowed a more reasonable distribution of income between the factors of production, and therefore, the return to labor may have been increased.

Table 24 - Regression Results of the Agriculture Wage Rate

```
                         Wage Rate, Agriculture
                       Coefficients Unconstrained

SEE   = 0.05 RSQ  = 0.9825 RHO =   0.37 Obser  =   11 from 1984.000
SEE+1 = 0.05 RBSQ = 0.9750 DW  =   1.26 DoFree =    7 to   1994.000
MAPE  = 0.57
  Variable name   Reg-Coef  Mexval t-value  Elas   NorRes     Mean
0 lgwpcag       - - - - - - - - - - - - - - - - - - - - -     7.02
1 intercept       -4.64883    11.4  -1.299  -0.66   57.24     1.00
2 lgprtag          1.52980    64.6   3.460   1.70    2.49     7.80
3 lgcuD[1]         0.64566    38.1   2.518  -0.03    1.00    -0.34
4 uunemp          -0.01954     0.1  -0.129  -0.01    1.00     2.25

                         Wage Rate, Agriculture
                        Coefficients Constrained

SEE   = 0.07 RSQ  = 0.9709 RHO =   0.48 Obser  =   11 from 1984.000
SEE+1 = 0.07 RBSQ = 0.9585 DW  =   1.04 DoFree =    7 to   1994.000
MAPE  = 0.71
  Variable name   Reg-Coef  Mexval t-value  Elas   NorRes     Mean
0 lgwpcag       - - - - - - - - - - - - - - - - - - - - -     7.02
1 intercept        2.11930   750.6  22.396   0.30 1716.05     1.00
2 lgprtag          0.70082     *       *     0.78 1152.56     7.80
3 lgcuD[1]         1.00120     *       *    -0.05   12.14    -0.34
4 uunemp          -0.09868     *       *    -0.03    1.00     2.25
```

Note: * Coefficients are soft-constrained.

Another possibility for the coefficient on productivity of being greater than one is the data on agricultural wage, which may have included non-agricultural income. Because non-agricultural sectors generally have greater productivity growth than the agricultural sector, the income growth in non-agricultural sectors is normally higher than in the agriculture sector. In that case, because agricultural productivity is used to predict non-agricultural income growth, the income growth can appear to be more elastic to the agricultural productivity change than if income is solely derived from the agricultural sector. However, such overreaction of income with respect to productivity change, while possible in the short run, is not sustainable in the long run. Therefore, the coefficient is softly constrained to a more plausible value of 0.7.

The coefficient on the inflation variable shows a value of 0.65. Like in the non-agricultural wage rate equation, a complete passthrough of inflation on wage is a desirable long run property, and therefore the coefficient is constrained to have a value of one.

The coefficient on the unemployment rate variable has the desired sign; however, it is not statistically significant. In order to improve the long-run property of the equation, the coefficient is softly constrained as –0.1. The bottom panel of Table 24 shows the estimation results after soft constraints are applied to coefficients. The MAPE value in the constrained version is still small in absolute term, but its increase from 0.57 to 0.71 represents a change of almost 25%, suggesting that historical fit is significantly worse. Figure 14 displays the graphs of the actual and estimated values of the wage rate equation.

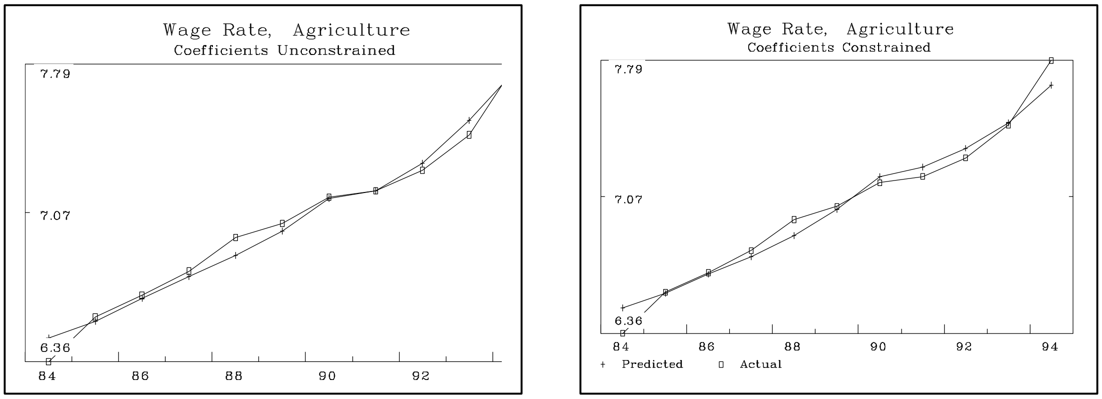


Figure 14 - Estimation of the Agricultural Wage Rate

Sectoral Wage Rate Equation

MuDan estimates sectoral wage rates based on the aggregate wage rates that are determined by the aggregate wage rate equations and a time trend. Estimation of the sectoral wage rate equations is based on the following functional form:

$$\ln \frac{wpcnoag_{i,t}}{wpcnoag_t} = a_0 + a_1 * \ln \frac{emp_{i,t}}{empnoag_t} + a_2 * T \qquad (4)$$

where $wpcag_{i,t}$ = the wage rate for sector *i*,

$emp_{i,t}$ = employment for sector *i*,

$wpcnoag_t$ = the aggregate wage rate for non-agricultural sectors,

$empnoag_t$ = total employment for all non-agricultural sectors,

T = a simple time trend, and

α_0, α_1, and α_2 are coefficients.

Coefficient α_1, the elasticity of the relative wage rate $wpcnoag_{i,t}/wpcnoag_t$ with respect to the employment ratio $emp_{i,t}/empnoag_t$, is expected to be positive and, ideally, close to one. The employment ratio $emp_{i,t}/empnoag_t$ is intended to explain the market demand conditions for labor. The intuition is that if demand for labor for an industry increase faster than other industries, wage rate for that industry must increase relative to the other industries in order to be attractive to potential workers. All other determinants for the sectoral wage rate is summarized by the time trend variable. The advantage of this specification is that it allows sectoral wage rates to diverge without having to explain why such differentials exist. In this specification, the divergence of sectoral wage rates is built in the coefficient α_1, the elasticity of relative wage rate with respect to the employment ratio, and the time trend.

The unconstrained estimation did not yield desired results and equations for many sectors displayed poor fit to the historical data. Several factors may have contributed to the poor fits in sectoral wage equations. The primary reason is probably the fact that sectoral wages were not competitively determined during much of the estimation period. In particular, sectoral wage rates before the late 1980s had followed closely those of state enterprises and the wage rates of state enterprises had been largely determined by the government. In addition, the quality of data on historical wage rates by sector also is an issue. Because sectoral employment and total wage are constructed separately, there is no available data to check whether the coverage of employment and wage data is consistent over the time. If different coverage of employment and total wage is used, as has likely happened, historical wage rates may have been significantly biased. Therefore, although the wage rate data that we have constructed are as good as one can get given publicly available information, there is plenty of room for improvement when new information becomes available.

Soft constraints are applied to the estimation of sectoral wage rate equations that have not yielded coefficients with the desired sign and magnitude. The sectoral wage rate equation is estimated in a Bayesian fashion. To avoid spurious coefficients, soft constraints are used to force the coefficient on the employment ratio variable to equal to an *a-priori* value. Since there is no information on the specific value *a priori* of the coefficient for any a sector, *a-priori* values of 1.0, 0.75, 0.50, 0.25, and 0.0 are tried for each sector to maximize $\overline{R}^2$, the adjusted R-squared of the equation. The selection procedure involves first estimating the equation without a constraint and then applying one constraint at a time on the elasticity. In addition, the equation is estimated by taking out the time trend; and finally, it is estimated with only the time trend and a constant term.

With seven different estimations for each sector, the selection process is straightforward. The unconstrained version is chosen for the model if the estimated coefficient is positive and less than one. Otherwise, the estimation with the highest $\overline{R}^2$ value is selected. Final results of the sectoral wage equations based on the above selection procedure are shown in Table 25.

The estimation results suggest that there is much to be desired regarding the sectoral wage equations. As indicated by the low R-squared values, most sectors show poor fit. Still, there are interesting results that can be learned from the estimation.

First, as the coefficients on the time trend seem to suggest, the wage rates for manufacturing sectors have fallen relative to the overall non-agricultural wage rate. Among the 27 mining and manufacturing sectors for which a significant trend is found, all but two sectors display negative coefficients. Therefore, *ceteris paribus*, these industries displayed slower growth in wage rates, which became smaller compared to the average wage rate as time went by. The 25 industries with negative coefficients on the time trend represented 70% of the total number of mining and manufacturing sectors. The falling wage rates of mining and manufacturing sectors could suggest that, historically, these sectors were overpaid, or these industries overall were experiencing difficulties during the 1984-94 period, or simply that other sectors had better performance or were better paid.

Table 25 - Regression Results for Wage Rates

	Sector	Const	Emp Ratio	Time	RBSQ
2	Coal mining	5.54	1.59		0.50
		(3.16)	(3.16)		
3	Crude petroleum and natural gas production	0.89	0.12		0.01
		(1.40)	(1.06)		
4	Ferrous ore mining	1.36		-0.02	0.68
		(3.80)		(4.51)	
5	Non-ferrous ore mining	8.70	1.00	-0.04	0.73
		(13.54)	**	(4.95)	
6	Non-metal minerals, and mining n.e.c.	3.29		-0.04	0.45
		(2.98)		(2.90)	
7	Logging and transport of timber and bamboo	9.04	1.58		0.86
		(7.51)	(7.52)		
8	Food process & manufacturing	5.35	1.00	-0.02	0.61
		(8.86)	**	(3.03)	
9	Beverages	3.55	0.25	-0.03	0.67
		(7.18)	**	(5.22)	
10	Tobacco manufacture	20.71	3.09		0.72
		(4.98)	(4.91)		
11	Textiles	5.26	1.16	-0.02	0.90
		(7.75)	(4.29)	(3.77)	
12	Wearing apparel	1.67		-0.02	0.68
		(4.15)		(4.50)	
13	Leather, fur and their products	2.73	0.02	-0.03	0.92
		(3.74)	(0.24)	(8.39)	
14	Sawmills and bamboo etc. products	4.94		-0.06	0.86
		(7.01)		(7.37)	
15	Furniture	5.47	0.98		0.77
		(5.62)	(5.60)		
16	Paper and paper products	8.62	1.00	-0.05	0.91
		(20.87)	**	(10.34)	
17	Printing industries	3.63	0.25	-0.03	0.74
		(7.61)	**	(4.99)	
18	Cultural, education, sports articles	1.40		-0.02	0.35
		(2.26)		(2.42)	
19	Petroleum refineries and coking products	1.20	0.03	-0.01	0.06
		(0.16)	(0.04)	(0.26)	
20	Chemical industries	4.73	0.69	-0.02	0.42
		(1.18)	(0.79)	(2.57)	
21	Medicines	1.52		-0.02	0.51
		(3.54)		(3.24)	
22	Chemical fibres	0.97	0.14		0.23
		(2.12)	(1.91)		
23	Rubber products	7.30	1.00	-0.02	0.54
		(14.26)	**	(3.77)	
24	Plastic products	3.09	0.25	-0.03	0.46
		(4.17)	**	(3.04)	
25	Building materials	1.68	0.06	-0.02	0.96
		(10.41)	(0.52)	(6.42)	
26	Primary iron and steel manufacturing	2.37	0.53		0.63
		(4.36)	(4.04)		

Note: ** Soft Constraints.
t-statistics in parentheses.

Table 25 - Regression Results for Wage Rates (Cont.)

	Sector	Const	Emp Ratio	Time	RBSQ
27	Primary non-ferrous metals manufacturing	2.96	0.21	-0.02	0.58
		(0.72)	(0.35)	(1.65)	
28	Metal products	3.53	0.25	-0.03	0.55
		(4.69)	**	(3.41)	
29	Machinery	1.62	0.55		0.94
		(11.65)	(11.91)		
30	Transportation equipment	-0.06		0.00	-0.03
		(0.21)		(0.85)	
31	Electric machinery and instrument	0.98		-0.01	0.38
		(2.72)		(2.55)	
32	Electronic and communication equipment	1.89	0.26	-0.01	-0.10
		(0.94)	(0.74)	(1.10)	
33	Instrument, meters and other measuring equipment	2.14		-0.02	0.90
		(10.93)		(9.05)	
34	Industries n.e.c	3.37		-0.04	0.73
		(5.37)		(5.06)	
35	Electricity, steam and hot water	-0.65		0.01	0.30
		(1.60)		(2.21)	
36	Gas production and supply	1.51	0.16		0.58
		(4.70)	(3.66)		
37	Production and supply of water	5.79	0.58	-0.02	0.12
		(1.57)	(1.59)	(1.32)	
38	Construction	4.00	0.47	-0.03	0.78
		(4.18)	(1.70)	(5.63)	
39	Railway transportation	5.49		-0.06	0.78
		(6.11)		(5.73)	
40	Highway transportation	-1.68	0.25	0.03	0.64
		(2.72)	**	(4.04)	
41	Water transportation	-0.43		0.01	-0.05
		(0.70)		(0.73)	
42	Air transportation	2.54	1.00	0.05	0.65
		(4.49)	**	(8.66)	
43	Pipeline transportation	3.28		-0.03	0.74
		(6.32)		(5.13)	
44	Communications	0.12	1.00	0.06	0.47
		(0.13)	**	(5.65)	
45	Commerce	0.55		-0.01	0.03
		(0.90)		(1.14)	
46	Restaurants	-2.28		0.02	0.54
		(3.91)		(3.39)	
47	Finance and insurance	1.82	0.45		0.31
		(2.43)	(2.24)		
48	Real estate management and social services	-1.28		0.02	0.13
		(1.43)		(1.53)	
49	Health care, sports and social welfare	-5.17		0.06	0.84
		(6.91)		(6.91)	
50	Education, culture, arts, radio, film and television	-1.98		0.02	0.49
		(3.16)		(3.13)	
51	Scientific research and polytechnic services	-6.02		0.07	0.88
		(8.29)		(8.27)	
52	Public administration and others	-5.51		0.06	0.92
		(10.32)		(10.18)	

Note: ** Soft Constraints.
t-statistics in parentheses.

The second observation from the estimation results is that the service sectors appear to have achieved above-average wage growth. Among the 13 service sectors that display a significant trend, all but three are positively trended. Several sectors such as Communication, Health care, sports and social welfare, and Scientific research and polytechnic services, have showed significant and substantial coefficients on the time trend, indicating wage growth in these industries were particularly strong. Not coincidentally, Communication was an industry that was state monopolized and that experienced tremendous domestic demand. The other two sectors, Health care, sports and social welfare and Scientific research and polytechnic services, were human-capital intensive, which, in the old planning system, was undervalued as intellectuals providing professional services such as medical services, scientific research and technical services, and educational services were significantly underpaid. The market force during economic reform was apparently strong enough so that the undervalued human capital was appreciated. Therefore, rapid growth of wage rates in these sectors was partly due to the catching-up process, and partly reflective of relatively short supply of well trained professionals.

Profits

MuDan divides capital income into two parts: profits and capital consumption or depreciation. Profits in MuDan include net profits, proprietor income, and net interest payment by business, and account for a large portion of capital income. Because profits tend to be cyclically volatile, they often serve as primary barometers for business conditions and main indicators for the business cycle. Capital consumption allowances, on the other hand, are not cyclical and tend to move steadily over the business cycle. Because of the differences in their behavior, profits and depreciation are naturally modeled separately.

Profits are notoriously volatile. Furthermore, profit movements across sectors tend to be heterogeneous rather than uniform over time because of the heterogeneity of factors that affect profits. Therefore, profits are difficult to model. However, because profits are a large component of value added, which, through the input-output equations, determines sectoral prices in MuDan, they constitute a direct part of price determination and play a vital role in the price-income side of the model.

The volatility of profits and the heterogeneity of sectoral profit movements have caused difficulties for modelers, many of whom have chosen not to specify explicitly the profit equation in macro models. For example, FRB/US, an aggregate macro model developed by the Federal Reserve Board, includes a single aggregate price equation that is specified as a restricted version of the VAR models (Brayton and Tinsley, 1996; Sims, 1980). Another example is MDM, the Cambridge Dynamic Multisectoral Model built by the Cambridge Growth Project team at the Cambridge University. Prices in the MDM model are determined by industry mark-up equations, and profits are not modeled explicitly except as part of the overall mark-up over labor costs (Barker and Peterson, 1987). Some aggregate macro models do have profit equations and profits are generally modeled by a single equation based on demand conditions in aggregate macro models. For example, the QUEST model, an aggregate macro model developed by Almon (1989), includes an explicit corporate profit equation whose primary explanatory variables include gross private product (GPP), the first difference of GPP, and lagged values of the first difference.

Profits are normally modeled explicitly in INFORUM type of multisectoral models (Monaco, 1991, 1994; Shackleton, 1992; and Werling, 1992). In Monaco's specification (1994) for LIFT, a multisectoral macroeconomic model for the U.S., sectoral profit equations are modeled based on mark-up over labor costs, allowing for changes in demand and changes in input costs to affect markup. The demand effect can be industry-specific, which is measured by change in real output, or aggregate, which is measured by tightness of labor market and is shown by the square of the ratio of the non-accelerating inflation rate of unemployment (NAIRU) to the actual unemployment rate. Input costs are calculated using the column of the input-output coefficient table. To ensure complete pass-through of input costs to prices, often with lags, coefficients on current and lagged costs are constrained to sum to zero.

Shackleton (1992) and Werling (1992) used similar profit specifications. In an INFORUM type of model for the Spanish economy, Werling modeled profits based on cost markups. In Werling's specification, the profit margin was computed as a proportion of nominal profits at factor cost, which equals capital plus labor income, rather than as a proportion of labor cost. The primary explanatory variable was the percentage change in output, a cyclical variable that was intended to explain the demand conditions. Other explanatory variables included the real unit labor cost for non-tradable goods sectors, a real exchange rate for some tradable goods sectors, and dummy variables.

Given the heterogeneity of sectoral profit movements and the important role that the profit equation plays in determining sectoral prices, it would be preferable to apply an eclectic approach, by employing different explanatory factors that could influence a sector's profitability, to estimating sectoral profit equations. However, short history of sectoral profit data has made elaborate specifications impossible. MuDan's profit equation has to focus on a small number of the most important determinants, which must include both industry specific and economy-wide factors. After experimenting with various specifications, the following form was adopted in the model:

$$pmrg_{i,t} = a_0 + a_1 * pcq_{i,t} + a_2 * unsq_t + a_3 * T \qquad (5)$$

where *pmrg* = profits divided by output in current prices,

pcq = the percentage change of current output,

unsq = the inverse of unemployment rate ratio squared,

T = a simple time trend, and

α_0, α_1, α_2, and α_3 are coefficients.

The dependent variable is essentially a markup over the full cost. For lack of empirical evidence on how profits are determined in the Chinese economy, closeness of fit is the only criteria that I use in choosing among alternative specifications. Modeling profits as a markup over either labor costs or factor cost alone does not yield nearly as good fits as modeling profits as a markup over all costs.

The change in production variable, $pcq_{i,t}$, is intended to model the pro cyclical movements of profits at sectoral level, and the coefficient on $pcq_{i,t}$ should have a positive sign. The impact of the overall slackness of the economy on sectoral profitability is explained by the unemployment variable, $unsq_t$, whose coefficient is also expected to have a positive sign. A simple time trend is used to account for everything else that is not explicitly identified. In addition, a dummy variable is used for several sectors to account for data irregularities around the 1989-90 period. The dummy variable is set to equal 1 in 1990 and 0 otherwise.

The use of current prices in the profit equation and profits are used in the input-output equations for sectoral prices make it necessary to employ an iterative procedure to determine prices and profits simultaneously. MuDan's simulation program indeed institutes a price-income sub-loop that, through an iterative procedure, solves for profits and prices simultaneously. Simulation shows that the price-income sub-loop converges fairly quickly, indicating that the simultaneity problem does not appear to have caused serious convergence problem to the model.

The regression results are shown in Table 26. Where soft constraints have been used, the t statistics are replaced by **. Given the volatile nature of profits and relatively simply explanatory variables that are used in the specification, the estimation results seem reasonable. The R-squared values for many sectors seem fairly high.

Table 26 - Regression Results of Sectoral Profits

	Sector	Const	Output Growth	Time Trend	Unemp Rate	Dummy	RBSQ
1	Farming	0.140	0.010	-0.001	0.001		0.70
		(6.93)	**	(4.46)	**		
2	Forestry	0.133	0.010	-0.001	0.001		0.49
		(6.15)	**	(3.16)	**		
3	Livestock	0.113	0.010	-0.001	0.001		-0.11
		(3.41)	**	(2.04)	**		
4	Fishing	0.137	0.010	-0.001	0.001		0.11
		(4.11)	**	(2.23)	**		
5	Coal mining	-1.094	0.136	0.011	0.056		0.37
		(1.70)	(1.40)	(1.64)	(2.23)		
6	Crude petroleum and natural gas production	-0.285	0.027	0.006	0.065		0.37
		(0.32)	(0.27)	(0.57)	(2.01)		
7	Ferrous ore mining	0.150	0.033	-0.001	0.030		0.63
		(0.27)	(0.39)	(0.17)	(1.52)		
8	Non-ferrous ore mining	-0.047	0.009	0.001	0.014		-0.18
		(0.14)	**	(0.40)	(1.04)		
9	Non-metal minerals, and mining n.e.c.	0.322	0.101	-0.003	0.017		0.61
		(1.03)	(2.93)	(0.91)	(1.46)		
10	Logging and transport of timber and bamboo	0.538	0.010	-0.003	0.003		-0.13
		(1.11)	**	(0.65)	(0.15)		
11	Food process & manufacturing	-0.406	0.048	0.005	0.004		0.45
		(1.10)	(1.14)	(1.29)	(0.31)		
12	Beverages	-0.256	0.009	0.004	0.010		-0.02
		(1.35)	**	(1.76)	(1.34)		
13	Tobacco manufacture	0.193	0.010	-0.002	0.000		0.13
		(2.49)	**	(1.99)	**		
14	Textiles	0.178	0.054	-0.001	0.004		0.17
		(0.75)	(1.64)	(0.48)	(0.42)		
15	Wearing apparel	-0.021	0.060	0.001	0.007		-0.13
		(0.05)	(1.02)	(0.19)	(0.44)		
16	Leather, fur and their products	-0.017	0.041	0.001	0.001		0.59
		(0.13)	(2.78)	(0.49)	**		
17	Sawmills and bamboo etc. products	0.394	0.096	-0.004	0.001		0.81
		(3.33)	(6.34)	(2.91)	**		
18	Furniture	0.605	0.007	-0.005	0.006		0.85
		(2.63)	(0.42)	(2.15)	(0.78)		
19	Paper and paper products	0.525	0.033	-0.005	0.006		0.89
		(3.87)	(1.49)	(3.29)	(0.98)		
20	Printing industries	0.138	0.074	-0.001	0.004		0.11
		(0.39)	(0.92)	(0.18)	(0.27)		
21	Cultural, education, sports articles	0.777	0.058	-0.008	0.013		0.92
		(3.36)	(2.10)	(3.18)	(1.62)		
22	Petroleum refineries and coking products	0.689	0.007	-0.007	0.010	-0.015	0.94
		(3.37)	(0.17)	(3.02)	(1.56)	(1.49)	
23	Chemical industries	0.305	0.001	-0.003	0.005		0.83
		(3.27)	(0.04)	(2.54)	(1.29)		
24	Medicines	-0.303	0.010	0.004	0.018		0.35
		(1.85)	**	(2.56)	(2.67)		
25	Chemical fibres	0.357	0.008	-0.003	0.008		0.22
		(1.03)	**	(0.80)	(0.60)		
26	Rubber products	0.335	0.010	-0.003	0.015		0.76
		(1.60)	**	(1.34)	(1.80)		
27	Plastic products	0.055	0.010	0.000	0.004		-0.28
		(0.41)	**	(0.22)	(0.74)		
28	Building materials	-0.035	0.069	0.001	0.011		0.52
		(0.12)	(2.32)	(0.37)	(1.05)		
29	Primary iron and steel manufacturing	0.066	0.017	0.000	0.012	-0.025	0.72
		(0.39)	(1.24)	(0.19)	(1.72)	(2.71)	
30	Primary non-ferrous metals manufacturing	0.187	0.050	-0.001	0.005	-0.008	0.76
		(1.78)	(2.46)	(1.14)	(1.12)	(1.15)	

Notes: ** Soft Constraints.
t-statistics in parentheses.
Dummy = 1 for 1990, and 0 otherwise.

Table 26 - Regression Results of Sectoral Profits (Cont.)

	Sector	Const	Output Growth	Time Trend	Unemp Rate	Dummy	RBSQ
31	Metal products	0.548	0.074	-0.005	0.001		0.57
		(3.56)	(2.73)	(2.97)	**		
32	Machinery	0.553	0.003	-0.005	0.012		0.80
		(1.74)	(0.09)	(1.44)	(0.93)		
33	Railroad equipment	-0.799	0.057	0.009	0.024	-0.016	0.86
		(3.66)	(2.47)	(3.87)	(2.71)	(1.52)	
34	Motor vehicles	0.104	0.010	0.000	0.022		0.75
		(0.54)	**	(0.07)	(2.88)		
35	Shipbuilding and repair of ships	-0.095	0.082	0.002	0.005	-0.021	0.61
		(0.19)	(1.49)	(0.29)	(0.30)	(1.48)	
36	Aircraft	-1.031	0.015	0.012	0.033	-0.021	0.79
		(3.51)	(0.61)	(3.81)	(2.83)	(1.47)	
37	Transportation equipment n.e.c.	-0.801	0.010	0.009	0.034		0.43
		(2.58)	**	(2.81)	(2.70)		
38	Electric machinery and instrument	0.435	0.028	-0.004	0.003		0.70
		(2.17)	(1.33)	(1.72)	(0.40)		
39	Electronic and communication equipment	0.245	0.020	-0.002	0.009		0.65
		(1.11)	(1.11)	(0.72)	(0.95)		
40	Instrument, meters and other measuring equipment	0.528	0.043	-0.005	0.010		0.68
		(1.29)	(1.02)	(1.07)	(0.71)		
41	Industries n.e.c	-0.227	0.053	0.003	0.001		-0.01
		(0.77)	(0.85)	(1.03)	**		
42	Electricity, steam and hot water	-0.066	0.010	0.001	0.030		0.45
		(0.18)	**	(0.35)	(2.08)		
43	Gas production and supply	-1.144	0.077	0.011	0.007		0.52
		(2.06)	(1.20)	(1.86)	(0.29)		
44	Production and supply of water	-0.688	0.009	0.008	0.046		0.13
		(1.19)	**	(1.26)	(1.96)		
45	Construction	-0.076	0.009	0.001	0.013		0.77
		(0.74)	(1.10)	(1.11)	(3.19)		
46	Railway transportation	0.015	0.010	0.002	0.000		-0.23
		(0.09)	**	(1.19)	**		
47	Highway transportation	-0.015	0.010	0.003	0.001	-0.029	0.21
		(0.11)	**	(1.98)	**	(2.03)	
48	Water transportation	-0.013	0.010	0.002	0.001	-0.024	0.16
		(0.12)	**	(1.92)	**	(2.02)	
49	Air transportation	-0.011	0.009	0.003	0.001	-0.028	0.03
		(0.08)	**	(1.75)	**	(1.95)	
50	Pipeline transportation	-0.012	0.010	0.002	0.001	-0.018	0.18
		(0.16)	**	(1.98)	**	(2.18)	
51	Communications	0.204	0.059	0.000	0.001		-0.08
		(0.57)	(0.61)	(0.05)	**		
52	Commerce	-0.603	0.009	0.010	0.002	0.038	0.85
		(2.54)	**	(3.82)	(0.19)	(2.87)	
53	Restaurants	-0.505	0.010	0.008	0.004	0.030	0.88
		(3.01)	**	(4.43)	(0.58)	(3.22)	
54	Finance and insurance	0.370	0.008	-0.001	0.001	0.032	-0.72
		(0.77)	**	(0.24)	**	(0.62)	
55	Real estate management and social services	-2.335	0.009	0.028	0.021	0.049	0.90
		(4.94)	**	(5.53)	(1.07)	(1.87)	
56	Health care, sports and social welfare	-0.323	0.010	0.004	0.003		0.80
		(3.52)	(0.51)	(3.85)	(0.78)		
57	Education, culture, arts, radio, film and television	-0.214	0.005	0.003	0.001		0.88
		(3.40)	(0.36)	(3.91)	(0.30)		
58	Scientific research and polytechnical services	-0.931	0.010	0.011	0.007	0.006	0.92
		(5.57)	**	(6.22)	(1.00)	(0.65)	
59	Public administration and others	-0.222	0.010	0.003	0.000		0.66
		(2.11)	**	(2.39)	(0.00)		

Notes: ** Soft Constraints.
t-statistics in parentheses.
Dummy = 1 for 1990, and 0 otherwise.

Depreciation

Capital consumption allowances, or depreciation, represent accounting depreciation of fixed assets as calculated for tax purposes. They are derived from the current value of the fixed assets, including equipment and structures, that are used in production. Depreciation is fairly predictable, and its movements are relatively stable during the business cycle. Primary determinants of depreciation include the depreciation rate, the method that depreciation is computed, and the size of capital stock.

The depreciation equation is specified as a function of capital stock with the following form:

$$dep_{i,t} = a_0 + a_1 * capstkN_{i,t-1} + a_2 * dum \qquad (6)$$

where *dep* = current value of depreciation,

capstkN = real capital stock inflated by output prices,

dum = a dummy variable, equal to 1 for t <= 1992 and 0 for t>=1993, and

α_0, α_1, α_2, and α_3 are coefficients.

The *capstkN* variable is intended to provide a measure of current capital stock. Since we are using the sectoral price to multiply the real capital stock, which is formed by accumulating real investment, the result is not exactly the current value of capital stock. While I tried to form another capital stock variable by accumulating nominal investment and used it in the specification, the regression results were no better than the current specification. Therefore, the current specification is used in the model. Furthermore, the coefficient on the capital stock variable can be interpreted as the depreciation rate. The primary reason for using the lagged value of the capital stock variable is to avoid the simultaneity problem that may arise because the sectoral price is used in forming the capital stock variable. A dummy variable is used for many sectors because there appears to be a change in pattern in the historical depreciation data series in 1992. Therefore, the dummy variable is set to equal one before 1993, and zero otherwise.

Estimation of the depreciation equation is straightforward. For each sector, the equation is first estimated without the dummy variable, and then estimated with the dummy variable. If the coefficient on the dummy variable is not statistically significant, or if the R-squared value for the regression with the dummy is not significantly improved over the one without the dummy, then the equation without the dummy is used. For most sectors, either or both forms yielded fairly good fits with a reasonable depreciation rate, whose *a-priori* value is 10% for machinery and equipment and 4% for structure. Because unconstrained estimates of the depreciation rate for several sectors, namely sectors 34, 38, 44, 46, and 47, are unreasonably high, coefficients on the capital stock for these sectors are softly constrained to be 8%. Estimation results are displayed in Table 27.

Table 27 - Regression Results for Depreciation

	Sector	Const	Capstk	Dummy	RBSQ
1	Agriculture	-18.8308	0.0817	-52.5913	0.96
		(0.49)	(8.20)	(3.23)	
2	Coal mining	6.0535	0.0447	-17.8161	0.90
		(0.27)	(5.14)	(1.52)	
3	Crude petroleum and natural gas production	104.1428	0.0277	-94.6659	0.84
		(2.21)	(2.34)	(3.40)	
4	Ferrous ore mining	2.9376	0.0371	-3.4401	0.88
		(1.04)	(3.53)	(2.24)	
5	Non-ferrous ore mining	-1.0175	0.0418		0.98
		(1.80)	(22.15)		
6	Non-metal minerals, and mining n.e.c.	7.8611	0.0666	-4.373	0.96
		(1.84)	(6.48)	(1.54)	
7	Logging and transport of timber and bamboo	0.8042	0.0412		0.69
		(0.50)	(4.54)		
8	Food process & manufacturing	47.5075	0.1097	-58.9393	0.99
		(4.13)	(15.16)	(7.89)	
9	Beverages	8.8069	0.0522	-10.844	0.94
		(1.21)	(5.92)	(2.40)	
10	Tobacco manufacture	2.5784	0.0371		0.98
		(6.74)	(20.75)		
11	Textiles	71.9598	0.0617	-62.4877	0.95
		(2.81)	(6.31)	(4.36)	
12	Wearing apparel	16.8296	0.0882	-18.1075	0.99
		(4.41)	(9.08)	(7.47)	
13	Leather, fur and their products	12.8201	0.0983	-15.6783	0.95
		(2.14)	(4.13)	(4.29)	
14	Sawmills and bamboo etc. products	13.0513	0.0315	-10.9764	0.96
		(6.20)	(3.12)	(8.85)	
15	Furniture	9.3095	0.0759	-5.6135	0.90
		(3.85)	(3.26)	(3.49)	
16	Paper and paper products	6.9311	0.057		0.93
		(3.62)	(11.35)		
17	Printing industries	10.5491	0.0576	-6.9353	0.93
		(3.29)	(4.64)	(3.26)	
18	Cultural, education, sports articles	3.5074	0.0374	-2.9767	0.94
		(3.04)	(4.96)	(3.99)	
19	Petroleum refineries and coking products	34.9469	0.0444	-20.5472	0.87
		(2.95)	(3.23)	(2.47)	
20	Chemical industries	20.9678	0.0547	-14.3809	0.96
		(1.15)	(9.66)	(1.27)	
21	Medicines	3.931	0.0626	-3.6803	0.97
		(1.31)	(9.66)	(1.80)	
22	Chemical fibres	4.337	0.0322		0.78
		(1.62)	(5.76)		
23	Rubber products	2.3735	0.0613		0.95
		(2.87)	(12.72)		
24	Plastic products	12.8327	0.0889	-14.3064	0.96
		(1.97)	(7.42)	(3.71)	
25	Building materials	97.9061	0.0546	-89.6544	0.94
		(3.17)	(4.19)	(4.97)	
26	Primary iron and steel manufacturing	129.2251	0.0478	-126.4966	0.96
		(4.52)	(4.33)	(7.37)	

Note: ** Soft Constraints
t-statistics in parentheses

Table 27. Regression Results for Depreciation (Cont.)

	Sector	Const	Capstk	Dummy	RBSQ
27	Primary non-ferrous metals manufacturing	22.364	0.0418	-19.7346	0.97
		(4.99)	(7.64)	(7.19)	
28	Metal products	32.9574	0.0607	-24.7011	0.99
		(7.74)	(11.09)	(8.26)	
29	Machinery	62.034	0.0537	-15.1903	0.96
		(3.31)	(7.46)	(1.11)	
30	Transportation equipment	47.6275	0.0528	-33.917	0.95
		(3.06)	(4.91)	(2.76)	
31	Electric machinery and instrument	28.3166	0.0489	-17.1763	0.97
		(3.65)	(6.83)	(3.04)	
32	Electronic and communication equipment	11.2882	0.0706	-17.1817	0.95
		(1.05)	(6.11)	(2.63)	
33	Instrument, meters and other measuring equipment	11.3326	0.0719	-9.0386	0.98
		(5.79)	(5.96)	(7.56)	
34	Industries n.e.c	64.9128	0.0952	-52.2245	0.95
		(11.43)	**	(9.31)	
35	Electricity, steam and hot water	-13.4208	0.0478		0.91
		(0.81)	(9.71)		
36	Gas production and supply	-0.679	0.0207	0.9197	0.88
		(0.66)	(6.12)	(1.28)	
37	Production and supply of water	1.4971	0.0487		0.96
		(2.06)	(14.74)		
38	Construction	88.5759	0.108	-72.4368	0.85
		(3.52)	**	(3.90)	
39	Railway transportation	7.4693	0.0741		0.93
		(0.70)	(11.06)		
40	Highway transportation	2.6588	0.0533	-8.7153	0.99
		(0.36)	(13.38)	(1.81)	
41	Water transportation	-10.6401	0.0581		0.97
		(2.87)	(16.84)		
42	Air transportation	-0.8358	0.0454		0.90
		(0.62)	(8.88)		
43	Pipeline transportation	2.3004	0.0902	-1.6611	0.77
		(3.60)	**	(2.41)	
44	Communications	15.0035	0.0989	-21.6969	0.99
		(1.87)	**	(3.42)	
45	Commerce	-20.2343	0.0917		0.93
		(1.20)	(10.84)		
46	Restaurants	16.145	0.0919	-12.0547	0.81
		(7.47)	**	(5.14)	
47	Finance and insurance	49.9661	0.1059	-43.5253	0.87
		(4.12)	**	(3.81)	
48	Real estate management and social services	50.3594	0.029		0.93
		(1.68)	(10.97)		
49	Health care, sports and social welfare	-1.6337	0.0596		0.97
		(1.11)	(18.14)		
50	Education, culture, arts, radio, film and television	-9.2872	0.0587		0.99
		(4.09)	(34.98)		
51	Scientific research and polytechnical services	-26.5775	0.0822		0.95
		(4.54)	(13.14)		
52	Public administration and others	-31.6879	0.0546		0.87
		(2.11)	(7.93)		

Note: ** Soft Constraints
t-statistics in parentheses

The regression yields few surprising results. The estimated coefficient on the capital stock variable has an interpretation of the depreciation rate. For most industries, they are fairly low, and are in line with the depreciation rates that had been used in practice before 1993. The depreciation rates of the mining, crude oil exploration, and gas extraction sectors are especially low, with the estimated rates being as low as 2%. The Machinery and equipment sector seems to experience high depreciation rates, presumably because of obsolescence of capital equipment in these rapidly changing industries. It is surprising, however, that the estimated depreciation rates of many service sectors are higher than those of industrial sectors. Since the majority of fixed assets of the service industry are furniture and structure, whose depreciation rates usually range from 2% to 4% (DNEA, 1997f), I had expected relatively small depreciation rates for these sectors. However, even with soft constraint on the coefficient of the capital stock variable, the estimated depreciation rates for many service sectors are still fairly high. Although this may be an indication of misspecification, inadequate depreciation and capital stock data and the inconsistency between the two are most likely to be the main culprits.

Taxes

Taxes in the MuDan model represent indirect business taxes (IBTs) net of subsidies. Direct taxes such as enterprise income taxes are not modeled because they are embodied in other variables that have been modeled. For example, enterprise income taxes are included in profits and personal income taxes are part of labor income. Before 1994, the IBTs for domestic firms were different from the ones for foreign companies. For domestic enterprises, the main IBTs included 13 categories of value added tax (VAT) with tax rates ranging from 8% to 45%, 21 categories of product tax with rates from 3% to 60%, and 4 types of excise tax with rates from 3%

to 15%. For foreign companies, the main IBTs included 40 categories of Uniform Industrial and Commercial Tax, whose tax rates ranged from 1.5% to 69%.

China's Tax System

As China started transforming the old profit-based fiscal system to a tax-based fiscal system, the tax system became rather complicated. Because of its deep root in the central planning system and its necessity to accommodate the distorted and irrational price system under central planning, the tax system had to incorporate many irregularities. For example, because prices of raw materials and energy products were directly or indirectly controlled by the government and usually were set at artificially low levels, the producers of these products had very low profit margins. Therefore, tax regulations had to include special provisions with low VAT rates for these products in order to help their producers to improve profitability. For products with high prices and hefty profits such as tobacco and liquor, on the other hand, the government had set high VAT rates so that the government could collect part of excessive profit gains from artificially set high prices. There were several problems with the old system.

First, the old system was full of uncertainties and inconsistencies. While the government would announce tax exemption stipulations to alleviate tax burdens of enterprises almost every year, it also frequently caught enterprises unprepared by imposing additional taxes without pre-announcement. For example, to reduce enterprises' tax burden, the government stipulated that enterprises deduct loan payments from taxable income. In the meantime, it imposed without warning a 15% special levy, the Energy and Transportation Fund and then a 10% Budget Adjustment Fund, both of which were levied on after-tax income. As a result, although the general enterprise income tax rate remained unchanged at 55%, the effective tax rate could go as high as 66.25%. Such uncertainties in taxes added significant uncertainties to companies' long term planning, especially investment decisions as companies were forced to assume risks of increased tax exposures.

Second, the old system lacked transparency and equity and often was subject to capricious decisions by local tax authorities. The central and local tax administrations under the old system were authorized to make tax reductions and exemptions to enterprises encountering hardship. In practice, therefore, an enterprise's actual tax burdens were determined by its negotiations with tax authorities, and the amount of taxes exempted through the negotiations was often determined by non-economic factors such as connections with the local tax authorities. As a result, enterprises under similar circumstances with the same income might end up paying different taxes. The lack of equity was also reflected in the differential treatment of foreign and domestic enterprises. Therefore, companies were not playing on a level field. In addition, because the central government's tax revenues were collected by local tax administrations, which were part of local governments, there was conflict of interest between tax collection for the central government and serving the interest of the local government. As a result, local tax administrations frequently made excessive tax exemptions to local enterprises and, therefore, allowed local governments to benefit at the expense of the central government's tax revenues. As a market system took shape in the Chinese economy, the old tax system could no longer meet the needs of a changing economic environment.

A major overhaul of the tax system took place in 1994. Several important steps were undertaken in the 1994 reform. First, the new system significantly simplified the tax categories. In the old system, there were 32 categories of taxes in addition to import tariff and the agricultural tax. In the new system, the number of tax categories other than tariff and the agricultural tax has been reduced to 18. Furthermore, a uniform set of IBT regulations is applied to all companies conducting business in China regardless of their ownership. Therefore, domestic or foreign companies, and public or private companies are subject to the same set of tax codes. As a result, the tax system becomes less discriminating one way or the other. Another major reform step was to establish two parallel tax collection systems, the Administration of National Taxation, which is responsible for collecting national taxes and national and local shared taxes, and the Administration of Local Taxation, which is responsible for collecting local taxes. At the same time, tax categories are clearly divided into national taxes, local taxes, and national and local shared taxes. For national-local shared taxes, the shares of the central and local governments are also clearly defined.

A uniform VAT system is the cornerstone of the new IBT systems under the 1994 tax reform. The VAT rates include 0%, 6%, 13%, and 17%. For most products, a single VAT rate of 17% applies. The other tax rates apply to exceptional cases. Agricultural products such as grain, milk and meat are exempted from VAT. Agricultural chemicals, agricultural machinery, gas and water supply, and natural gas extraction carry a reduced VAT rate of 13%. The 6% rate is only used in a handful of products.

The 1994 tax reform unified the tax rates for domestic companies, whose rates had been divided according to their ownership. A single tax rate of 33% applies to all domestic enterprises. Therefore, the new tax system is more equitable for domestic companies, and beneficial to encourage fair competitions among domestic companies. At the same time, a uniform tax schedule applies to personal income of domestic and foreign taxpayers, including proprietor income of the self-employed. However, the new enterprise income tax regulation does not apply to foreign companies, which are subject to a separate set of income tax regulations.

Tax Equation

Several difficulties exist in modeling sectoral indirect taxes in MuDan. First, because much of the estimation period, 1984 to 1994, falls under the old tax system, which as we mentioned in the previous section was full of ad hoc changes and irregularities, it is rather difficult to quantify the complicated tax rules into a model such as MuDan. Furthermore, the extensive use of profits in lieu of taxes further blurred the picture of true tax burdens. While the new VAT system will make it easier for MuDan to have good tax equation, it will be at least several years away before historical VAT data can be used in empirical modeling. Given these problems and the low quality of the historical data, MuDan has adopted a simplified approach in modeling taxes.

MuDan computes the ratio of taxes to output and uses the ratio as a proxy for tax rates. The use of the tax-output ratio to represent the tax rate is natural because IBT tax rates under the old tax system usually were specified based on tax-inclusive prices (Li and Gong, 1991). Behavioral equations for taxes in MuDan are estimated for the tax-output ratio variable, which is a policy variable that can be varied during simulation. If the tax-output ratios are exogenously given, the exogenous values override the equation estimates.

Tax rates are usually exogenous to a model because they are set by tax authorities and historical data is a poor predictor of future tax rates. If any variable is appropriate by exogenously given, it is the tax rate. Therefore, whenever new information on the tax-output ratio is available, such as when a new I-O table is released, the new information should be used to replaced or modify the results predicted by the tax equation. The main purpose to establish a tax equation is is to provide a base forecast of taxes so that a simulation can be completed without having to rely on exogenous input of tax rates, which are not readily available. For simulations that do not involve tax policy analysis, the tax equation provides a useful alternative to specifying actual tax rates.

MuDan's tax equation is explained by a simple time trend. Therefore, the tax-output ratios are, in essence, determined exogenously. Initially, I tried variables such as sectoral output growth as explanatory variable. However, the simple time trend overpowers other variables once it is included in the specification. If the time trend is not present, other variables have little explanatory power. Consequently, the time trend ends up being the only explanatory variable. The estimated tax equation has the following form:

$$taxout_{i,t} = a_0 * (1 - \frac{a_1}{T} + \frac{a_2}{T^3}) \qquad (7)$$

where *taxout* = the ratio of taxes and current value of output,

T = a time trend started in 1971 (1971=1), and

α_0, α_1, α_2, and α_3 are coefficients.

Originally, I estimated a linear form of the tax-output ratio equation with the time trend T being the only explanatory variable. Both the linear and the non-linear forms have reasonable fit during the historical period. However, the predicted values by the two equations often differ substantially. The non-linear form is selected because its prediction appears more reasonable, particularly in the long run, while the prediction of the linear form often moves off the limit as will be exemplified next. The complete regression results are shown in Table 28.

Table 28 - Regression Results for Taxes

Sector	a_0	a_1	a_2	SEE
1 Agriculture	1.0	-36.4	-2146.6	0.04
	(16.79)	(12.21)	(15.81)	
2 Coal mining	-4.3	1.3	1580.8	0.42
	(1.42)	(0.07)	(1.10)	
3 Crude petroleum and natural gas production	2.5	18.3	2431.5	0.09
	(2.22)	(4.14)	(6.57)	
4 Ferrous ore mining	2.6	-3.8	4592.0	0.29
	(1.78)	(0.19)	(7.14)	
5 Non-ferrous ore mining	0.7	-73.5	825.6	0.27
	(0.80)	(0.62)	(1.05)	
6 Non-metal minerals, and mining n.e.c.	3.3	-13.5	6755.9	0.52
	(2.70)	(0.71)	(9.08)	
7 Logging and transport of timber and bamboo	0.6	-350.1	-27904.6	0.55
	(3.81)	(4.41)	(40.90)	
8 Food process & manufacturing	13.6	20.8	2099.5	0.31
	(3.27)	(9.25)	(6.37)	
9 Beverages	14.1	3.3	719.7	0.84
	(2.93)	(0.39)	(0.82)	
10 Tobacco manufacture	26.1	-21.8	-1571.5	1.82
	(6.71)	(3.42)	(2.91)	
11 Textiles	3.4	-6.6	708.1	0.22
	(2.30)	(0.47)	(0.94)	
12 Wearing apparel	4.9	11.1	2507.3	0.31
	(0.90)	(0.58)	(3.22)	
13 Leather, fur and their products	3.5	4.4	2079.0	0.20
	(1.47)	(0.28)	(4.10)	
14 Sawmills and bamboo etc. products	1.6	-42.9	1998.4	0.42
	(0.60)	(0.38)	(2.19)	
15 Furniture	0.3	-235.4	14295.7	0.21
	(1.65)	(1.31)	(29.89)	
16 Paper and paper products	1.4	-64.2	1642.5	0.25
	(1.08)	(0.79)	(3.32)	
17 Printing industries	4.8	4.4	1801.1	0.17
	(3.39)	(0.67)	(5.55)	
18 Cultural, education, sports articles	0.6	-161.2	4165.9	0.20
	(0.86)	(0.72)	(10.36)	
19 Petroleum refineries and coking products	5.0	-14.5	7647.7	0.93
	(2.44)	(0.66)	(12.63)	
20 Chemical industries	0.4	-394.8	-17558.4	0.30
	(3.66)	(4.04)	(25.08)	
21 Medicines	14.4	14.1	1651.1	0.34
	(3.84)	(3.92)	(4.49)	
22 Chemical fibres	2.1	-44.4	-975.5	0.58
	(1.86)	(1.35)	(0.72)	
23 Rubber products	9.7	7.1	2470.4	0.55
	(1.69)	(0.60)	(9.11)	
24 Plastic products	4.2	2.2	1684.0	0.18
	(3.19)	(0.28)	(4.25)	
25 Building materials	5.5	1.3	2088.1	0.43
	(1.10)	(0.06)	(2.38)	
26 Primary iron and steel manufacturing	12.1	13.0	2004.7	0.36
	(3.22)	(2.92)	(6.36)	

Note: t-statistics in parentheses

Table 28 - Regression Results for Taxes (Cont.)

Sector	a_0	a_1	a_2	SEE
27 Primary non-ferrous metals manufacturing	7.4	10.1	1896.2	0.26
	(2.38)	(1.34)	(3.45)	
28 Metal products	1.2	-66.8	3861.8	0.20
	(0.79)	(0.54)	(11.74)	
29 Machinery	0.7	-146.1	4058.1	0.24
	(0.50)	(0.41)	(7.34)	
30 Transportation equipment	11.5	16.3	2372.6	0.17
	(5.93)	(8.35)	(17.05)	
31 Electric machinery and instrument	6.8	6.6	2208.2	0.20
	(2.56)	(0.79)	(5.48)	
32 Electronic and communication equipment	6.7	10.8	2415.9	0.13
	(4.89)	(3.23)	(17.25)	
33 Instrument, meters and other measuring equipment	4.0	-8.4	1972.2	0.24
	(0.92)	(0.21)	(1.62)	
34 Industries n.e.c	3.7	-6.9	1162.8	0.44
	(1.34)	(0.28)	(0.98)	
35 Electricity, steam and hot water	14.5	13.5	2508.8	1.00
	(1.30)	(1.26)	(4.75)	
36 Gas production and supply	1.0	-24.9	15428.4	0.82
	(1.80)	(0.49)	(6.61)	
37 Production and supply of water	4.9	14.3	2056.3	0.28
	(1.73)	(1.87)	(3.03)	
38 Construction	5.5	13.4	655.2	0.24
	(1.82)	(1.61)	(0.45)	
39 Railway transportation	5.6	0.7	-324.2	0.25
	(4.45)	(0.12)	(0.50)	
40 Highway transportation	4.8	-6.9	-1278.5	0.27
	(8.45)	(2.01)	(2.67)	
41 Water transportation	3.1	0.7	-324.3	0.14
	(4.37)	(0.11)	(0.47)	
42 Air transportation	3.8	0.7	-324.2	0.17
	(3.51)	(0.09)	(0.39)	
43 Pipeline transportation	7.5	0.7	-324.6	0.34
	(3.35)	(0.08)	(0.31)	
44 Communications	3.9	0.7	-324.0	0.18
	(3.04)	(0.08)	(0.33)	
45 Commerce	2.0	14.1	1015.0	0.04
	(4.80)	(4.57)	(2.02)	
46 Restaurants	10.8	14.1	1015.5	0.21
	(5.62)	(5.50)	(2.39)	
47 Finance and insurance	0.7	-393.9	-59293.9	0.91
	(5.16)	(7.43)	(10.23)	
48 Real estate management and social services	25.6	21.8	1869.1	0.43
	(5.03)	(16.30)	(6.71)	
49 Health care, sports and social welfare	2.1	23.8	2016.7	0.04
	(4.20)	(20.34)	(6.65)	
50 Education, culture, arts, radio, film and television	6.7	24.2	2427.8	0.11
	(5.04)	(27.75)	(13.27)	
51 Scientific research and polytechnical services	14.6	22.3	1705.7	0.14
	(6.99)	(22.62)	(6.53)	
52 Public administration and others	5.9	23.7	2059.0	0.19
	(2.29)	(10.29)	(3.32)	

Note: t-statistics in parentheses

A nice feature of the nonlinear logistic curve type of the tax-output equation is the existence of an asymptote, which prevents the projected tax-output ratio from divergence. In that sense, the projection of the nonlinear form is relatively more conservative than the estimate of the linear form. Figure 15 displays, as examples, historical and forecasted tax-output ratios for the first six aggregate sectors to demonstrate the typical fits of the two forms. The fit for Sector 1 Agriculture is typical for many sectors. Both historical fit and predicted future values from the two forms show relatively small differences. The fit for Sector 2 Coal mining exemplifies the relatively conservative estimate of the non-linear form. While both showing an upward trend, prediction of the non-linear form shows less drastic changes than that of the linear form. The estimations for Sector 3 Crude petroleum and natural gas are puzzling: the linear and the nonlinear forms have made opposite projections. While the non-linear form seems to have better fit, its projection of a turning around does not seem convincing. However, without further information to choose one or the other, I have opted to select the non-linear form. The nonlinear form makes differences in the forecasts of the remaining three sectors. Instead of predicting vary small or even negative tax-output ratios by the linear form, projections of the nonlinear, although conservative, seem to have made more sense. Estimations for Sectors 4, 5 and 6 illustrate a point similar to the one for Sector 2. Both the linear and the non-linear forms show a downward slope. However, the linear prediction is so radical that the tax-output ratios would go negative, possible but very unlikely. Therefore, the non-linear predictions seem more reasonable.

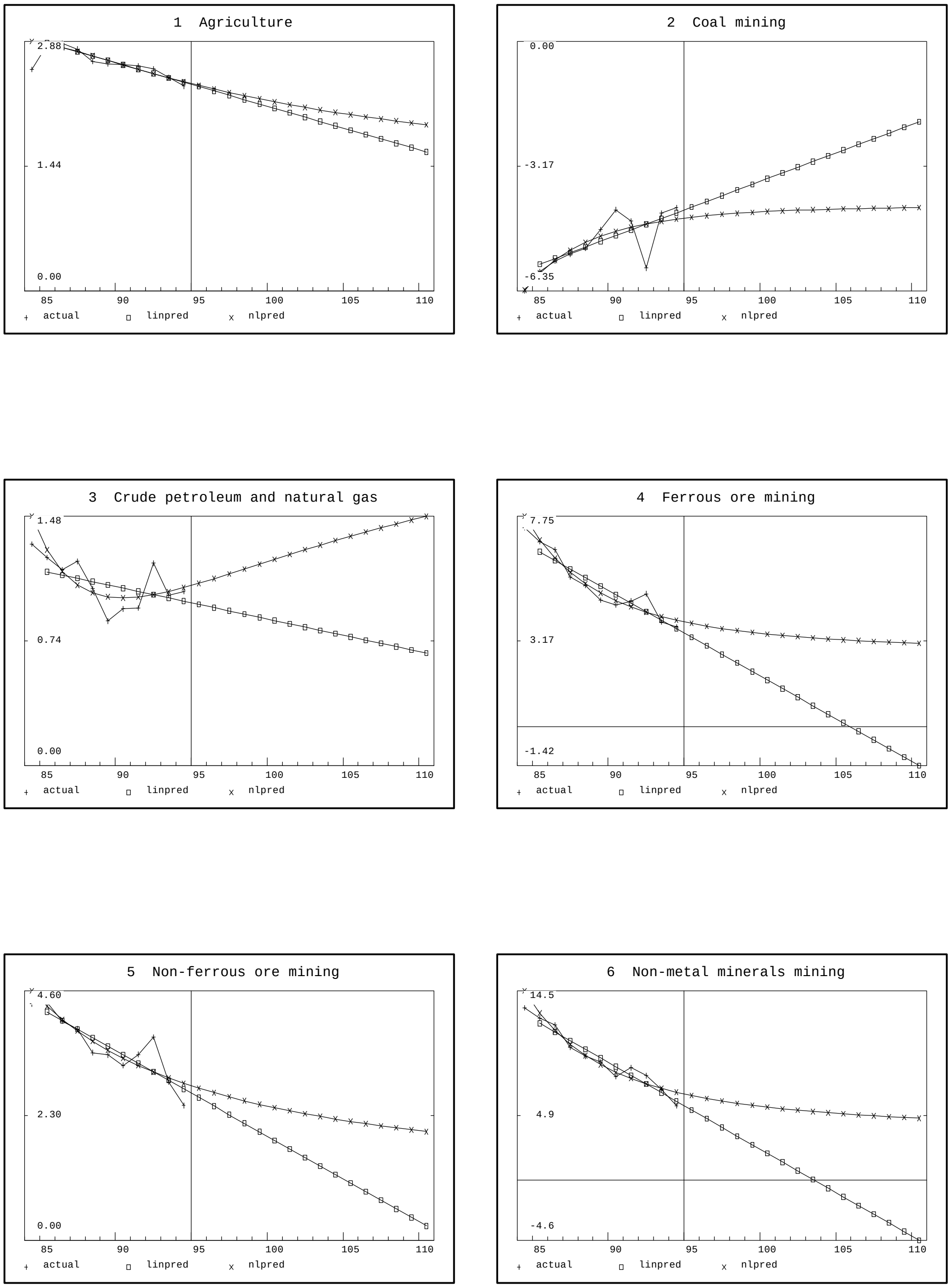


Figure 15 - Estimation of the Tax Equation

(+ actual, • linear prediction, × non-linear prediction)

CHAPTER VIII :

PRODUCTIVITY, EMPLOYMENT AND THE ACCOUNTANT

This chapter covers two important components of MuDan: labor productivity and employment, and the Accountant. Sectoral labor productivity, defined as constant price gross output divided by employment in MuDan, is estimated in the model by behavioral equations. Since output is solved from the input-output equation, the determination of productivity suffices to determine employment, which is simply real output divided by productivity.

The Accountant establishes the connection among various components of the model. It compiles national economic aggregates such as GDP, the unemployment rate, and inflation. It also determines macroeconomic variables such as the savings rate and the interest rate. In addition, all other macro variables such as personal income for urban and rural residents that are estimated by regression equations are conveniently categorized in the Accountant. The descriptions of regression equations for all the macro variables are therefore logically given in the section of the Accountant.

Productivity and Employment: An Overview

Employment

China has a dual labor market system in which the markets for urban and rural labor laborers are segmented. The urban labor market opens only to people with urban *hukou* or registration of urban residency while the rural market serves participants holding rural *hukou*. Because almost three-quarters of the total labor force are in the rural area, the rural labor market is almost three times as large as the urban market. China's total labor force included 702 million people, and 696 million were "officially" employed.[16] The total labor force in rural area was 494 million and accounted for 70% of the total.

The government's employment policy has been specifically unfavorable to the rural labor force. In the pre-reform period, China's countryside served as a giant reservoir for underused labor force. There was no unemployment by definition in the countryside as rural unemployment was masked by the commune system in which every able man or woman with rural *hukou* was officially employed. Consequently, the collective farming system that avoided rural unemployment resulted in serious disguised unemployment, which became especially evident when economic reform in the late 1970s started a rapid expansion of agricultural output in the face of a large exodus of labor force from agricultural sectors. Since economic reform, farmers freed from the agricultural sectors are gradually allowed to work in non-agricultural sectors and often land in jobs in cities. However, because the *hukou* system remains intact, rural migrants' participation to the urban labor market is still extremely limited even though there are increasing opportunities for the rural labor force.

While the government's employment policy in the past had largely opted to neglect the vast majority of the rural labor force, the government has always kept urban labor markets under close watch and has adopted a proactive employment policy in the urban markets. Urban unemployment has been a particularly sensitive issue and reducing urban unemployment has always been a top priority for the Chinese government. As a result, China probably has one of the lowest urban unemployment

[16] In the Chinese statistics, unemployment includes only those people who are urban residents, unemployed, and have registered in the government employment services. It does not include those who are out of active duty (*xiagang*), the ones who are laid off but still receive a stipend from their previous employers. Unemployment also does not include rural unemployment, which is zero by definition. For 1997, the official urban unemployment rate is 3.1%. Some economists estimate that, if a more standard definition is used, the urban unemployment rate is as high as 7% (Hu, 1998).

rates among large and populous developing countries. As displayed in Table 29, the urban unemployment rate, the only publicly available unemployment index, has been maintained at less than 3% for most of the 1980s and 1990s. Such low unemployment rates have been achieved through active intervention by the government, which includes restriction of rural-urban migration as well as the segmentation of the urban and rural labor markets. As a long-standing government policy, permanent positions in state-owned enterprises are open only to urban labor markets. Although urban residency does not guarantee a permanent position in state-owned enterprises, an urban *hukou* is almost always a prerequisite for a permanent position in state-owned enterprises. In addition, the government, through direct assignments or providing financial incentives such as favorable loans, encourages managers to select production technologies that substitute equipment, energy and other materials for labor (Jefferson and Rawski, 1992).

Table 29 - Urban Unemployment Rate

(percent)

1978	1980	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
5.3	4.9	1.8	2.0	2.0	2.0	2.6	2.5	2.3	2.3	2.6	2.8	2.9	3.0	3.1

Source: TJNJ 1997, T4-21.

China's labor force is highly concentrated in the agricultural sectors. In the pre-reform year of 1978, almost 71% of the total labor force was engaged in agricultural production activities. Economic reform and the concurrent booming economy, however, have transformed a significant portion of the agricultural labor force into manufacturing and service sectors. By 1995, the percentage of the labor force in

Agriculture had dropped to 53%, an average reduction of one percentage point every year since 1978. Given the huge size of the labor force, the one-percentage reduction can be translated into 4 million to 6 million new jobs in non-agricultural sectors. Even more significantly, most of the new openings, including those for urban residents, were created by rural residents rather than by the government (Sabin, 1994). It was a significant reversal of the historical job-creating pattern because, historically, rural residents had sought employment in the cities, not vice-versa.

Employment of the 51 non-agricultural sectors in MuDan for selected years is shown in Table 30, which is sorted by the 1994 employment. As displayed in the table, six sectors accounted for almost half of all non-agricultural employment in 1994. Commerce, including wholesale, retail sales, and catering, was the largest non-agricultural sector, accounting for 14% of the total non-agricultural employment. Construction was close behind, accounting for 12%, followed by Government, which accounted for 8% of the total. Apparently, government as one of the largest employers reflects the legacy of central planning in which everything was controlled by government.

Not only the largest employers, Commerce and Construction were also the largest job creators in the last decade. Although their respective annual growth rates of 6% and 5% were not the fastest, the two industries created 15 and 12 million new jobs, respectively, from 1985 to 1994. The rapid expansion of Commerce coincided with the economic reform that was aimed at establishing a market system, underlining the seriousness and success of China's drive toward a market economy. The development in the construction sector appeared to have reflected the labor-intensive nature of the industry in the Chinese economy and the industry's effort to meet the demand created by the strong domestic and foreign capital investment.

Table 30 - Non-agricultural Employment

Sorted by 1994 Employment
(Levels in thousands of people)

Sector number and title		1985	Cum %	1994	Cum %	1985-94
45	Commerce	21,230	11.3	36,680	14.3	6.1
38	Construction	20,350	22.2	31,880	26.7	5.0
52	Public administration and others	15,980	30.7	20,660	34.8	2.9
50	Education, culture, arts, radio, film and television	12,730	37.5	14,360	40.4	1.3
25	Building materials and other non-metallic mineral products	10,800	43.3	13,110	45.5	2.2
11	Textiles	8,370	47.7	10,090	49.4	2.1
29	Machinery	10,470	53.3	10,020	53.3	-0.5
48	Real estate management and social services	5,240	56.1	8,400	56.6	5.2
47	Finance and insurance	3,730	58.1	7,130	59.4	7.2
2	Coal mining	6,210	61.4	6,960	62.1	1.3
40	Highway transportation	4,340	63.7	6,570	64.7	4.6
51	Scientific research and polytechnical services	6,820	67.4	6,340	67.1	-0.8
46	Restaurants	3,760	69.4	5,870	69.4	4.9
49	Health care, sports and social welfare	6,070	72.6	5,640	71.6	-0.8
8	Food process & manufacturing	4,270	74.9	5,550	73.8	2.9
20	Chemical industries	3,820	76.9	5,320	75.9	3.7
28	Metal products	3,480	78.8	4,500	77.6	2.9
26	Primary iron and steel manufacturing	2,850	80.3	4,420	79.3	4.9
30	Transportation equipment	3,070	81.9	4,400	81.1	4.0
34	Industries n.e.c	2,940	83.5	4,000	82.6	3.4
31	Electric machinery and instrument	2,610	84.9	3,890	84.1	4.4
12	Wearing apparel	2,830	86.4	3,880	85.7	3.5
39	Railway transportation	2,080	87.5	2,760	86.7	3.1
16	Paper and paper products	1,650	88.4	2,400	87.7	4.2
6	Non-metal minerals, and mining n.e.c.	2,120	89.5	2,370	88.6	1.2
24	Plastic products	1,880	90.5	2,360	89.5	2.5
32	Electronic and communication equipment	1,530	91.4	2,260	90.4	4.3
13	Leather, fur and their products	1,180	92.0	2,110	91.2	6.5
41	Water transportation	1,430	92.7	2,090	92.0	4.2
9	Beverages	1,240	93.4	2,050	92.8	5.6
35	Electricity, steam and hot water production and supply	1,340	94.1	2,030	93.6	4.6
17	Printing industries	1,120	94.7	1,420	94.2	2.6
27	Primary non-ferrous metals manufacturing	850	95.2	1,370	94.7	5.3
21	Medicines	660	95.5	1,230	95.2	6.9
44	Communications	930	96.0	1,220	95.7	3.0
3	Crude petroleum and natural gas production	570	96.3	1,160	96.1	7.9
23	Rubber products	840	96.8	1,160	96.6	3.6
33	Instrument, meters and other measuring equipment	830	97.2	1,090	97.0	3.0
18	Cultural, education, sports articles	460	97.5	1,070	97.4	9.4
14	Sawmills and bamboo etc. products	690	97.8	940	97.8	3.4
19	Petroleum refineries and coking products	420	98.1	930	98.1	8.8
5	Non-ferrous ore mining	660	98.4	880	98.5	3.2
15	Furniture	890	98.9	850	98.8	-0.5
7	Logging and transport of timber and bamboo	710	99.3	720	99.1	0.2
22	Chemical fibres	300	99.4	620	99.3	8.1
4	Ferrous ore mining	370	99.6	510	99.5	3.6
10	Tobacco manufacture	250	99.8	390	99.7	4.9
37	Production and supply of water	200	99.9	380	99.8	7.1
36	Gas production and supply	90	99.9	200	99.9	8.9
42	Air transportation	140	100.0	200	100.0	4.0
43	Pipeline transportation	30	100.0	30	100.0	0.0

Note 1) Cum % is cumulative percentage of sectoral employment to total employment.
2) 1985-94 is the average annual percentage change from 1985 to 1994.
3) Sorted by the 1994 employment levels.

Culture, education and sports articles, Petroleum refineries, Chemical fibers, Crude petroleum and natural gas, and Gas production had the fastest employment growth. In each of these industries, employment more than doubled. The significance of the rapid growth in these industries, however, has to be discounted by their small initial bases. Even with the rapid expansion, these five industries remain insignificant in terms of total employment, together representing just 1.5% of the total non-agricultural employment or less than 4 million people in 1994.

While most industries showed employment growth, only four of the 51 sectors showed net job losses during 1985 and 1994. The magnitude of the job losses, however, is rather small.

It seems evident that economic reform has resulted in two important corrections to China's employment structure. First, for the economy as a whole, the once-suppressed service sector has grown rapidly and has gained an increasing share in terms of total employment. Second, labor-intensive light manufacturing industries have shown faster growth than have capital-intensive heavy industries; their difference reflects the development of the Chinese economy's transition toward a consumer-oriented economy. As market competition intensifies, many companies turn to low-pay, hard-working and obedient migrant workers from rural areas (Zhang, 1995; Han and Li, 1994). These migrant workers generally do not enjoy the same level of benefits as do permanent staff, so their employers enjoy significant cost saving.

A large portion of rural labor force freed from the agricultural sector has landed jobs in mining, manufacturing, construction, and service sectors, triggering the process of industrializing the Chinese economy. This large scale of labor transformation from agriculture to non-agricultural industries has been mainly market driven rather than designed by government. Because the changes were almost spontaneous, it is somewhat surprising that, in spite of the rapid change of the economic structure, there was little change in the relative size of employment between the secondary industry and the tertiary or service industry during the 1985 to 1994 period. Secondary industry, including mining, manufacturing, construction and public utilities, maintained roughly 45% while the service industry kept 55% of the total non-agricultural employment. It is unclear, however, whether such a coincidence happened by chance or by choice.

The government's policies of segregating urban and rural labor markets, restricting rural-urban migration, and prodding state enterprises to over-employ have carried significant costs, including the persistent income gap between urban and rural residents, over-paid urban laborers, and distorted labor income relative to capital, energy and materials. In particular, labor productivity suffered from a large hoard of disguised unemployment, which was directly responsible for the persistent inefficiencies and lack of competitiveness in many state enterprises. As the government becomes more flexible to allow market forces to play in the labor markets, dismissal of a large number of workers becomes inevitable. It has already caused social unrest in several regions where state enterprises dominate the local economy. Apparently, the reform of the labor markets has posed a challenge to the Chinese government that will continue well into the next century. It is likely, however, that as more rural labor moves into the non-agricultural sector, urban unemployment may stay at a relatively high level.

Labor Productivity

Labor productivity in MuDan is defined as gross output in 1992 prices divided by employment. Table 31 displays labor productivity by industry for selected years and has been arranged in the descending order of average annual growth of MuDan sectors between 1985 and 994. It is evident from the table that labor productivity growth was strong across industries. During the ten-year period, labor productivity recorded a median annual growth rate of more than 6%. Only 5 of the 52 industries showed mild average decline of labor productivity. Labor productivity growth in industries such as telecommunication, air transportation, and electronic equipment manufacturing was particularly strong. In general, labor productivity growth seemed to be negatively correlated with the initial labor productivity level. That is, labor productivity growth appeared to have occurred in industries with lower labor productivity levels, as displayed in the last column, which shows the rankings of productivity levels in 1985. In fact, nine of the 20 industries showing fastest labor productivity growth were among the 20 of the least productive industries in 1985. In contrast, eight of the 20 most productive industries in 1994 were among the industries showing slowest growth.

Table 31 - Labor Productivity

(Levels in yuan per worker, 1992 prices)

Sec#	Sector Name	1985	1992	1994	85-94
44	Communications	7,800	22,541	38,965	17.9
42	Air transportation	32,383	83,110	104,317	13.0
13	Leather, fur and their products	18,050	30,515	53,293	12.0
24	Plastic products	19,159	37,248	55,983	11.9
32	Electronic and communication equipment	28,310	51,524	81,787	11.8
29	Machinery	16,484	29,882	46,410	11.5
6	Non-metal minerals, and mining n.e.c.	9,802	18,957	27,583	11.5
15	Furniture	26,934	40,310	72,378	11.0
34	Industries n.e.c	17,570	33,335	46,223	10.7
14	Sawmills and bamboo etc. products	15,528	21,393	37,696	9.9
36	Gas production and supply	11,817	33,560	27,850	9.5
31	Electric machinery and instrument	26,537	46,203	62,515	9.5
25	Building materials and other non-metallic mineral products	12,846	21,473	29,720	9.3
33	Instrument, meters and other measuring equipment	20,777	36,692	47,907	9.3
17	Printing industries	16,616	28,094	38,239	9.3
5	Non-ferrous ore mining	10,137	17,231	23,031	9.1
9	Beverages	24,474	43,463	53,249	8.6
20	Chemical industries	32,087	48,422	68,609	8.4
30	Transportation equipment	33,359	55,112	70,378	8.3
8	Food process & manufacturing	33,240	51,235	69,624	8.2
18	Cultural, education, sports articles	15,799	23,184	33,067	8.2
4	Ferrous ore mining	10,575	19,872	21,926	8.1
22	Chemical fibres	42,996	66,054	86,981	7.8
28	Metal products	23,812	35,068	45,993	7.3
16	Paper and paper products	23,532	30,781	43,888	6.9
21	Medicines	37,096	60,670	67,706	6.7
38	Construction	15,370	19,560	26,780	6.2
37	Production and supply of water	18,187	27,737	30,916	5.9
11	Textiles	28,135	33,913	47,730	5.9
12	Wearing apparel	27,225	29,668	45,565	5.7
35	Electricity, steam and hot water production and supply	38,857	63,299	65,013	5.7
2	Coal mining	7,043	10,391	11,310	5.3
47	Finance and insurance	21,021	25,585	33,724	5.3
50	Education, culture, arts, radio, film and television	4,520	5,556	7,152	5.1
40	Highway transportation	15,028	21,384	23,645	5.0
23	Rubber products	33,030	40,520	51,030	4.8
1	Agriculture	2,116	2,664	3,246	4.8
46	Restaurants	13,687	17,208	20,826	4.7
10	Tobacco manufacture	135,578	206,176	197,590	4.2
26	Primary iron and steel manufacturing	46,152	62,244	66,653	4.1
49	Health care, sports and social welfare	10,102	8,521	12,470	2.3
51	Scientific research and polytechnical services	11,533	10,424	14,231	2.3
41	Water transportation	17,963	21,091	21,462	2.0
48	Real estate management and social services	23,481	24,548	26,862	1.5
3	Crude petroleum and natural gas production	65,014	81,287	72,054	1.1
7	Logging and transport of timber and bamboo	18,979	17,382	20,908	1.1
27	Primary non-ferrous metals manufacturing	60,226	70,991	66,107	1.0
45	Commerce	17,591	18,398	17,283	-0.2
43	Pipeline transportation	69,426	56,189	62,700	-1.1
52	Public administration and others	11,622	8,318	9,784	-1.9
19	Petroleum refineries and coking products	114,954	116,897	85,225	-3.3
39	Railway transportation	27,173	24,119	19,192	-3.9

Note: (1) The 85-94 column shows the annual percentage changes during 1985-94.
(2) Sorted by 85-94 growth rates.

Empirical Studies on Productivity

Productivity is closely related to the material well-being and the long-term economic growth of a society. It is well established that there is a close link between gross domestic investment ratios and long-term growth performance. Economists' best efforts to determine the factors that underlie or contribute to productivity growth, however, have had only limited success. Quantifying the underlying factors contributing to productivity growth has been further behind. This study does not propose any new theory. Rather, it attempts to use the best available data and apply an appropriate method to conduct an empirical study. It seems appropriate, therefore, to provide a brief review of quantitative productivity study.

Solow pioneered in the quantitative study of productivity with a defensible technique to measure the individual contributions to economic growth of several major factors (Solow 1957). Economic growth was found much greater than could be explained simply by increases in the quantities of labor and capital used in production. Much of the unexplained increment of growth, the famous Solow residual that is about half of the growth in *per capita* output, has been attributed to reflect the productivity-enhancing effects of technical progress and other advances in human knowledge. Since then, a host of interrelated factors has been identified and commonly accepted as the determinants of a country's economic growth. Physical productive capital, human capital, research and development efforts, and the pace at which new technology and improved techniques are introduced into the production, and economies of scale are examples.

The link between productivity and capital investment in the long run is very important, particularly to a long-term growth model such as MuDan. Both capital investment and productivity are important factors of long-term growth, and cross-country comparative studies generally support that investment is a significant determinant of economic growth (Delong and Summers, 1991, 1992; Christensen, Cummings and Jorgenson, 1995). Disagreements exist, however. For example, the conventional wisdom that investment caused economic or overall productivity growth is questioned by Blomstrom, et al. (1996) and by Lipsey and Kravis (1987). Furthermore, there have been mixed results in empirical studies on the impact of capital investment on labor productivity within a country, particularly at the industrial level. Baily (1981), for example, found correlation in the aggregate level between the slowdown in labor productivity growth in the US in the 1969 and 1973 period and a slowdown in capital investment slowdown; at the industry level, however, he found puzzling discrepancies.

Studies on productivity for the Chinese economy have been very active since economic reform started. Interest in the consequences of productivity, particularly that of total factor productivity (TFP), of China's reform efforts has been especially strong and continues to grow. There are occasionally heated debates over whether and to what extent the Chinese economy has shifted from the extensive growth pattern that relies on increasing inputs to an intensive growth pattern that is contributed substantially by productivity improvements. The claims that the Asian tiger economies may have relied more on savings and investment to drive rising living standards and less on productivity gains (Lau and Kim 1992; Young 1992, 1994a, 1994b; Krugman 1994, 1998), and the recent Asian financial crisis have further fueled the discussion and added both importance and urgency on this issue.

Earlier studies on state industry often concluded that reform had failed to alter the TFP stagnation (Rawski, 1983, 1986; Tidrick, 1986.) Subsequent studies (Chen 1988a, 1988b), however, found that these earlier studies were faulted in using arbitrary weights to aggregate inputs and in estimating capital stock measures. By using a revised capital stock measure and refined input weights, Chen found modest, but definite rising trend for TFP in China's state industries. Jefferson et al. (1992 and 1996) found that TFP growth in China's fast-growing collective sector outpaced comparable results for the state sector by a considerable margin. Huang (1997) confirmed that reform policies improved productivity. He also found, however, that the overall size of reform effects on productivity was found to be negligible. The TFP gains were found by many recent studies (Li, 1997; Hu, 1997; and Naughton, 1994), and TFP growth was typically estimated to be around 2% to 5% per year. However, some researchers challenged the findings and argued that there was little TPF growth during the reform period (Woo, Fan, Hai, and Jin 1993; Woo, Hai, Jin, and Fan 1994; Woo, Hai, and Jin 1994; Sachs and Woo 1994). Surveys on the subject can be found in Wu (1993) and Jefferson and Singh (1993).

While many researchers are attempting to identify TFP consequences of reform policies, some are questioning the relevance or validity of using TFP growth as a measure for economic efficiency gains. Bai et al (1997) argue, in the sprit of a counterexample, that when firms are not profit maximizers for whatever reason, higher productivity may actually lead to greater allocative distortion, lower profits, and lower economic efficiency. On the basis of existing evidence, they argue that these conditions held for many Chinese state enterprises during the reform period.

Productivity growth in the agricultural sector appears less controversial than the industrial counterpart. Lin (1992), Fan (1997), and Fan et al (1997) all found positive productivity gains after reforms, although there were disagreements on the magnitude of the productivity gains.

Despite the arguments, it appears that TFP growth is a good measure to identify underlying sources of economic growth. However, lack of statistical data makes it impossible to conduct a TFP study on the Chinese economy at the detailed sectoral level. Since the primary interest on productivity in MuDan is to determine sectoral employment, this study has used the narrowly defined labor productivity. Although narrow in definition, the sectoral labor productivity study can identify industrial productivity disparities and therefore offers insights on industries that aggregated TFP studies cannot. As the data show, labor productivity grows more smoothly, and consistently faster in some industries than in others. The magnitude of labor productivity also varies from industry to industry. For example, capital-intensive sectors generally show higher labor productivity than do labor-intensive sectors. The productivity growth of capital-intensive industries, however, is not necessarily higher than that of labor-intensive sectors. Recognizing the inequality of productivity growth across industry and integrating sectoral labor productivity functions into an interindustry model such as MuDan provide a useful environment for examining impacts of economic policies on employment and people's standard of living.

Although it seems ideal to use a multi-factor type of productivity specification in estimating MuDan's productivity functions, past experience suggests that the application of the multi-factor type of productivity specification in highly disaggregated empirical studies has not been very successful. For example, Barbera (1983) and Meade (1990) both attempted to estimate the demand for labor as part of a system of demand equation for three factors: equipment investment, labor, and energy. A Generalized Leontief (GL) cost function specification for each industry was assumed, and factor demand equations were derived using Shephard's Lemma. However, because of undesirable simulation properties, the estimated productivity equations were rejected in practical use in both cases despite the sound theoretical foundation of their specification. Because GL cost function is very flexible, labor and capital could be either complements or substitutes. Such flexibility can have undesirable consequences. In Meade (1990), it was reported that capital and labor complementarities were found in 17 of the 53 industries for which the equations were estimated. For these sectors, increasing the equipment capital stock would result in reduction in labor productivity! Grassini (1996) constructed a labor productivity specification in the sprit of the multi-factor productivity study and reported that his form fit Italian data extremely well, but later rejected its use in his model of Italy.

Productivity Equation

Productivity in MuDan is computed simply as real output divided by employment. Due to lack of data, it is not feasible to adopt a more refined concept of labor input such as work hours. The following equation is posited as the basic form for productivity equations:

$$\ln prt_{i,t} = a_{i,0} + a_{i,1} * t + a_{i,2} * dlgq_{i,t} + a_{i,3} * lgkl_{i,t-1} + a_{i,4} * D \tag{1}$$

where $prt_{i,t}$ = labor productivity of industry i at time t, computed as the ratio of $out_{i,t}$ to $emp_{i,t}$,

$out_{i,t}$ = real output of sector i at time t,

$emp_{i,t}$ = total employment in industry i at time t,

t = a simple time trend,

$dlgq_{i,t}$ = the difference between $\log(out_{i,t})$ and its lagged value,

$lgkl_{i,t-1}$ = the log of capital-employment ratio of industry i at time t-1,

D = a dummy variable, and

$\alpha_{i,0}$, $\alpha_{i,1}$, $\alpha_{i,2}$, $\alpha_{i,3}$, and $\alpha_{i,4}$ are sector specific parameters to be estimated.

The output term, $\ln(out_{i,t}) - \ln(out_{i,t-1})$, is included in order to capture the productivity behavior over a business cycle and the coefficient of the output term is expected to be positive. The intuition behind this output term is that when responding to a positive or negative demand shock, companies tend to first adjust the utilization level of existing employment, and then adjust the level of employment. If there is an unexpected negative shock to demand or when the business is in a downswing, companies tend to hoard the existing labor by retaining skilled workers on the payroll and reducing production hours instead of reducing employment despite falling levels of output. This labor hoarding will continue unless such a downswing or negative shock is perceived as permanent, in which case employment levels may be reduced. Similarly, companies tend to extend standard hours of operation for workers rather than hiring more people when business is in an upswing or there is a positive demand shock that is perceived as temporary. In both cases, it appears that output tends to adjust faster than the level of employment. Consequently, productivity increases during an expansion and falls during a contraction. In the current specification, responses by companies to both positive and negative shocks are assumed to be symmetric.

The symmetry assumption of companies' response to positive and negative demand shock appears fairly restrictive. In many INFORUM models, positive and negative changes of output generally are identified separately in the productivity function, therefore allowing asymmetric responses of productivity to an expansion or a contraction. For example, the typical productivity specification of an INFORUM model include the following two terms:

$$QUP_{i,t} = Q_{i,t} - QPK_{i,t-1} \text{ if } Q_{i,t}-QPK_{i,t-1} >= 0,$$
$$QDN_{i,t} = QPK_{i,t-1} - Q_{i,t} \text{ if } Q_{i,t}-QPK_{i,t-1} < 0,$$

where $QPK_{i,t}$ is the peak output for product i at time t. Therefore, $QUP_{i,t-1}$ measures output in excess of last period's production capacity while $QDN_{i,t}$ is a measure of excessive capacity of production. Such deviations are intended to capture labor hoarding during recessions and overtime production during expansions.

I attempted the typical specification of labor productivity's asymmetric response to output change and encountered problems in estimation. During the estimation period of 1984-94, few sectors experienced negative output growth. For the few that did have negative growth, it occurred only in a year or two. Therefore, the number of observations of $QDN_{i,t}$ was usually too few to be useful in estimation. For this reason, it seemed impossible to estimate separately the positive and negative impacts of output changes for most sectors. Therefore, the term $Q_{i,t}/QPK_{i,t-1}$ is used as a compromise with the interpretation of a more simplistic assumption that there is a symmetric impact on labor production of deviation of real output from preceding peak output.

The capital/labor ratio of $lgkl_{i,t-1}$ is introduced to account for the contribution of capital accumulation on productivity growth. To avoid the simultaneity of determining productivity and employment, the lagged employment is used. The productivity function is estimated by OLS for all 52 aggregated sectors. Soft constraints intended to restrict the size of the coefficient on the time variable are applied in estimation.

Dummy variables are used to counter data irregularities. For some sectors, the data irregularity appeared around 1989. For some other sectors, there appeared a broken trend in 1992 when there was a major change in coverage of statistical data. A list of dummy variables is provided at the end of the regression results that are displayed in Table 32.

Table 32 - Estimation of Productivity Equation

	Productivity	const	t80	dlgqR	lgkl[1]	dummy	Rbsq
1	Agriculture	4.259	0.028	0.816	0.164	-0.104 a	0.97
		(3.46)	(6.95)	(1.33)	(0.84)	(3.79)	
2	Coal mining	5.141	0.044	0.670		0.118 b	0.94
		(12.78)	(9.75)	(4.04)		(4.68)	
3	Crude petroleum and natural gas production	6.602	0.046	0.929		0.441 a	0.80
		(7.55)	(5.01)	(3.85)		(6.10)	
4	Ferrous ore mining	0.792	0.063	0.099	0.300		0.92
		(1.65)	**	**	**		
5	Non-ferrous ore mining	3.162	0.072	0.457		0.219 c	0.84
		(3.12)	(6.43)	(1.54)		(2.85)	
6	Non-metal minerals, and mining n.e.c.	1.403	0.091	0.627			0.96
		(1.91)	(10.87)	(2.50)			
7	Logging and transport of timber and bamboo	9.698	0.002	0.509		-0.091 b	0.94
		(36.47)	(0.60)	(4.27)		(5.91)	
8	Food process & manufacturing	3.235	0.055	0.700	0.251		0.97
		(8.14)	**	**	**		
9	Beverages	3.131	0.058	0.400	0.201		0.89
		(5.48)	**	**	**		
10	Tobacco manufacture	7.913		0.104	0.381		0.91
		(15.69)		(0.38)	(8.50)		
11	Textiles	3.355	0.035	0.700	0.400	-0.153 b	0.93
		(9.57)	**	**	**	(4.49)	
12	Wearing apparel	3.106	0.052	0.223	0.285	-0.125 b	0.87
		(2.04)	(1.62)	(0.67)	(0.81)	(1.49)	
13	Leather, fur and their products	2.106	0.048	0.868	0.401		0.93
		(3.55)	**	(4.14)	**		
14	Sawmills and bamboo etc. products	10.391	-0.010	2.164		0.245 b	0.97
		(11.36)	(0.93)	(9.88)		(4.20)	
15	Furniture	4.260	0.069	0.911		-0.167 b	0.99
		(10.19)	(14.36)	(11.10)		(7.56)	
16	Paper and paper products	4.344	0.066	0.515		-0.119 d	0.95
		(8.14)	(10.71)	(2.41)		(3.24)	
17	Printing industries	2.657	0.050	1.050	0.301		0.95
		(6.28)	**	(3.77)	**		
18	Cultural, education, sports articles	4.850	0.054	1.001			0.95
		(7.91)	(7.67)	(5.19)			
19	Petroleum refineries and coking products	12.526	-0.010	0.566			0.30
		(10.02)	(0.76)	(1.10)			
20	Chemical industries	3.874	0.056	1.106	0.154	-0.120 e	0.98
		(3.71)	(4.14)	(5.95)	(0.76)	(3.41)	
21	Medicines	5.250	0.061	0.630		0.071 f	0.90
		(8.55)	(9.08)	(1.32)		(0.59)	
22	Chemical fibres	4.504	0.071	0.415			0.99
		(18.07)	(25.90)	(4.29)			
23	Rubber products	6.367	0.046	0.859		-0.077 b	0.92
		(13.55)	(8.55)	(3.28)		(2.49)	
24	Plastic products	1.873	0.061	0.489	0.301	-0.046 b	0.83
		(2.04)	**	(1.01)	**	(0.43)	
25	Building materials and other non-metallic mineral	3.136	0.041	0.954	0.301		0.93
		(6.13)	**	(3.66)	**		
26	Primary iron and steel manufacturing	7.898	0.034	0.244			0.85
		(18.87)	(7.24)	(1.27)			
27	Primary non-ferrous metals manufacturing	8.169		0.632	0.267	0.107 d	0.42
		(5.18)		(2.57)	(1.82)	(1.60)	

Notes: ** Soft constraints.
t-statistics in parentheses.

Table 32 - Estimation of Productivity Equation (Cont.)

	Productivity	const	t80	dlgqR	lgkl[1]	dummy	Rbsq
28	Metal products	5.382	0.055	0.473			0.89
		(8.61)	(7.83)	(2.57)			
29	Machinery	-0.616	0.079	0.355	0.389	-0.214 b	0.95
		(0.56)	(2.24)	(1.38)	(0.95)	(3.91)	
30	Transportation equipment	1.679	0.099	0.366		-0.127 b	0.95
		(1.89)	(9.69)	(1.48)		(1.87)	
31	Electric machinery and instrument	1.894	0.052	0.700	0.401		0.89
		(3.10)	**	**	**		
32	Electronic and communication equipment	2.263	0.058	0.600	0.301		0.85
		(2.65)	**	**	**		
33	Instrument, meters and other measuring equip	2.314	0.089	0.287		-0.156 b	0.93
		(2.21)	(7.32)	(1.11)		(2.64)	
34	Industries n.e.c	1.897	0.062	0.700	0.301		0.84
		(2.31)	**	**	**		
35	Electricity, steam and hot water production	4.090	0.035	0.500	0.301		0.91
		(10.14)	**	**	**		
36	Gas production and supply	1.422	0.094	0.149		0.323 d	0.92
		(1.67)	**	(0.44)		(3.67)	
37	Production and supply of water	5.204	0.053	0.545			0.90
		(8.04)	(7.17)	(1.77)			
38	Construction	4.614	0.059	0.290		-0.210 d	0.94
		(9.55)	(10.66)	(2.84)		(6.50)	
39	Railway transportation	11.299	-0.039	0.860		0.212 a	0.82
		(4.76)	(3.40)	(1.69)		(0.76)	
40	Highway transportation	6.242	0.041	0.068		-0.053 a	0.80
		(10.65)	**	(0.12)		(0.59)	
41	Water transportation	7.554	0.026	0.222			0.93
		(33.51)	(10.53)	(1.49)			
42	Air transportation	3.377	0.0839	0.296			0.79
		(6.50)	(14.90)	(0.58)			
43	Pipeline transportation	10.322	0.008	1.274		0.075 a	0.13
		(7.06)	(0.47)	(1.20)		(0.91)	
44	Communications	-0.309	0.074	0.701	0.305	0.077 f	0.88
		(0.25)	**	**	**	(0.39)	
45	Commerce	9.057	0.008	0.255		0.130 c	0.62
		(15.26)	(1.20)	(1.53)		(3.75)	
46	Restaurants	4.794	0.054	0.185		0.151 c	0.74
		(3.50)	(3.77)	(0.55)		(1.54)	
47	Finance and insurance	4.839	0.030	0.600	0.300		0.80
		(12.19)	**	**	**		
48	Real estate and social services	6.384	0.017	0.300	0.183	-0.211 d	0.65
		(2.06)	(0.59)	(1.58)	(0.41)	(3.24)	
49	Health care, sports and social welfare	10.061	-0.026	0.575	0.189	-0.217 a	0.92
		(15.44)	(3.18)	(3.88)	(1.65)	(5.67)	
50	Education, culture, arts, radio, film and TV	6.465	0.026	0.375		-0.197 a	0.94
		(11.00)	(4.17)	(1.26)		(4.08)	
51	Scientific research and polytechnical services	9.849	-0.004	0.664		-0.103 a	0.80
		(17.38)	(0.63)	(3.96)		(2.24)	
52	Public administration and others	5.975	-0.027	0.255	0.592		0.91
		(4.61)	(7.67)	(1.14)	(4.66)		

Notes: ** Soft constraints.
t-statistics in parentheses.
The following dummy variables are used in estimation: a = 1 for 1984-92, 0 otherwise;
b = 1 for 1989-92, 0 otherwise; c = 1 for 1989-91, 0 otherwise; d = 1 for 1990-92, 0 otherwise;
e = 1 for 1992, 0 otherwise; and f = 1 for 1989, 0 otherwise.

The incorporation of the capital stock variable in the productivity equation has limited success. Among the 52 sectors, only 29 sectors managed to keep the capital stock variable in the actual estimation. For other sectors, inclusion of the capital stock variable will result in either insignificant or negative coefficient on the capital stock variable, and soft constraints will make the estimation significantly worse. Therefore, the influence of capital or investment on productivity growth appears difficult to detect.

The coefficient on the change in output variable reveals results that in general have fit our expectations, and the values appear reasonable. Ideally, the magnitude of the coefficient on the change in output variable represents the degree to which productivity responds to change in output. A large coefficient tends to suggest that productivity respond strongly to a change in output. That, in turn, suggests that employment is less sensitive to change in output. In other word, for industries with a large coefficient on the output variable, an increase in output in the short run is more likely to be met by an increase in productivity than by an increase in employment. Therefore, we would expect to find a large coefficient on the output variable for industries dominated by state enterprises because a change in employment in either direction is difficult. We would also expect to find that capital-intensive industries tend to have relatively larger coefficients than do labor-intensive industries, and manufacturing industries tend to have relatively larger coefficient than do service industries. Indeed, the estimated coefficients for many industries fit the expectation fairly nicely. For example, we find that Highway transportation, Waterway transportation, Restaurant, Commerce, Wearing apparel, and Construction sectors are among the industries whose coefficient on the output variable are small. These industries have experienced fairly substantial employment changes. On the other end, we find Chemical, Air transportation, and Pipeline transportation sectors that display a large coefficient on the output variable. However, there are sectors whose coefficients are out of line with our expectation. For example, given the state dominance in the Tobacco industry, we would expect it to have a relatively larger coefficient. Yet, its estimated coefficient is only 0.1. The coefficient for the Furniture sector, 0.9, is probably larger than expected.

The time trend is powerful in explaining productivity. If we use technological progress to interpret the coefficient on the time trend, we will find that such technological progress is very significant. However, if we take into account the efficiency improvements that are resulted from better incentives and better management since economic reform started, the high growth rates of technological progress are in fact quite plausible. The estimated coefficients on the time trend range from 0.02 to 0.09 except several coefficients that fall out of the range. Coefficients on the time trend for four industries, namely Railway transportation, Healthcare, Scientific research and polytechnic services, and Public administration are actually negative, suggesting a trend of declining productivity in these industries. Although the time trend variable tends to overpower other variables in explaining productivity, the efforts to use alternative variables in the specification has resulted in fits being significantly worse. Therefore, the time trend is used in the productivity equation for almost all sectors.

Accountant

The Accountant in MuDan plays the role of an national income accountant for a national economy: it compiles the national income and product accounts, and computes macroeconomic variables such as GDP and the unemployment rate. The Accountant is also responsible for checking the convergence of the model. Since the Accountant’s role of convergence checking has been described in Chapter 3, this section focuses on its role of accounting. In MuDan, some macro variables such as GDP are aggregated from sectoral variables. Other macro variables such as the interest rate are estimated by behavioral equations and the estimation results are also presented in this section. In what follows, a list of names of vectors, macro variables, and identities that are used in MuDan is presented first, followed by a description of the functional forms and estimation results for the macro variables that are estimated with behavioral equations in the model.

Vectors, Macro Variables and Identities in MuDan

MuDan is a multisectoral model that includes some fairly highly disaggregated sectoral detail. Because the model adopts the bottom-up approach, most macro variables are aggregated from sectoral variables. The following table, Table 33, lists the model's more important vectors, macro variables, and, when applicable, the identities that define a vector or a macro variable. The first column is a textual description of the variable, followed by the actual variable name that is used by the MuDan model. The third column indicates the variable type: "macro" means a single time series, and a number indicates a vector that contains the specified number of time series. The last column describes how a variable is formed. When an entry in the last column starts with an equal sign "=", it indicates that the variable is formed by an identity, which is specified by a formulae or a description following the "=" sign. Unless explicitly specified otherwise, vector operations are conducted on an element by element basis. The "@csum(a, b)" function is standard in InterDyme, the software used to build MuDan, and it computes the sum of vector a's elements within the range of "b". Other possible entries of the last column include:

"regression"   meaning the variable is determined by a regression equation;

"exogenous"   meaning the variable is exogenous to MuDan,

"solution"	meaning the variable is solved through an iterative procedure, and
"derived"	meaning the variable is derived from other variables based on certain posited relations among these variables.

Table 33 - Vectors, Macro Variables, and Identities in MuDan

Variable	Variable Name	Variable Type	Equation / Identity
Gross Domestic Product (GDE)			
GDP, current prices	gdpN	macro	=crNsum+cuNsum+ifaNsum+ivnNsum+ exNsum-imNsum+oNsum
GDP, 1992 prices	gdpR	macro	=crRsum+cuRsum+ifaRsum+ivnRsum+ exRsum-imRsum+oRsum
GDP deflator	gdpD	macro	=gdpN/gdpR
Gross Domestic Expenditure (GDE)			
GDE, current prices	gdeN	macro	=gdpN-oNsum
GDE, 1992 prices	gdeR	macro	=gdpR-oRsum
GDE deflator	gdeD	macro	=gdeN/gdeR
GDP, product side			
Personal consumption of rural residents			
Consumption per capita of rural residents			
Rural consumption by category, current prices	hcrN	10	= hcr*rp
Rural consumption by category, 1992 prices	hcr	10	regression, controlled by hcrRsum
Consumption per capita, current prices	hcrNsum	macro	=hriNsum*(1-rsavrat/100)
Consumption per capita, 1992 prices	hcrRsum	macro	=hcrNsum/crD
Total consumption of rural residents			
Rural consumption by category, current prices	hcrNT	10	=hcrN*rpop
Rural consumption by category, 1992 prices	hcrT	10	regression, controlled by hcrRsum
Rural consumption by sector, current prices	crN	59	=Bmcr*hcrNT
Rural consumption by sector, 1992 prices	cr	59	=Bmcr*hcrT
Total consumption, current prices	hcrNTsum	macro	=hcrNsum*rpop
Total consumption, 1992 prices	hcrRTsum	macro	=hcrRsum*rpop
Rural consumption prices			
Rural consumption price index by sector	pricecr	10	derived from "prices" and "priceimp"
Rural consumption price index by category	rp	10	derived from Bmcr and pricecr
Rural consumption price index	crD	macro	= weighted average of "rp"
Personal consumption of urban residents			
Consumption per capita of urban residents			
Urban consumption by category, current prices	hcuN	24	= hcu *up
Urban consumption by category, 1992 prices	hcu	24	regression, controlled by hcuRsum
Consumption per capita, current prices	hcuNsum	macro	=huiNsum*(1-usavrat/100)
Consumption per capita, 1992 prices	hcuRsum	macro	=hcuNsum/cuD
Total consumption of urban residents			
Urban consumption by category, current prices	hcuNT	24	=hcuN*upop
Urban consumption by category, 1992 prices	hcuT	24	regression, controlled by hcuRsum
Urban consumption by sector, current prices	cuN	59	=Bmcu*hcuNT
Urban consumption by sector, 1992 prices	cu	59	=Bmcu*hcuT
Total consumption, current prices	hcuNTsum	macro	=hcuNsum*upop
Total consumption, 1992 prices	hcuRTsum	macro	=hcuRsum*upop
Urban consumption prices			
Urban consumption price index by sector	pricecu	59	derived from "prices" and "up"
Urban consumption price index by category	up	24	derived from Bmcu and "prices"
Urban consumption price index	cuD	macro	= weighted average of "up"
Investment			
Investment by source, current prices	invN	52	=inv * priceoth
Investment by source, 1992 prices	inv	52	regression
Investment by sector, current prices	ifaN	59	=Bminv*invN
Investment by sector, 1992 prices	ifa	59	=Bminv*inv
Total investment, current prices	ifaNsum	macro	=@csum(ifaN,1-59)
Total investment, 1992 prices	ifaRsum	macro	=@csum(ifa,1-59)
Investment price index by sector	priceinv	vector	
Investment deflator	ifaD	macro	=ifaNsum/ifaRsum

Table 33 - Vectors, Macro Variables, and Identities in MuDan (Cont.)

Variable	Variable Name	Variable Type	Equation / Identity
Inventory changes			
Inventory change by sector, current prices	ivnN	59	= ivn * priceoth
Inventory change by sector, 1992 prices	ivn	59	regression
Total inventory change, current prices	ivnNsum	macro	=@csum(ivnN,1-59)
Total inventory change, 1992 prices	ivnRsum	macro	=@csum(ivn,1-59)
Inventory deflator	ivnD	macro	=ivnNsum/ivnRsum
Government consumption			
Government consumption by sector, current prices	csN	59	= cs * priceoth
Government consumption by sector, 1992 prices	cs	59	exogenous
Total government consumption, current prices	csNsum	macro	=@csum(csN,1-59)
Total government consumption, 1992 prices	csRsum	macro	=@csum(cs,1-59)
Government consumption deflator	csD	macro	=csNsum/csRsum
Exports			
Exports by sector, current prices	exN	59	= ex * priceexp
Exports by sector, 1992 prices	ex	59	exogenous
Total exports, current prices	exNsum	macro	=@csum(exN,1-59)
Total exports, 1992 prices	exRsum	macro	=@csum(ex,1-59)
Export price indexes by sector	priceexp	59	derived from "prices" and priceimp
Export deflator	exD	macro	=exNsum/exRsum
Imports			
Imports by sector, current prices	imN	59	=im * priceimp
Imports by sector, 1992 prices	im	59	regression
Total imports, current prices	imNsum	macro	=@csum(imN,1-59)
Total imports, 1992 prices	imRsum	macro	=@csum(im,1-59)
Import price indexes by sector	priceimp	59	exogenous converted by exchange rate
Import deflator	imD	macro	=imNsum/imRsum
Other final demand			
Other final demand by sector, current prices	othN	59	=oth*priceoth
Other final demand by sector, 1992 prices	oth	59	exogenous
Total other final demand, current prices	oNsum	macro	=@csum(othN,1-59)
Total other final demand, 1992 prices	oRsum	macro	=@csum(oth,1-59)
GDP, income side			
Wages			
Wage rates for agriculture	agwpc	macro	regression
Wage rates for non-agriculture	nonagwpc	macro	regression
Wage rates by sector	wpc	52	regression
Wages by sector	wages	59	=emp*wpc
Total wages, agricultural sectors	agwage	macro	= @csum(wages,1-4)
Total wages, non-agricultural sectors	noagwage	macro	= @csum(wages,5-59)
Depreciation			
Depreciation by sector	dep	59	regression
Total depreciation, agricultural sectors	agdep	macro	= @csum(dep,1-4)
Total depreciation, non-agricultural sectors	noagdep	macro	= @csum(dep,5-59)
Profits			
Profits by sector	profits	59	regression
Total profits, agricultural sectors	agprofit	macro	= @csum(profits,1-4)
Total profits, non-agricultural sectors	noagprofit	macro	= @csum(profits,5-59)

Table 33 - Vectors, Macro Variables, and Identities in MuDan (Cont.)

Variable	Variable Name	Variable Type	Equation / Identity
Taxes			
Taxes by sector	taxes	59	regression
Total taxes, agricultural sectors	agtax	macro	= @csum(taxes,1-4)
Total taxes, non-agricultural sectors	noagtax	macro	= @csum(taxes,5-59)
Other vectors			
Gross output			
Gross output by sector, current prices	outN	59	=prices*out
Gross output by sector, 1992 prices	out	59	solution
Gross output by aggregate sector, current prices	aggoutN	52	aggregated from 'outN'
Gross output by aggregate sector, 1992 prices	aggout	52	aggregated from 'out'
Output prices by sector	prices	59	solution
Output prices by aggregate sector	pricesagg	52	=aggoutN/aggout
Labor			
Employment by aggregate sector	emp	52	=prt/aggout
Labor productivity by aggregate sector	prt	52	regression
Other prices			
Price indexes for investment and	priceoth	59	derived from 'prices','pricecu','pricecr', 'priceexp' and 'pricimp'
User prices, a mix of foreign and domestic prices	pricepmx	59	derived from 'prices' and 'pricimp'
Other macro variables			
Personal income of urban residents			
Total, current prices	huiNTsum	macro	regression
Total, 1992 prices	huiRTsum	macro	=huiNTsum/cuD
Income per capita, current prices	huiNsum	macro	=huiNTsum/upop
Income per capita, 1992 prices	huiRsum	macro	=huiNsum/cuD
Personal income of rural residents			
Total, current prices	hriNTsum	macro	regression
Total, 1992 prices	hriRTsum	macro	=hriNTsum/crD
Income per capita, current prices	hriNsum	macro	=hriNTsum/rpop
Income per capita, 1992 prices	hriRsum	macro	=hriNsum/crD
Personal Income, rural and urban			
Total, current prices	tincomeN	macro	=hriNTsum+huiNTsum
Total, 1992 prices	tincomeR	macro	=hriRTsum+huiRTsum
Savings rate, rural residents	rsavrat	macro	regression
Savings rate, urban residents	usavrat	macro	regression
Savings rate, all residents	savrat	macro	=(hriNsum*rsavrat+huiNsum*usavrat)/ (hriNsum+huiNsum)
Rural population	rpop	macro	exogenous
Urban population	upop	macro	exogenous
Total labor force	totlabor	macro	exogenous
Total employment	emptot	macro	=@csum(emp,1-52)
Unemployment rate	uunemp	macro	=(totlabor - emptot) / totlabor * 100
Real interest rate	intrat	macro	=intratN-(cuD-cuD[1])/cuD[1]*100
Nominal interest rate	intratN	macro	regression
Money supply	M2	macro	exogenous
Exchange rate, yuan/US$	exrate	macro	exogenous

Personal Income

Personal income in MuDan is divided between the income of rural residents and urban residents. For rural residents, proprietor income from household business operations has become the main source of income since economic reform started. For example, in 1978, proprietor income accounted for 28.9% of total productive income; in 1996, it accounted for 75%. From an industrial perspective, income for rural residents was derived almost exclusively from agricultural sectors in 1978, accounting for 91.5% of total productive income. By 1996, rural income from agricultural sectors had fallen to 66% of the total while income from non-agricultural sectors had steadily gained importance. Table 34 displays personal income *per capita* for rural residents in selected years.

Table 34 - Personal Income *per capita*, Rural Residents

(yuan in current prices)

	1978	% of Total	1985	% of Total	1990	% of Total	1996	% of Total
Disposable income, per capita	133.6	100.0	397.6	100.0	686.3	100.0	1,926.1	100.0
Productive income	124.1	92.9	367.7	92.5	657.4	95.8	1,813.3	94.1
by income type								
Labor income	88.3	66.1	71.7	18.0	138.8	20.2	450.8	23.4
Proprietor income	35.8	26.8	296.0	74.4	518.6	75.6	1,362.5	70.7
Agriculture	33.8	25.3	253.7	63.8	441.7	64.4	1,123.9	58.4
Industry & construction	2.0	1.5	9.6	2.4	21.3	3.1	64.6	3.4
Services	0.0	0.0	22.6	5.7	41.2	6.0	150.6	7.8
by sector								
Agriculture	113.5	85.0	298.3	75.0	510.9	74.4	1,192.6	61.9
Industry & construction	10.6	7.9	29.5	7.4	70.7	10.3	372.4	19.3
Services	0.0	0.0	40.0	10.0	75.8	11.0	248.3	12.9
Other income	9.5	7.1	29.9	7.5	29.0	4.2	112.8	5.9

Note: The column marked "%" is percentage of Productive income.
Source: TJNJ1997, T9-10 and author's calculation.

Personal income for urban residents is derived mainly from wages and salaries, which accounted for 89.6% in 1985 and 82.5% in 1996 of their total disposable income. Income for urban resident also includes proprietor income, property income, pension, and transfer payment. While most urban residents are engaged in non-agriculture business, some do work in the agriculture sector. Therefore, it is necessary for MuDan to allocate sectoral wages of both agricultural and non-agricultural sectors into urban income. Table 35 lists urban income by type for selected years. Since industrial sources of income for urban residents are not currently available, assumptions have to be made on the industrial breakdowns of the income sources of rural residents.

Table 35 – Personal Income *Per Capita*, Urban Residents

(yuan in current prices)

	1985	% of Total	1990	% of Total	1996	% of Total
Disposable Income, per capita	685.3	100.0	1,387.3	100.0	4,377.2	100.0
Wages and salaries	614.3	89.6	1,127.1	81.2	3,611.6	82.5
Proprietary income	10.2	1.5	18.7	1.3	115.9	2.6
Other income	60.8	8.9	241.5	17.4	649.7	14.8

Source: TJNJ 1997 T9-5 and author's computation.

Prior to 1998, Chinese statistics do not provide personal income totals, but only *per capita* figures[17]. Therefore, historical values for total personal income in MuDan are computed by multiplying population by *per capita* income. The *per capita* income used in the computation is not equal to the one shown in Table 34 and Table 35, which is taken directly from household survey. Instead, it is computed by scaling the household survey's income figure by a factor. The factor is the ratio of the published total consumption to the product of population and household survey's *per capita*

[17] The 1998 Statistical Yearbook of China for the first time published personal income totals for 1992, 1993, 1994, and 1995. However, total personal income for prior years is still not available.

consumption figure. By scaling household survey's income and consumption by the same factor, the saving rate that is implicit in the household survey is preserved.

In the forecast, personal incomes of rural and of urban residents are each computed by regression on two variables: agricultural and non-agricultural incomes. Agricultural income includes labor income and profits in Farming, Forestry, Fishing, and Animal husbandry, and non-agricultural income includes labor income and profits of the remaining 55 non-agricultural sectors. It should be emphasized that rural residents are not necessarily employed in the agricultural sectors; some of them are also engaged in non-agricultural activities. Therefore, rural residents' income is derived from both agricultural and non-agricultural sectors. The same is true for urban residents as some of them are engaged in agricultural activities even though most work in non-agricultural sectors. Therefore, the exact distribution of agricultural and nonagricultural income between rural and urban residents is determined by regressions.

MuDan does not explicitly model the accumulation of assets[18] by households or interest income from such assets even though personal saving is explicitly modeled. Nor does MuDan explicitly model transfer income from the government and from abroad because such data, even if it exists, is not publicly available. Consequently, consumption is assumed to be a function of current income that is generated and distributed to households in the current period. As noted previously, labor income is a large component of MuDan's current income and is fully distributed into personal income. To compute total personal income, some of the remaining value-added other than wages must also be distributed. Since government transfer payments, including

[18] In China's I-O tables, interest payments by financial institutions on savings deposits of domestic residents are imputed and distributed to profits of non-financial sectors (DNEA, 1997f). By distributing part of sectoral profits to personal income, interest income can be thought of having been accounted for in the model.

explicit price subsidies and welfare payments[19], are historically not a significant source of personal income, tax revenues, through transfer payments, are not likely to be a significant source of personal income. Depreciation or the capital consumption allowance fund is generally invested, therefore cannot contribute much to personal income either. The only remaining item is profit, which seems logically to be part of the personal income sources for several reasons. First, as China moves toward a market economy, the previously prohibited private ownership of capital has been legalized and grown steadily. Some profits are distributed to personal income in the form of dividends or proprietor income. Second, in China's I-O account, interest payments by financial institutions to domestic residents on savings deposits have been imputed and distributed into sectoral profits; therefore they must be included as part of personal income. Third, profit sharing as an incentive contract is widely used to reform state-owned enterprises. Under such agreement, both management and workers are given bonuses, welfare benefits or similar rewards if they achieve specified profit targets that are mutually agreed upon by the enterprises and the government. These rewards normally come from the retained profits. While the I-O accounting requires these bonuses and benefits to be accounted as labor income, it is not uncommon that these bonuses and benefits are underreported in order to evade taxes or government controls. Since profits in the Chinese I-O tables are computed as residuals, the underreported labor income is most likely included in profits. Therefore, both wages and profits are used as explanatory variables in the personal income equations.

[19] In 1996, for example, the total government expenditures amounted to 601.50 billion yuan, among which two major categories were distributed directly to personal income, the expenditures for social welfare of 12.80 billion yuan and price subsidies of 8.08 billion yuan on curbing general inflation and on meat price increases. The sum of the two is about 3.5% of total government expenditures, representing 0.7% of total private consumption in 1996 of 3258.87 billion yuan (TJNJ1997, T2-13, T7-4, and T7-19).

MuDan's total rural and urban incomes in current prices are estimated by the following two equations:

$$y^u = a_0^u + a_1^u * agwage + a_2^u * agprofit + a_3^u * nonagwage + a_4^u * nonagprofit \qquad (2)$$

$$y^r = a_0^r + a_1^r * agwage + a_2^r * agprofit + a_3^r * nonagwage + a_4^r * nonagprofit \qquad (3)$$

where y^u and y^r = total personal income, urban and rural residents, respectively

agwage = the sum of labor income of the agricultural sectors,

nonagwage = the sum of labor income of the non-agricultural sectors,

agprofit = the sum of profits of the agricultural sectors,

nonagprofit = the sum of profits of the non-agricultural sectors, and

α_0, α_1, α_2, α_3 and α_4 are parameters to be estimated with superscripts r and u indicating the equation for rural and urban residents.

Eqs (2) and (3) are estimated simultaneously with soft constraints

$$\alpha^u_1 + \alpha^r_1 = 1 \text{ and } \alpha^u_3 + \alpha^r_3 = 1.$$

Such constraints will ensure that labor income is fully distributed into personal income. Furthermore, the coefficient of *agwage* for rural residents, α^u_1, is softly constrained to be 0.95, an *a-priori* on the portion of agricultural labor income that goes to rural residents. In addition, a soft constraint of 0.7 is applied on the coefficient of *agprofit* in the rural income equation.

The assumptions on the income functions are fairly restrictive, which may cause undesirable constraints on the performance of the model. For example, Eqs. (2) and (3) have implicitly assumed fixed income elasticities with respect to wages and profits. As shown in Table 36, elasticities of total rural income with respect to *agwage*, *agprofit*, *nonagwage* and *nonagprofit* are estimated to be 0.61, 0.04, and 0.11 and 0.15, respectively, regardless the size of rural population and the portion of rural residents that is employed in non-agricultural sectors. As more labor from the countryside is employed in non-agricultural sectors, the elasticities of income with respect to *nonagwage* and *nonagprofit* of 0.11 and 0.15 may soon become too low and may result in underestimation of total rural income. Correcting the underestimation requires information that is not currently available. Hence, a quick fix can be applied in the model simulation by assuming slow or even negative growth of rural population so that adequate growth of *per capita* rural income can be achieved. Given the rapid urbanization in the last decade that has caused reclassification of many rural residents as urban residents, that assumption appears fairly realistic.

Table 36 displays estimation results of the personal income equation. With soft constraints on a number of coefficients, there are no surprises in the estimation result. The coefficients on unconstrained variables also look reasonable, and the RBSQ of regressions are decent. Therefore, the income equations seem in good shape.

Table 36 - Regression Results for Personal Income

: Total rural income

SEE = 174.49 RSQ = 0.9959 RHO = 0.53 Obser = 22 from 1984.000
SEE+1 = 157.10 RBSQ = 0.9931 DW = 0.95 DoFree = 12 to 1994.000
MAPE = 2.69 SEESUR = 2.19

	Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0	hriNTsum	- - - - - - -	- - - - -	- - - - -	- - - -	- - - -	6157.16
1	intercept	563.69391	42.4	10.429	0.09	2.15	1.00
2	agwage	0.94823	874.9	99.770	0.61	1.46	3945.23
3	agprofit	0.69909	619.4	73.289	0.04	1.37	387.27
4	nonagwage	0.13295	4.3	3.066	0.11	1.06	5138.04
5	nonagprofit	0.16824	10.2	4.752	0.15	1.00	5341.31

: Total urban income

SEE = 160.67 RSQ = 0.9974 RHO = 0.65 Obser = 22 from 1984.000
SEE+1 = 142.97 RBSQ = 0.9956 DW = 0.69 DoFree = 12 to 1994.000
MAPE = 4.41 SEESUR = 2.19

	Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0	huiNTsum	- - - - - - -	- - - - -	- - - - -	- - - -	- - - -	4626.30
1	intercept	-675.04897	60.0	-12.847	-0.15	188.38	1.00
2	agwage	0.04798	7.7	4.127	0.04	101.14	3945.23
3	agprofit	0.04925	11.9	5.164	0.00	100.07	387.27
4	nonagwage	0.86237	117.7	19.898	0.96	1.12	5138.04
5	nonagprofit	0.12396	5.7	3.521	0.14	1.00	5341.31

Note: hriNTsum and huiNTsum correspond to total personal income for rural (y^r) and urban (y^u) residents, respectively.

Personal Savings

Saving has been at the core of economic discussion for several centuries. The prominence of saving in economic discussion can be traced to the interest in finding the possible links among saving, investment, and income growth. Conventional wisdom suggests a self-reinforcing virtuous circle by which the anticipation of growth encourages investment, investment supports growth, and income growth raises saving. Therefore, foreign capital notwithstanding, saving is a necessary condition to achieve economic expansion and income growth. Although the precise links among them are not conclusive, there is evidence to suggest that strong correlation does exist among saving, investment, and income growth (Feldstein and Horioka, 1980; Feldstein and Bacchetta, 1991; and Summers 1988).

Saving is intimately related to consumption behavior. Economic theories, therefore, have been mostly focusing on consumption behavior. Leading economic theories to explain consumption and saving behavior include neoclassical permanent-income and lifecycle models. Both models predict that the effect of income fluctuation on personal saving depends on whether consumers perceive the income change as permanent or temporary, provided consumers are not subject to significant liquidity constraints. A temporary income change has a positive effect on saving because consumers, in anticipation of no permanent change of income in the future, need not revise their decision on consumption. Therefore, most temporary income fluctuations will be reflected by changes in saving rather than consumption. An anticipated permanent change in income, on the other hand, has a negative effect on current saving because consumers, in anticipation of a permanent change of future income, adjust current consumption accordingly. In practice, most empirical studies tend to find a strong positive effect of income change on saving.

The savings equations in MuDan are estimated in terms of the savings rate, which is computed simply as the ratio of the personal savings to disposable income. The savings are simply the difference between personal disposable income and personal consumption. Personal savings of rural and urban residents are estimated separately. Historical data of both income and consumption come from household expenditure surveys.

The savings rate is postulated as a function of its lagged value, the growth of real income, the unemployment rate, and the nominal interest rate:

$$s_t^u = a_0^u + a_1^u * s_{t-1}^u + a_2^u * uunemp_t + a_3^u * griu_t + a_4^u * intratN_t \qquad (4)$$

$$s_t^r = a_0^r + a_1^r * s_{t-1}^r + a_2^r * uunemp_t + a_3^r * grir_t + a_4^r * intratN_t \qquad (5)$$

where s_t^u and s_t^r = the savings rates of urban and rural residents, respectively, *uunemp* = the unemployment rate,

griu and *grir* = real income growth of urban and rural residents, respectively,

intratN = the nominal interest rate, and

α_0, α_1, α_2, α_3 and α_4, with superscripts r and u to indicate rural or urban residents, are parameters to be estimated. Because the savings rate establishes the crucial link between income and consumption, which is a major component of final demand and eventually an important determinant of total output, the behavior of the savings rate equation can have a significant impact on the overall performance of the model.

The inclusion of the lagged dependent variable in the savings rate equation represents the persistency and the long-term characteristic of the savings behavior. Savings are generally geared toward a long-term cause such as retirement, education, or housing or durable goods purchase. To reach the long-term goal, a continuing endeavor of savings is necessary, an endeavor lasting for decades. Therefore, it seems reasonable to expect that there is a positive correlation between current and past savings.

The unemployment rate is included in the specification to reinforce the stabilizing effect of the savings rate, and its coefficient is expected to have a negative sign. The intuition is that when the economy slows down and unemployment rises, the savings rate falls. Consequently, the falling savings rate pushes up consumption demand, therefore stabilizes the model to avoid a vicious cycle. The coefficient on the income variable is expected to be positive, as suggested by most empirical studies.

The coefficient on the interest rate is tricky. Empirical results on the relationship between the interest rate and the savings rate are ambiguous. On the one hand, an increase in the interest rates makes saving more attractive because the expected return from savings is increased. This suggests that there is a positive relationship between the savings rate and the interest rates. On the other hand, the increase in the interest rate results in the current assets being more valuable. Therefore, it may discourage savings because, to reach a certain targeted future value, people need to save less with the higher interest rates. Furthermore, high interest rates mean high interest payments, which may cut into funds for saving. Consequently, there may be a negative relationship between the savings rate and the interest rate. Apparently, whether there is a positive or negative net impact of the change in the interest rate on the savings rate should be determined empirically.

MuDan includes two separate savings rate equations for rural and urban residents, respectively. Table 37 shows the estimation of the savings rate for rural residents. The top panel in Table 37 displays the estimation results without soft constraints. Both the lagged savings rate and the income variable are statistically significant and show desired sign. The coefficient on the interest rate shows a negative impact on the savings rate although such impact does not appears statistically significant. The insignificant impact of the interest rate on saving has been found in many other empirical studies (Carlino, 1982; Campbell and Mankiw, 1989), therefore should not be a surprise. The insignificance of the unemployment rate in the equation is due to at least three factors. First, the urban unemployment rate is used in the equation and it is probably not a very good indicator of overall employment conditions. Second, the unemployment rate shows relatively little variations. Third, the lagged dependent variable may have been too significant an explanatory variable to leave explanatory power to other variables. Since a negative impact of the unemployment rate on the savings rate appears a desirable long-term property and a significant stabilizing force for the model, a soft constraint is applied to the coefficient on the unemployment rate.

The constrained estimation results are shown in the bottom panel of Table 37. With the soft constraint, the historical fit is only slightly worse as indicated by the statistics such as RBSQ or MAPE although such deterioration seems marginal. Figure 16 displays the historical fit of the constrained equation. Since the lagged depended variable is used in the specification, the graph includes three lines. The line showing actual values, Actual, is marked with $\bullet$'s. The line Predicted, marked with +'s, shows the prediction of the estimated structural relationship based on actual values of explanatory variables. The third line, BasePred, marked with $\times$'s, shows the prediction of the equation based on actual values of all explanatory variables except the lagged dependent variable, *rsavrat[1]*, and the predicted values of *rsavrat[1]*. While the Actual and Predicted lines show the closeness of the fit with historical values, the closeness of Actual and BasePred is more illustrative and more important. It shows how well the equation would have performed in a forecast over the fit period if values of all but the dependent variables were known. In this case, all three lines show fairly good fits.

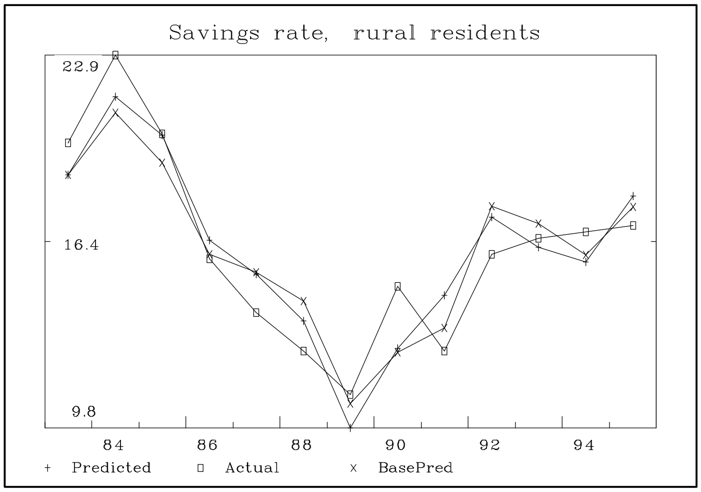


Figure 16 - Estimation of the Rural Savings Rate with Soft Constraints

Table 37 - Regression Results for Rural Savings Rates

```
:                Savings rate, rural residents
 SEE   =    1.19 RSQ  = 0.8658 RHO =  0.01 Obser  =   13 from 1983
 SEE+1 =    1.19 RBSQ = 0.7987 DurH =  0.04 DoFree =    8 to   1995
 MAPE  =    6.65 Test period:   SEE     1.99 MAPE    10.85 end  1996
   Variable name  Reg-Coef  Mexval t-value  Elas   NorRes     Mean
 0 rsavrat      - - - - - - - - - - - - - - - - - - - - -     16.12
 1 intercept       4.52635     6.7   1.049   0.28    7.45      1.00
 2 rsavrat[1]      0.53792    65.7   3.737   0.54    3.59     16.24
 3 uunemp[1]       0.77944     2.1   0.586   0.11    2.48      2.33
 4 grir            0.22246    52.5   3.257   0.08    1.02      5.89
 5 intratN        -0.02021     0.8  -0.353  -0.02    1.00     13.17


:              Savings rate, rural residents
 SEE   =    1.26 RSQ  = 0.8485 RHO =  0.17 Obser  =   13 from 1983
 SEE+1 =    1.26 RBSQ = 0.7727 DurH =  0.71 DoFree =    8 to   1995
 MAPE  =    7.53 Test period:   SEE     3.25 MAPE    17.69 end  1996
   Variable name  Reg-Coef  Mexval t-value  Elas   NorRes     Mean
 0 rsavrat      - - - - - - - - - - - - - - - - - - - - -     16.12
 1 intercept       8.16201    48.6   3.111   0.51    7.71      1.00
 2 rsavrat[1]      0.48907    55.9   3.388   0.49    4.30     16.24
 3 uunemp[1]      -0.57299    **        **  -0.08    3.53      2.33
 4 grir            0.26179    83.5   4.357   0.10    1.01      5.89
 5 intratN        -0.01426     0.3  -0.236  -0.01    1.00     13.17
```

Note: *rsavrat* corresponds to rural savings rate s^r in the text.
** indicates the variable is softly constrained.

Table 38 shows the estimation of the savings rate for urban residents. The top panel in Table 38 displays the unconstrained estimation results. The change-in-income variable is statistically significant and displays the desired sign. The interest rate shows a positive impact on the savings rate. The unemployment rate is shown to be statistically significant, but shows an undesirable positive sign. In contrast, the lagged dependent variable appears statistically insignificant and its coefficient shows a negative sign.

To maintain a desirable long-term property for the savings equation, a soft constraint is applied to the unemployment variable. The results are shown in the bottom panel of Table 38. With the soft constraint, the historical fit deteriorates significantly. While the statistical significance of the lagged dependent variable increases in the equation, the significance of the interest variable decreases. Despite the setback, the constrained estimation is selected for its desirable long-term property, and is used in the model.

Figure 17 displays the historical fit of the constrained equation.

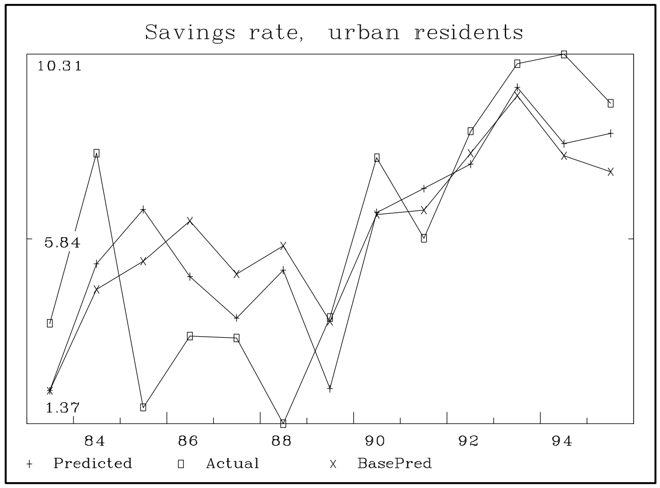


Figure 17 - Estimation of the Urban Savings Rate with Soft Constraints

Table 38 - Regression Results for Urban Savings Rates

: Savings rate, urban residents

SEE = 1.59 RSQ = 0.7258 RHO = -0.51 Obser = 13 from 1983
SEE+1 = 1.34 RBSQ = 0.5887 DurH = 999.00 DoFree = 8 to 1995
MAPE = 42.08 Test period: SEE 3.26 MAPE 31.21 end 1996

	Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0	usavrat	- -					5.95
1	intercept	-8.18568	21.7	-1.961	-1.37	3.65	1.00
2	usavrat[1]	-0.08249	0.5	-0.275	-0.08	2.45	5.62
3	uunemp[1]	4.32460	31.4	2.413	1.69	2.24	2.33
4	griu	0.50714	48.3	3.098	0.56	1.13	6.56
5	intratN	0.09095	6.5	1.038	0.20	1.00	13.17

: Savings rate, urban residents

SEE = 2.17 RSQ = 0.4869 RHO = -0.01 Obser = 13 from 1983
SEE+1 = 2.17 RBSQ = 0.2303 DurH = 999.00 DoFree = 8 to 1995
MAPE = 61.39 Test period: SEE 4.26 MAPE 40.72 end 1996

	Variable name	Reg-Coef	Mexval	t-value	Elas	NorRes	Mean
0	usavrat	- -					5.95
1	intercept	2.18361	6.7	1.054	0.37	2.19	1.00
2	usavrat[1]	0.38080	7.8	1.141	0.36	1.56	5.62
3	uunemp[1]	-0.40739	**	**	-0.16	1.35	2.33
4	griu	0.35340	16.3	1.686	0.39	1.00	6.56
5	intratN	0.02001	0.2	0.175	0.04	1.00	13.17

Note: *usavrat* corresponds to urban savings rate s^u in the text.
** indicates the variable is softly constrained.

The Nominal Interest Rate

The nominal interest rate paid by Chinese banks on one-year time deposits is selected as the nominal interest rate to be modeled by MuDan. The one-year interest rate is chosen because it probably is the most watched interest rate in China. Chinese banks follow a set of unified interest rates set by China's central bank, the Peoples Bank of China (PBC), so there is little room for banks to determine their own interest rates.

China's interest rates on longer-term time deposits, three and more year terms, are indexed to the inflation rate. An inflation subsidy will be paid on the longer term interest rates when the inflation rate exceeds a threshold. However, inflation subsidies are not available to shorter-term interest rates. Consequently, when the inflation rate gets high enough, the short term real interest rate could be negative. Table 39 displays the interest rate on One-Year time deposits.

Table 39 - Nominal Interest Rates on One-Year Time Deposits

(% per annum)

	Nominal Interest Rate, Low	Nominal Interest Rate, High	Inflation	Real Interest Rate, Low	Real Interest Rate, High
	A	B	C	D=A-C	E=B-C
1986	6.12	8.28	6.5	-0.38	1.78
1987	6.12	8.28	7.3	-1.18	0.98
1988	7.2	9.72	18.8	-11.6	-9.08
1989	7.2	9.72	18	-10.8	-8.28
1990	7.2	13.14	3.1	4.1	10.04
1991	6.12	10.08	3.4	2.72	6.68
1992	6.12	8.28	6.4	-0.28	1.88
1993	6.11	12.24	14.7	-8.59	-2.46
1994	10.98	12.24	24.1	-13.12	-11.86
1995	10.98	12.24	17.1	-6.12	-4.86
1996	7.47	10.98	8.3	-0.83	2.68

Note: Low and High interest rates indicate the range of interest rates applied to different customers and terms.

Interest rates in Table 39 are quoted with high and low rates that were floated in that year depending on specific terms or types of deposits. However, even with the higher interest rate, the real interest rates after adjusting for inflation were negative about half of the time between 1986 and 1996. With China's underdeveloped capital market where investment options are limited on the one hand, and consumers and producers are liquidity constrained on the other hand, such negative real interest rates can happen. However, the negative real interest is not sustainable in the long run, and it certainly does not reflect the true cost of capital. For the interest rate to be useful in the model, adjustments are needed. One way is to adjust the one-year interest rate by the inflation subsidies that are applied to the longer-term time deposits. For example, the inflation rates for 1995 and 1996 were 17.1% and 8.3%. In contrast, the interest rates were between 10.98% and 12.24% for 1995 and between 7.47% and 10.98% for

1996. At the same time, the inflation subsidies for the longer-term interest rates were 12.2% for 1995 and 6.31% for 1996.[20] If the same inflation subsidies had been applied to the one year term interest rates, the adjusted real interest rates would have been 5.9% to 7.16% for 1995 and 5.48% to 8.99% for 1996. These real interest rates, although a bit high, appear more reasonable. Due to lack of historical series of the inflation subsidies, imputing the real interest rate based on the official interest rate subsidies was not an option at this time. Therefore, a simplified adjustment is used.

MuDan adjusts the historical time series of actual nominal interest rates by adding an inflation premium to the actual interest rate whenever inflation exceeds 5%, and the inflation premium is simply the difference between the actual interest rate and 5%. The actual interest rates are computed as the simple average of the high and low rates. By such an adjustment, the historical, realized real interest rates in MuDan were estimated as between 2% to 7%.

A behavioral equation for the nominal interest rate equation is then estimated. MuDan's nominal interest rate is explained by inflation, the slackness of the economy, and the monetary policies, and the nominal interest rate equation is postulated as a function of expected inflation, money supply conditions, the unemployment rate, and the GDP share of investment. In particular, the following structural relation is postulated and estimated:

$$intratN_t = a_0 + a_1 * gcpiu_t + a_2 * uunemp_t + a_3 * gm2_t + a_4 * invshr_t \qquad (6)$$

where *intratN* = the nominal interest rate,

gcpiu = inflation rate of urban consumption prices,

[20] The annual rates of inflation subsidies were computed as the geometric means of the monthly rates, which can be found in *Almanac of China's Finance and Banking* (1997).

uunemp = the unemployment rate,

gm2 = growth of money supply M2, and

invshr = the GDP share of investment.

α_0, α_1, α_2, α_3 and α_4 are parameters to be estimated.

Perfect adjustment of the interest rate to inflation is assumed as current inflation is used in the specification. Furthermore, the coefficient on the inflation variable should ideally be equal to one. The money growth variable *gm2* captures the influence of the easiness of money supply on the interest rate in the short-term, and the long-term effect of a change in growth of money supply is already reflected in the coefficient on the inflation variable. The unemployment rate captures the slackness of economic conditions, and an investment variable expressed as the share of GDP is used to capture the impact of investment demand on the interest rate. As investment demand has a large influence on the capital market, higher investment demand relative to GDP will likely cause the interest rate to rise.

The equation is first estimated without constraints, and the results are reported in the top panel of Table 29. The unconstrained estimation displays wrong signs of coefficients on the unemployment rate and the money growth variable. This should not be too surprising because, given the way the interest rate is determined by the central bank, the postulated equation is more of a desired relationship in the future than one that was actually observed. Therefore, it is necessary to constrain the coefficients so that the equation has the desired long-run properties. Consequently, soft constraints are used and the equation is re-estimated. Specifically, the coefficient on the inflation variable is constrained to be one, a complete passthrough of inflation to the nominal interest rate. The coefficient on the unemployment is constrained to be –0.5, a plausible value that approximately equals the coefficient on similar equations for the U.S. (Almon, 1989; Monaco, 1993). The coefficient on the money supply variable is constrained to equal –0.1. Regression results of the interest rate equation with soft constraints are shown in the bottom panel of Table 40. The equation fit of the constrained version is plotted in Figure 18.

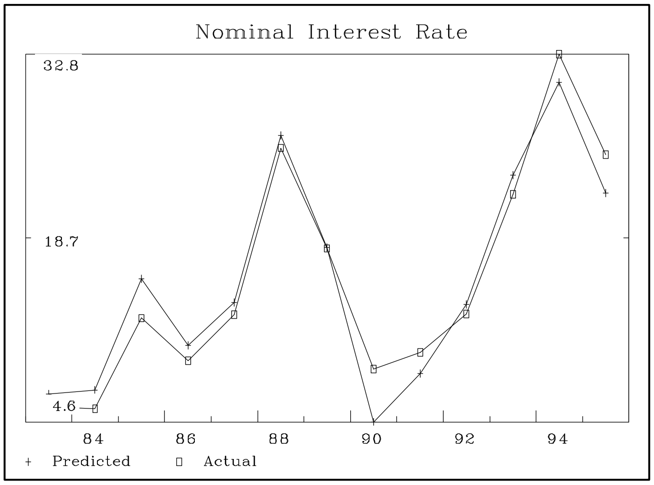


Figure 18 - Estimation of the Nominal Interest Rate with Soft Constraints

Table 40 - Regression Results for the Nominal Interest Rate

```
:                        Nominal Interest Rate
 SEE   =    0.91 RSQ  = 0.9875 RHO = -0.08 Obser  =   13 from 1983
 SEE+1 =    0.91 RBSQ = 0.9813 DW  =  2.16 DoFree =    8 to   1995
 MAPE  =    6.93
   Variable name  Reg-Coef  Mexval t-value  Elas   NorRes     Mean
 0 intratN      - - - - - - - - - - - - - - - - - - - - -     15.44
 1 intercept     -12.04458    21.9  -1.969  -0.78   80.32      1.00
 2 gcpiu           1.10608   358.7  12.662   0.80    3.77     11.13
 3 uunemp          3.33345    38.8   2.723   0.50    1.49      2.31
 4 gm2             0.12182    12.9   1.479   0.19    1.05     24.71
 5 invshr          0.11931     2.5   0.631   0.29    1.00     37.48

:                      Nominal Interest Rate (Constrained)
 SEE   =    1.97 RSQ  = 0.9423 RHO =  0.51 Obser  =   13 from 1983
 SEE+1 =    1.75 RBSQ = 0.9134 DW  =  0.98 DoFree =    8 to   1995
 MAPE  =   14.23
   Variable name  Reg-Coef  Mexval t-value  Elas   NorRes     Mean
 0 intratN      - - - - - - - - - - - - - - - - - - - - -     15.44
 1 intercept     -13.24571    10.4  -1.351  -0.86  146.69      1.00
 2 gcpiu           1.00184    **    32.854   0.72    7.80     11.13
 3 uunemp         -0.49521    **    -7.114  -0.07    1.78      2.31
 4 gm2            -0.07114    **    -1.538  -0.11    1.52     24.71
 5 invshr          0.54523    23.3   2.083   1.32    1.00     37.48
```

Note: ** indicates the variable is softly constrained.

CHAPTER IX :

THE CHINESE ECONOMY TO 2010 – A MUDAN FORECAST

In the previous chapters, I have described the structure, equations, and solution of the MuDan model. As a macro model with sectoral detail, MuDan is designed as a tool to provide a consistent framework for policy simulation and for long term forecasts of the Chinese economy up to the year 2010. The application of the model is demonstrated in this and the next chapters. In this chapter, I will present a basic forecast, which will be used as a benchmark during policy simulations. In Chapter X, I will demonstrate the use of MuDan in policy simulations by applying the model to evaluate the impact of China's accession to the World Trade Organization (WTO).

Assumptions on Values of Exogenous Variables

MuDan's exogenous variables include rural and urban population, labor force, money supply, the exchange rate, import prices, exports, and government expenditures.

For this study, MuDan's forecast and the simulations are made outside of the INFORUM international model system. More specifically, exports and import prices are taken as exogenous values from the February 1999 version of forecast by the INFORUM international model system.

Rural and urban population is extended separately by a simple time trend. According to our assumption, China's total population in 2010 will reach 1,425 million, which is in line with the government's population target of 1.4 billion for 2010.

Total labor force is determined by multiplying total population by a labor participation rate defined as the ratio of total labor force to total population.[21] Historically, the labor participation rate was relatively stable at 57% between 1990 and 1997. However, because Chinese population is aging rapidly as a result of an increase in life expectancy and government's enforcement of family planning, China's labor participation rate is expected to fall in the next two decades. Therefore, I have assumed a moderate decline in the labor participation rate, from 57% for 1998 to 55% for 2010, with the years between 1998 and 2010 linearly interpolated. Total labor force is determined by multiplying total population by the labor participation rate.

A summary of the assumptions on exogenous variables is presented in Table 41.

Table 41 – Assumptions on the Values of Exogenous Macro Variables

	1994	1995	1996	1997	2000	2005	2010
Total Population (million)	1198.50	1211.21	1223.89	1236.26	1276.58	1347.56	1418.33
Rural	855.49	859.47	864.39	866.37	878.50	903.17	927.94
Urban	343.01	351.74	359.50	369.89	398.08	444.38	490.39
Labor participation rate (%)	56.6	56.8	56.9	56.8	56.6	55.8	55.0
Total labor force (million)	678.79	687.37	696.65	701.70	722.26	751.86	780.18
M2 growth (%)	34.5	29.5	25.3	19.6	17.3	16.1	15.0
Exchange rate (yuan/US$)	8.62	8.35	8.31	8.31	8.50	9.25	10.00

The forecasts for M2 assume a slowdown of money supply growth, a trend consistent with the historical statistics. The government consumption expenditures in

[21] China's labor statistics revised upward the total labor force figures in 1998. For example, total labor force or the economically active population in Chinese statistics for 1994 was revised from 614.7 million in previous publications to 678.8 million in 1998. The revised statistics has not been incorporated in the current version of MuDan.

real terms are assumed to grow at 6.2 percent per year, slightly lower than the historical average growth of 6.9 percent between 1984 and 1994.

The exchange rate projections assume a modest depreciation of the yuan relative to the U.S. dollar between 2000 and 2010, increasing from 8.5 yuan in 2000 to 10 yuan in 2010. The exchange rate before 2000 uses historical averages, including the exchange rate for the first half of 1999. Ever since the Asian financial crisis started, there have been speculations that China will devalue the yuan. So far, however, the speculations have not materialized. While acknowledging the difficulties of going forward, the Chinese government has continued to pledge to preserve the value of the yuan in 1999. Given China's favorable trade balances in recent years and its large foreign exchange reserves, China's promise of maintaining the value of the yuan in the near future seems credible. Whether China can withstand the pressure and maintain the value of the yuan for an extended period of time, however, is difficult to predict.

The Chinese Economy to 2010 – A MuDan Forecast

Macroeconomic Forecast

Table 42 displays the macroeconomic results of a MuDan forecast, made in the fall 1999, that is based on the values of the exogenous variables presented in the previous section. The table starts in the year 1994, the last year for which historical data was used to estimate the equations for the current version of MuDan. In making the forecast, the GDP price deflator, aggregate consumption, investment and government expenditures for the 1995-97 period are used in various ways to guide the projections for these years.

Table 42 – The Benchmark Forecast of the Chinese Economy

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
Values in 1992 prices, 100M yuan												
Gross Domestic Product	33622	46097	49496	52890	74221	101322	8.3	8.2	7.4	6.9	7.0	6.4
Private Consumption	14811	21128	23016	24917	34694	47619	7.0	9.3	8.9	8.3	6.8	6.5
Consumption of Rural Householc	7385	10304	11126	11917	15641	21931	4.3	8.7	8.0	7.1	5.6	7.0
Consumption of Urban Househol	7427	10824	11891	13000	19053	25689	10.7	9.9	9.9	9.3	7.9	6.2
Public Consumption (*)	4526	5754	6110	6488	8758	11822	6.9	6.2	6.2	6.2	6.2	6.2
Total Fixed Investment	12071	15689	16915	17989	24794	33204	9.8	6.8	7.8	6.3	6.6	6.0
Inventory Investment	1806	1967	2164	2372	3716	5573	9.6	2.2	10.0	9.6	9.4	8.4
Net exports	600	1752	1483	1316	2452	3296	0.0	30.7	-15.3	-11.2	13.2	6.1
Exports (*)	6771	10088	10728	11555	17349	24778	14.0	10.5	6.3	7.7	8.5	7.4
Imports	-6170	-8337	-9245	-10238	-14897	-21481	11.4	7.8	10.9	10.7	7.8	7.6
Other final demand (*)	-193	-193	-193	-193	-193	-193	0.0	0.0	0.0	0.0	0.0	0.0
Deflators, 1992=100:												
GDP	132	174	182	190	219	250	10.8	7.2	4.4	4.2	2.9	2.7
Rural private consumption	130	166	172	178	194	208	10.2	6.2	3.8	3.5	1.7	1.4
Urban private consumption	136	180	189	198	229	260	11.0	7.2	5.0	4.8	2.9	2.6
Fixed asset investment	137	176	184	188	214	246	11.8	6.6	4.0	2.6	2.6	2.8
Exports	142	172	179	187	222	260	15.7	5.0	4.2	4.4	3.5	3.2
Imports	160	170	177	188	245	310	18.8	1.6	4.2	6.0	5.5	4.8
Other data												
Total income, 100M yuan												
Rural, nominal	12598	19418	21643	24130	35201	52835	15.1	11.4	11.5	11.5	7.8	8.5
Rural, real	9662	11709	12572	13540	18128	25403	4.4	4.9	7.4	7.7	6.0	7.0
Urban, nominal	11973	21446	24883	28412	47579	72586	23.9	15.7	16.0	14.2	10.9	8.8
Urban, real	8780	11898	13151	14332	20788	27878	11.6	7.9	10.5	9.0	7.7	6.0
Income per capita, yuan												
Rural, nominal	1473	2228	2468	2736	3875	5652	14.3	10.9	10.8	10.8	7.2	7.8
Rural, real	1129	1343	1434	1535	1996	2718	3.7	4.4	6.7	7.1	5.4	6.4
Urban, nominal	3491	5655	6403	7140	10712	14809	19.6	12.8	13.2	11.5	8.4	6.7
Urban, real	2560	3137	3384	3602	4680	5687	7.7	5.2	7.9	6.4	5.4	4.0
Population (millions)	1199	1251	1265	1280	1352	1425	1.4	1.1	1.2	1.1	1.1	1.0
Rural	855	872	877	882	908	935	0.6	0.5	0.6	0.6	0.6	0.6
Urban	343	379	389	398	444	490	3.6	2.5	2.5	2.4	2.2	2.0
Total labor force (millions)	607	635	641	646	673	698	2.3	1.2	0.9	0.8	0.8	0.7
Employment (millions)	584	621	627	629	653	674	2.1	1.6	1.0	0.2	0.7	0.7
Unemployment rate (%)	3.8	2.2	2.1	2.7	3.0	3.5						
Exchange rate, yuan/US$	8.6	8.3	8.4	8.5	9.2	10.0						
Savings rate, rural residents (%)	16.7	12.0	11.5	12.0	13.7	13.7						
Savings rate, urban residents (%)	10.3	9.0	9.6	9.3	8.3	7.8						
Values in current prices, 100M yuan												
Gross Domestic Product	44318	80350	90036	100235	162286	252817	20.0	16.0	12.1	11.3	10.1	9.3
Private Consumption	19710	36741	41909	47385	75457	116164	18.3	16.8	14.1	13.1	9.8	9.0
Rural private consumption	9577	17029	19125	21230	30710	46942	14.9	15.5	12.3	11.0	7.7	8.9
Urban private consumption	10133	19712	22784	26156	44746	69222	22.9	18.1	15.6	14.8	11.3	9.1
Investment	16494	27689	31040	33876	53087	81720	22.7	13.8	12.1	9.1	9.4	9.0
Inventory change	2330	3216	3710	4244	7617	12853	21.1	8.4	15.4	14.4	12.4	11.0
Government	5859	10289	11328	12652	20810	33401	19.1	15.1	10.1	11.7	10.5	9.9
Exports	9597	17351	19222	21610	38548	64398	31.9	16.0	10.8	12.4	12.3	10.8
Imports	-9876	-14200	-16404	-19250	-36540	-66609	32.3	9.5	15.5	17.4	13.7	12.8
Value added, current prices, 100M yuan												
Depreciation	6127	11484	12610	14273	21988	31535	20.8	17.0	9.8	13.2	9.0	7.5
Wages	17871	30445	33805	37723	58422	84213	17.8	14.2	11.0	11.6	9.1	7.6
Profits	14286	27445	31205	33865	56837	89672	22.3	17.7	13.7	8.5	10.9	9.5
Taxes	6035	10975	12416	14375	25039	47397	21.4	16.1	13.1	15.8	11.7	13.6

* - exogenous

Steady economic growth, low inflation, and slow growth of employment are among the main themes in our forecast of the Chinese economy for the next decade. The average GDP growth rates of 7.0% for the 2000-05 period and 6.4% for the 2005-10 period are slightly lower than the historical average growth since 1984, although the slower growth appears more sustainable than the explosive growth in the past. One of the noticeable trends in our forecast is the reversal of the roles of private consumption and investment demands in determining economic growth. Historically, China's economic growth has been driven by heavy investment, which is evident from the faster growth of fixed investment than the GDP growth during the 1984-94 period in Table 42. In our forecast, however, private consumption demand plays a more important role than investment, as the growth of personal consumption exceeds the investment growth throughout the forecast period. In fact, our forecast predicts that the average growth of private consumption surpasses the GDP growth during the 2005-10 period. An improvement in investment efficiency is a main contributing factor for the change of growth patterns, as investors, particularly a growing number of non-state investors, seek better returns on investment and make better investment decisions than did state enterprises, which accounted for a majority of total investment. The development in China's drive toward a market economy also contributes, as producers strive to meet consumer demand rather than to dictate what consumers should buy. In addition to vigorous domestic consumption demand, foreign trade remains strong. Exports continue to be a main driving force of the economic growth, as exports outgrow GDP by about one percentage point on average each year in our forecast. We expect that China will maintain a favorable trade balance throughout the next decade. By the end of 2010, private consumption will account for 47.0% of GDP, 2.9 percentage points higher than that in 1994. However, The gain of private consumption in the share of

GDP is offset by a decrease in the investment's share of GDP, which fall from 41.3% in 1994 to 38.3% in 2010. The composition of GDP in 1994, 2000, and 2010 is shown in Figure 19.

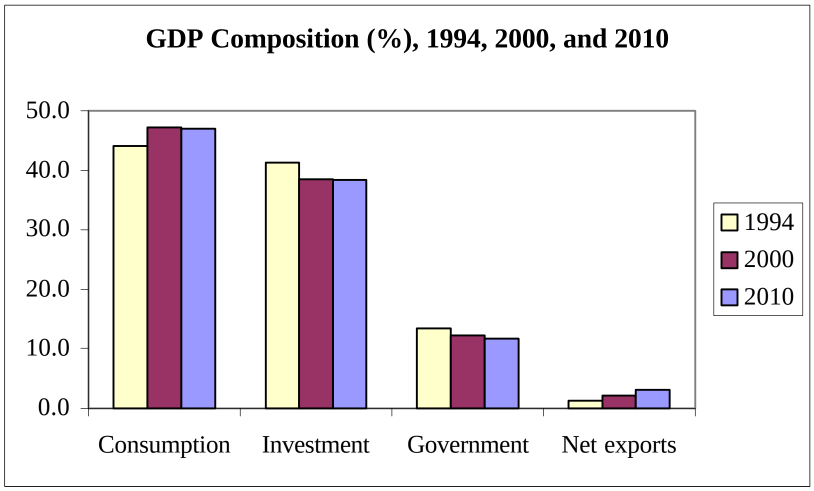


Figure 19 - GDP Composition, 1994, 2000, and 2010

The MuDan forecast calls for strong growth of personal income, and faster growth of rural per-capita real income than urban per-capita real income. China's continuing industrialization is the main benefactor for the faster rural income growth, as rural labor continues to move away from the agriculture sector into higher paying industrial and service sectors. However, even with the faster growth, the income gap between rural and urban residents persists. By 2010, per-capita real income for rural residents still amounts to only 47.8% of that for urban residents, although it is slightly higher than the 44 percent in 1994. As personal income maintains steady growth, private consumption spending remains strong, and the decrease in inflation further strengthens the purchasing power. Due to rapid urbanization, total urban consumption grows at a faster pace than rural consumption.

Our forecast of inflation is rather optimistic. The average inflation of less than 3% is significantly lower than the historical average of more than 10%. The high inflation in the past was due to a number of factors, including price reform and supply constraints or bottlenecks. However, we do not anticipate these same factors will play a significant role in our forecast period. The price reform in the last two decades brought about structural changes in price setting from centrally planning to market determination. One important development was the release of controls over the depressed prices of agricultural products, energy, and raw material under central planning. As a result, prices for agricultural products, energy, and raw material increased significantly and rapidly, causing increases in production costs, which pushed up prices of almost everything else. However, after two decades of price reform, few prices are not market driven. The few exceptions include apartment rent, government health care, and tuition; reform in these areas is expected to be cautious. Therefore, no major inflationary price reform steps are anticipated.

From the supply side, there used to be very restrictive bottlenecks in sectors such as transportation, energy, and raw materials. However, the rapid expansion of capacity of transportation, raw material production and other infrastructure in the last two decades has significantly lessened the bottleneck problem. Furthermore, producers have become more prudent and efficient in the use of energy and raw materials because of the increases in prices of these sectors. Therefore, these old-bottleneck sectors are much more accommodating than in the past, allowing economic development at a fast pace. In addition, the existence of a large pool of underutilized labor force further helps keep inflation in check. Moreover, increasing competition between state and non-state enterprises, and stiffer competition from abroad will force domestic enterprises to hold the line on price increases and enhance productivity, easing price growth.

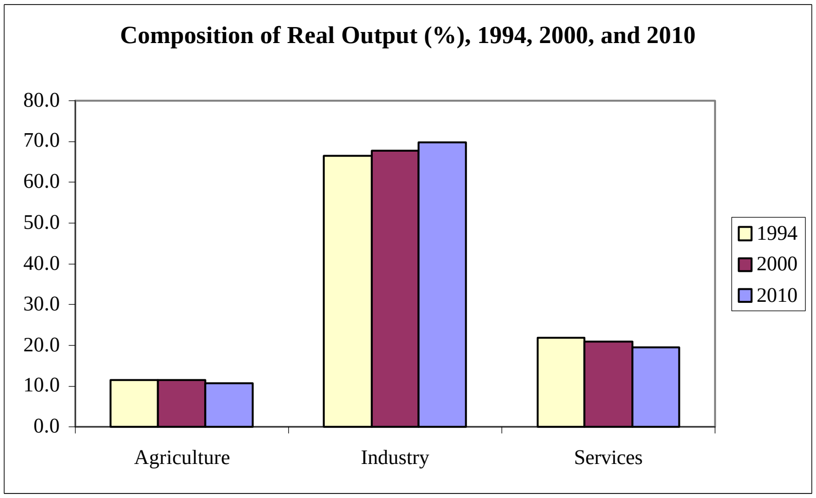
In the labor market, we anticipate that labor will continue to move away from the rural area in search of employment opportunities in industrial and service sectors; in state enterprises, redundant employment will be further reduced as economic reform continues. The combination of the two forces will put significant pressure on the labor market, resulting in an increase in unemployment from the current level.

Sectoral Forecast

Table 43 at the end of this chapter consists of a series of detailed MuDan forecasts for various sectors, including output, output price indexes, employment, consumption, investment, imports, net exports, and value added. These tables are part of the standard results that are generated by MuDan. As I have emphasized throughout this dissertation, one of the advantages of the MuDan model is its level of disaggregation. From these sectoral projections, we can gain an understanding of how the structure of the economy will change overtime. In the remaining portion of this chapter, I will highlight some of MuDan's industrial forecast. In the following discussion, I will use Agriculture, Industry and Services to refer to the three main sectors of the economy. Agriculture includes MuDan's sectors 1-4. Industry includes MuDan's sectors 5-45 and covers mining, manufacturing and construction. The Services sector includes MuDan's sectors 46-59.

The MuDan forecast predicts that the Chinese economy will continue to develop into an industrialized economy, with production and employment gaining share at the expense of Agriculture. By 2010, the share of agricultural output will fall to 10.7% from 11.6% in 1994, and agricultural employment will fall to 47.1% from 56.1% in 1994. In contrast, the output share of Industries increases from 66.5% in 1994 to 69.7% in 2010, and industrial employment will account for 27.0% of the total, an increase of 3.3 percentage points from 23.7% in 1994. While the output share of

Services will fall from 21.9% in 1994 to 19.6% in 2010, its share of employment will increase significantly, from 20.2% in 1994 to 25.9% in 2010. In summary, our basic outlook for the economy is that the industrial sectors hold the greatest potential for economic growth; the service sectors have the greatest potential for new jobs; Agriculture remains an important sector of the economy. Figure 20 displays the shares of real output and employment of the three main sectors in 1994, 2000, and 2010.



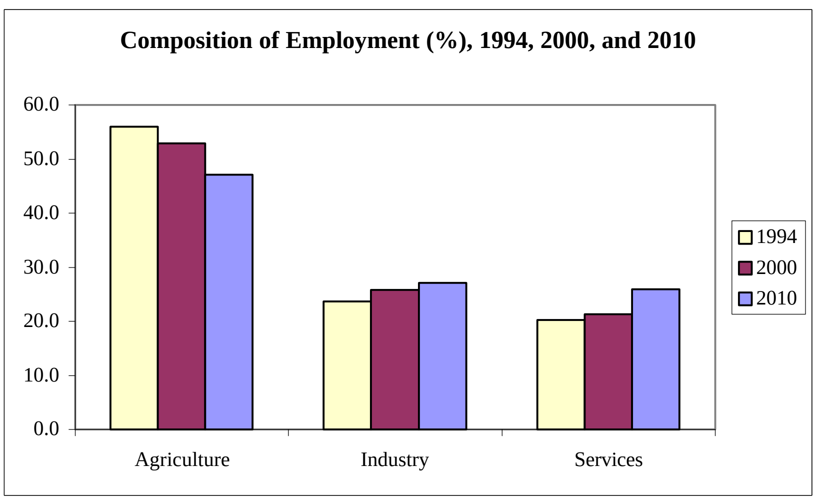


Figure 20 - Shares of Output and Employment in 1994, 2000, and 2010

A close examination of the table for Output in Table 43 reveals some insights on the industrial structural changes in the next decades. Motor vehicles, Gas utility, Post and telecommunication, and Electronic and communication equipment are among the fastest growing industries. Within industrial sectors, output of machinery, energy, and raw material products tends to grow faster than output of consumer products, and their growth correlates with the expansion of the automobile industries. For some industries, the output growth represents a continuation of the historical trends. For many others, it is a reversal. For example, the growth rates of Leather product and Tobacco products were among the fastest in the past, but their growths in the future are less than average. On the other hand, our forecast calls for significantly faster growth in Crude petroleum and natural gas and Petroleum refineries than in the past. China's increasing reliance on petroleum can be attributed to the expansion in chemical industries such as Chemical fibers, Chemicals, and Plastic products, whose output growth are among the fastest. The rapid growth of Air and Highway transportation has further fueled the demand on petroleum products such as gasoline.

As shown in Figure 20, MuDan predicts that the Services sector gains an increasing share of employment at the cost of Agriculture. More detailed results are shown in the Employment table in Table 43. According to the forecast, Agriculture employs 9.7 million fewer people in 2010 than in 1994 while the economy overall adds 91 million jobs, resulting a net gain of about 100 million jobs in industry and service sectors between 1994 and 2010. Of the 100 million new jobs, Industry accounts for 44 million while the Services sector creates 56 million. The sectors with largest increases in employment include Commerce, Education and entertainment, and Real estate and social services. Commerce has the greatest potential for job creation, and Employment in Commerce will be increased by 24 million, an increase of 66% between 1994 and 2010. The Real estate and social services sectors and Education and entertainment are also large job creators, and each sector will add 11 and 10 million new jobs respectively from 1994 to 2010. These changes represent increases of 127% and 68% from their respective 1994 levels. The Government and Textiles sectors are expected to be the main job losers; they will reduce employment from their 1994 levels by 3.4 million and 1.7 million, respectively.

Investment spending by industry in Table 43 displays large variations among sectors. Highway transportation, Water Transportation, Post and telecommunication, Electronic product, Finance and insurance, Tobaccos, and Electricity sectors will have the fastest growth in investment spending. These industries historically received high priorities in investment, and the fast investment growth in these sectors represents a continuation of their historical role. Recall that in estimating the investment equations, we created a vector of policy variables, one for each industry, to model the existence of government's investment priorities on certain industries. An industry is modeled as receiving some priority in investment when the value of its investment policy variable is greater than one. The larger the value, the higher the investment priority on the industry. The default value of the policy variable is set to the coefficient on the wear-out variable in the investment equation for that industry. Historically, the values of the policy variable for Tobaccos and a number of other industries are very large. In making this forecast, I have reduced the values of the policy variable for Tobaccos by fixing the value in 2010 to be half of its estimated 1994 value. The values between 1994 and 2010 are obtained through a linear interpolation. I have similarly reduced the values of the policy variables for investment sectors 10, 35, 41, 42, 44, 45, and 47, which are also found to be historically the "priority" investment sectors. However, investment demand by these industries remains very strong. On the other hand, we find that the Primary iron and steel and Leather product sectors would experience the lowest investment growth in the coming decade.

MuDan predicts trade surpluses in constant prices throughout the forecast period. However, trade balances for each individual industry vary. The Imports and Net Exports tables in Table 43 provide sectoral details on foreign trade. Sectors with the largest increase in the value of imports from 1994 to 2010 include Machinery, which displays an increase of 267 billion 1992 yuan from 114 billion yuan in 1994, Textiles (an increase of 194 billion yuan from 68 billion yuan), Chemicals (an increase of 158 billion from 66 billion yuan), and Motor vehicles (an increase of 149 billion yuan from 30 billion yuan). While most sectors will experience increases in imports, imports for a number of sectors will actually fall, including, most notably, the Primary iron and steel and Railway equipment sectors. The primary reason for such a fall is that import shares for these sectors are anticipated to continue to fall as they did in recent years.

MuDan predicts that sectors with the largest trade surpluses will be Wearing apparel, which has a net exports of 286 billion yuan in 2010 representing an increase of 200 billion yuan from its 1994 level, and Electronic and communication equipment, which has a net gain of 159 billion yuan from its 1994 level. Sectors with the most significant trade deficits include Machinery (an increase of 213 in deficit from its 1994 level of 87 billion yuan), Motor vehicles (an increase of 145 billion in deficit from 28 billion yuan), and Chemical products (an increase of 77 billion in deficit from 38 billion yuan).

On consumer spending of rural residents, our forecast predicts that rural consumers, not content with merely feeding themselves, will seek greater satisfaction in culture, education, and entertainment activities. We anticipate that rural consumers will spend a significantly smaller share on food, grain in particular, and larger on clothing, household goods, and cultural, education and entertainment activities. Our forecast predicts that the expenditure share of food will fall to 41.3% in 2010 from 53.1% in 1994, a reduction of almost 12 percentage points. In contrast, expenditure shares of cultural, educational and entertainment activities will almost double from 9.7% in 1994 to 19.3% in 2010. It should be noted that consumption on the Housing category includes housing maintenance, not construction of new housing, which is included in investment. Therefore, a slightly declining share of consumption spending on Housing should not be a concern. Figure 21 displays the composition of rural consumption expenditures in 1994, 2000, and 2010.

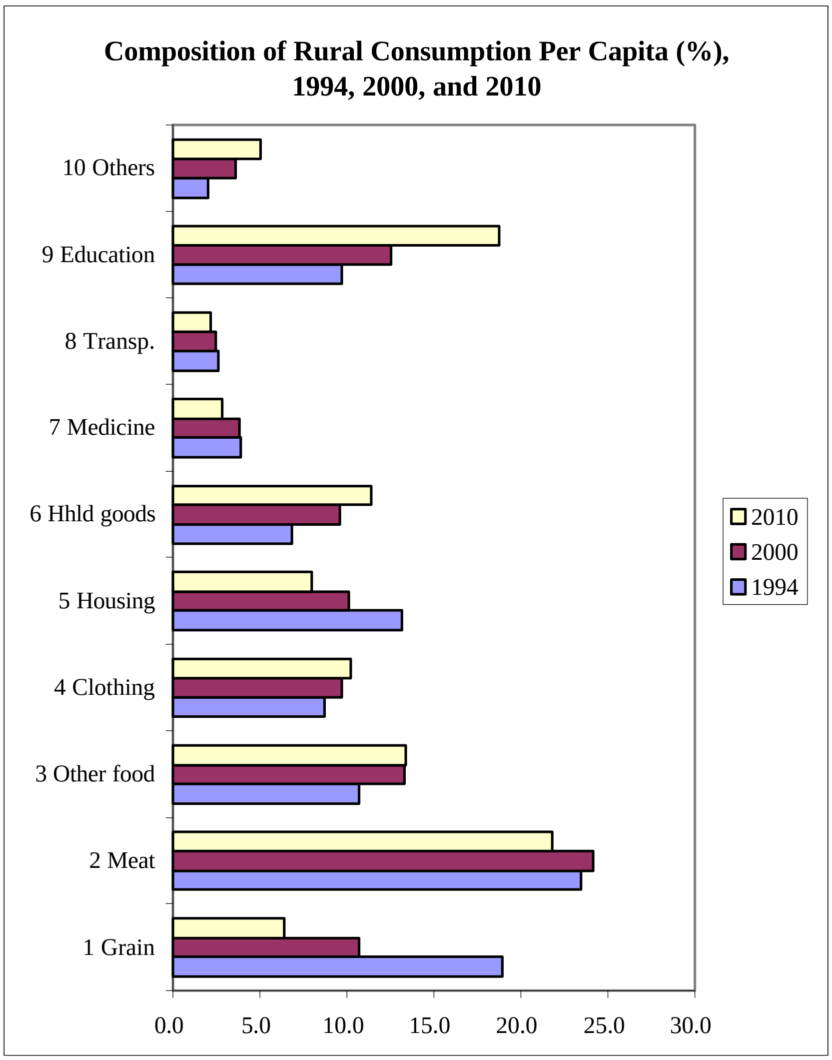


Figure 21 – Composition of Rural Consumption Per Capita, 1994, 2000, and 2010

Urban consumers share a similar tendency with rural consumers on grain consumption, as the expenditure share for urban residents falls from 5.7% in 1994 to 2.6% in 2010. They will spend relatively less on meat, poultry, fats, flavorings, and spend more on fish, vegetables, fruits, beverage and tobaccos in the food categories. The sum of expenditure shares of all food categories decline slightly from 46.8% in 1994 to 45.8% in 2010. However, urban consumers will spend relatively more on garments, but relatively less on shoes, cloths, and tailoring services. They will also spend relatively less on Appliances, furniture, TV, VCR and other durable goods, probably because the durable good rush in the late 1980s and early 1990s has prematurely saturated the demand. It could also mean that consumers are attracted to other durable products such as motorcycles and automobiles, as the expenditure shares of Transportation and other household categories are on the rise. Indeed, as shown in the "Private Consumption By I-O Sector" table in Table 43, we predict significant growth in private consumption spending on automobiles, although the fast growth comes from a very low basis. However, we do not predict a dramatic increase of consumer spending on automobiles either.

Our forecast does not predict significant increases in housing-related expenditures by urban consumers. While housing reform will inevitably increase urban residents' spending on housing, we expect the reform will follow a cautious process. Since the timing of the reform is difficult to predict, housing reform is not modeled.

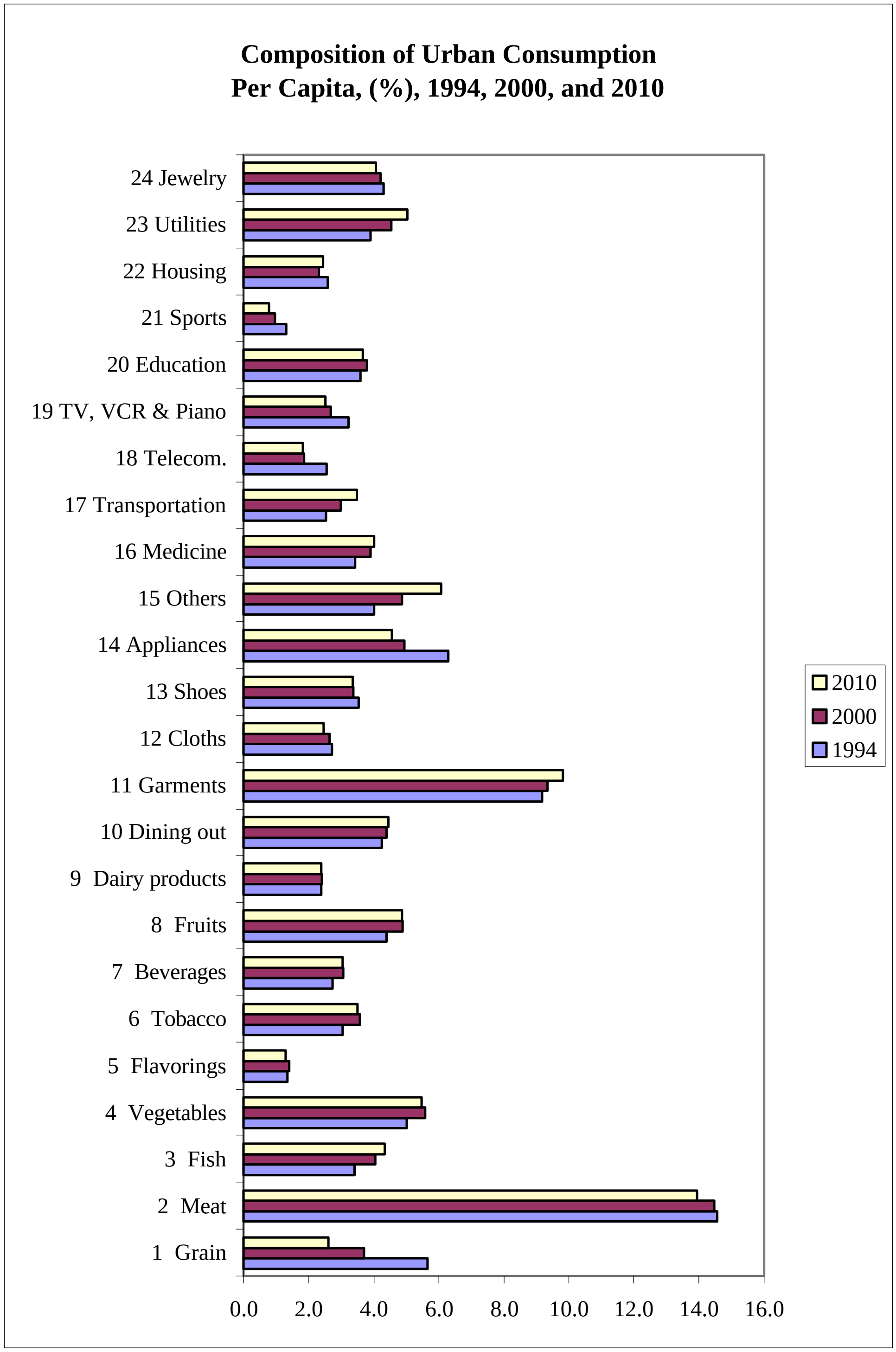


Figure 22 - Composition of Urban Consumption by Category, 1994, 2000, and 2010

Table 43 – Details of The Benchmark Forecast of the Chinese Economy

Output (in 100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	91814	130863	141999	153325	226472	322714	9.8	9.3	8.5	8.0	8.1	7.3
1 Farming	6069	8101	8714	9311	13067	17869	3.4	7.5	7.6	6.9	7.0	6.5
2 Forestry	497	642	686	729	1024	1432	3.8	6.6	6.8	6.3	7.0	6.9
3 Livestock	3180	4874	5311	5753	8340	11741	9.5	11.3	9.0	8.3	7.7	7.1
4 Fishing	872	1433	1571	1712	2536	3560	14.7	13.2	9.7	9.0	8.2	7.0
5 Coal mining	787	1090	1180	1276	1899	2718	6.7	8.5	8.3	8.1	8.3	7.4
6 Crude petroleum and natural ga	839	1283	1412	1547	2458	3674	9.3	11.2	10.0	9.6	9.7	8.4
7 Ferrous ore mining	111	131	138	146	234	342	12.5	4.2	6.0	5.2	9.9	7.9
8 Non-ferrous ore mining	202	266	283	302	452	636	13.0	7.2	6.2	6.7	8.4	7.1
9 Non-metal minerals mining and	653	1004	1110	1222	1984	3032	11.9	11.3	10.6	10.0	10.2	8.8
10 Logging and transport of timbe	149	168	176	182	232	295	0.6	3.0	4.5	3.8	4.9	4.9
11 Food processing and manufactu	3863	5787	6335	6899	10349	14604	12.0	10.6	9.5	8.9	8.5	7.1
12 Beverages	1090	1816	2023	2224	3325	4796	15.9	13.6	11.4	9.9	8.4	7.6
13 Tobacco manufacture	777	1169	1273	1367	1813	2358	10.6	10.8	8.9	7.4	5.8	5.4
14 Textiles	4817	6706	7210	7789	11096	15460	9.2	8.6	7.5	8.0	7.3	6.9
15 Wearing apparel	1768	2589	2824	3067	4499	6136	8.6	10.0	9.1	8.6	8.0	6.4
16 Leather, fur and their products	1125	1381	1489	1602	2313	3235	20.5	5.3	7.8	7.6	7.6	6.9
17 Sawmills and bamboo etc. prod	355	533	587	642	994	1478	13.1	10.7	10.2	9.4	9.1	8.3
18 Furniture	616	847	905	966	1390	1955	11.3	8.3	6.8	6.8	7.5	7.1
19 Paper and paper products	1052	1509	1633	1763	2596	3700	11.9	9.5	8.2	7.9	8.1	7.3
20 Printing industries	544	886	989	1099	1806	2807	13.9	13.0	11.7	11.1	10.4	9.2
21 Culture, education, and sports a	354	495	530	569	842	1220	19.7	8.7	7.2	7.3	8.2	7.7
22 Petroleum refineries and coking	793	1218	1343	1476	2343	3519	6.0	11.3	10.3	9.9	9.7	8.5
23 Chemical industries	3647	5609	6136	6703	10655	16204	12.5	11.4	9.4	9.2	9.7	8.7
24 Medicines	836	1334	1483	1642	2484	3641	14.5	12.4	11.1	10.7	8.6	7.9
25 Chemical fibers	541	874	973	1082	1782	2755	18.9	12.7	11.4	11.2	10.5	9.1
26 Rubber products	590	836	909	984	1476	2162	9.8	9.1	8.7	8.3	8.4	7.9
27 Plastic products	1322	2061	2270	2494	3979	6053	16.3	11.8	10.1	9.9	9.8	8.8
28 Building materials and non-me	3896	5570	6082	6590	9902	14285	12.2	9.3	9.2	8.4	8.5	7.6
29 Primary iron and steel manufac	2946	3629	3826	4006	5402	7007	10.2	5.4	5.4	4.7	6.2	5.3
30 Primary non-ferrous metals ma	906	1064	1099	1141	1518	1936	7.0	4.1	3.2	3.9	5.9	5.0
31 Metal products	2069	2896	3135	3383	5053	7319	11.2	8.8	8.2	7.9	8.4	7.7
32 Machinery	4651	6805	7231	7627	11687	17046	12.5	10.0	6.3	5.5	8.9	7.8
33 Railway Equipment	210	261	287	298	392	506	13.3	5.6	9.7	4.1	5.6	5.3
34 Motor vehicles	1924	3265	3716	4183	7132	11239	18.9	14.1	13.8	12.6	11.3	9.5
35 Ships, boats	229	366	403	441	706	969	14.9	12.5	10.2	9.3	9.9	6.5
36 Aerospace	106	158	170	184	281	414	12.4	10.6	7.7	8.0	8.9	8.0
37 Transportation equipment, n.e.	626	850	919	1000	1401	1858	8.7	7.9	8.2	8.8	7.0	5.8
38 Electric machinery and equipm	2431	3609	3938	4283	6672	9959	16.4	10.4	9.1	8.8	9.3	8.3
39 Electronic and communication	1850	3003	3341	3683	6109	9681	19.0	12.9	11.3	10.2	10.7	9.6
40 Instrument, meters and office m	522	737	789	840	1208	1663	12.9	9.0	7.1	6.4	7.5	6.6
41 Manufacture, n.e.c.	1848	2860	3136	3413	5222	7601	16.8	11.5	9.7	8.8	8.9	7.8
42 Electricity, steam and hot wate	1322	2068	2293	2531	4100	6253	11.3	11.8	10.8	10.4	10.1	8.8
43 Gas utility	55	95	109	125	208	314	19.2	14.5	14.3	14.6	10.8	8.5
44 Water	119	191	213	237	385	586	13.7	12.6	11.6	11.1	10.2	8.7
45 Construction	8537	11221	12077	12839	17589	23480	12.9	7.1	7.6	6.3	6.5	5.9
46 Railway transportation	530	604	623	642	767	911	-1.2	3.3	3.1	3.1	3.6	3.5
47 Highway transportation	1553	2300	2522	2751	4146	6012	11.6	10.3	9.7	9.1	8.6	7.7
48 Water transportation	448	628	677	729	1072	1520	7.7	8.8	7.7	7.7	8.0	7.2
49 Air transportation	204	328	359	396	639	971	20.4	12.5	9.7	10.0	10.1	8.7
50 Pipeline transportation	20	28	30	33	48	69	0.7	8.7	8.2	8.0	8.2	7.4
51 Post and communications	477	778	872	971	1613	2508	21.6	13.0	12.1	11.4	10.7	9.2
52 Commerce	6340	8467	9079	9686	13315	17724	8.2	7.5	7.2	6.7	6.6	5.9
53 Restaurants	1223	1632	1749	1865	2536	3404	10.8	7.5	7.1	6.7	6.3	6.1
54 Finance and insurance	2406	3614	3963	4323	6721	9959	12.3	10.7	9.6	9.1	9.2	8.2
55 Real estate, and social services	2258	3166	3428	3705	5336	7448	12.3	8.8	8.3	8.1	7.6	6.9
56 Health care, sports and social v	704	939	1018	1102	1519	2038	0.3	7.5	8.5	8.2	6.6	6.0
57 Education, culture, arts, movie	1028	1350	1453	1566	2162	3076	6.3	7.1	7.6	7.8	6.7	7.3
58 Scientific research and polytech	903	1093	1144	1195	1498	1869	0.3	4.9	4.6	4.5	4.6	4.5
59 Public administration and other	2023	2644	2823	3010	4162	5707	-0.1	6.9	6.8	6.6	6.7	6.5

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Output Price Indexes (1992 = 100)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
1 Farming	125	158	164	172	183	192	8.6	6.0	4.3	4.4	1.2	1.1
2 Forestry	99	125	130	137	145	151	7.7	5.9	4.3	5.0	1.1	0.9
3 Livestock	126	167	176	186	205	223	10.7	7.2	5.4	5.6	2.0	1.7
4 Fishing	127	166	175	184	204	224	12.7	7.0	5.1	5.3	2.0	1.9
5 Coal mining	167	243	259	259	305	351	12.9	9.9	6.5	0.2	3.3	2.8
6 Crude petroleum and natural ga	167	216	224	216	232	253	12.9	6.6	3.8	-3.5	1.4	1.8
7 Ferrous ore mining	168	230	239	240	267	295	13.0	8.2	3.9	0.4	2.1	2.0
8 Non-ferrous ore mining	166	233	245	250	285	321	12.9	8.9	4.8	2.3	2.7	2.4
9 Non-metal minerals mining and	150	197	205	208	230	254	13.1	7.1	4.0	1.5	2.0	2.0
10 Logging and transport of timbe	135	173	180	188	218	253	12.8	6.4	4.1	4.7	3.0	3.0
11 Food processing and manufactu	129	177	187	199	235	274	8.4	8.2	5.9	6.2	3.4	3.1
12 Beverages	132	178	187	197	230	267	8.7	7.7	5.3	4.9	3.2	3.0
13 Tobacco manufacture	133	169	175	185	210	248	8.8	6.1	3.8	5.7	2.5	3.4
14 Textiles	134	171	178	186	211	237	9.9	6.3	4.3	4.2	2.6	2.3
15 Wearing apparel	131	170	178	186	214	241	18.4	6.7	4.7	4.4	2.8	2.5
16 Leather, fur and their products	135	170	180	190	227	265	10.9	5.9	5.7	6.0	3.6	3.2
17 Sawmills and bamboo etc. prod	135	169	175	181	201	223	12.9	5.8	3.6	3.3	2.2	2.1
18 Furniture	135	167	173	178	197	217	12.9	5.4	3.5	2.9	2.1	1.9
19 Paper and paper products	110	141	147	151	167	182	9.0	6.4	4.0	3.2	2.0	1.7
20 Printing industries	117	149	155	161	178	193	7.6	6.3	3.8	3.6	2.0	1.6
21 Culture, education, and sports a	116	154	160	165	182	198	7.6	7.3	4.0	2.8	2.0	1.7
22 Petroleum refineries and coking	250	329	343	341	381	432	17.3	7.1	4.3	-0.5	2.2	2.5
23 Chemical industries	122	167	175	182	208	236	8.3	8.2	5.3	3.6	2.8	2.5
24 Medicines	120	172	184	193	236	282	8.2	9.4	6.6	4.7	4.2	3.7
25 Chemical fibers	120	164	172	178	205	232	8.2	8.0	5.0	3.4	2.9	2.5
26 Rubber products	116	150	157	162	179	196	7.8	6.8	4.4	3.2	2.0	1.8
27 Plastic products	121	163	171	178	206	233	8.3	7.7	4.9	4.1	2.9	2.5
28 Building materials and non-me	150	204	213	218	248	281	13.1	8.0	4.2	2.5	2.7	2.5
29 Primary iron and steel manufac	166	219	229	235	274	329	15.9	7.2	4.4	2.9	3.1	3.7
30 Primary non-ferrous metals ma	165	224	233	241	277	326	15.9	7.9	4.2	3.1	2.9	3.3
31 Metal products	165	204	209	214	230	253	15.9	5.4	2.6	2.2	1.5	1.9
32 Machinery	127	156	161	163	175	189	8.9	5.2	3.1	1.7	1.3	1.6
33 Railway Equipment	127	172	179	183	212	249	8.9	7.7	4.6	2.0	3.0	3.2
34 Motor vehicles	126	170	178	181	206	232	8.8	7.8	4.8	1.6	2.7	2.4
35 Ships, boats	126	163	169	174	197	223	8.8	6.6	3.8	3.0	2.5	2.5
36 Aerospace	124	171	180	182	216	256	8.6	8.4	5.1	1.3	3.4	3.5
37 Transportation equipment, n.e.c	129	177	186	188	217	251	16.8	8.3	5.1	1.1	2.9	2.9
38 Electric machinery and equipm	128	158	161	165	177	190	9.0	5.3	2.5	2.2	1.4	1.5
39 Electronic and communication	123	154	157	160	171	181	8.5	5.8	2.1	1.9	1.3	1.1
40 Instrument, meters and office m	127	155	159	162	173	184	8.9	5.0	2.7	1.6	1.3	1.3
41 Manufacture, n.e.c.	143	180	187	195	221	249	10.9	5.8	4.0	4.3	2.5	2.4
42 Electricity, steam and hot water	186	276	291	294	332	369	11.6	10.4	5.3	1.3	2.4	2.2
43 Gas utility	166	230	242	246	283	320	12.9	8.5	5.2	1.7	2.9	2.5
44 Water	145	226	241	243	280	315	11.0	11.8	6.6	1.0	2.9	2.4
45 Construction	139	182	190	194	221	255	11.8	7.0	4.0	2.4	2.6	2.9
46 Railway transportation	129	198	210	226	279	317	11.5	11.5	5.9	7.6	4.3	2.6
47 Highway transportation	128	176	187	196	241	283	11.4	8.4	5.9	5.1	4.2	3.3
48 Water transportation	128	189	204	220	302	382	11.5	10.2	7.5	8.3	6.5	4.8
49 Air transportation	123	168	177	184	217	253	11.0	8.2	5.2	4.1	3.4	3.1
50 Pipeline transportation	128	150	156	162	182	204	11.4	4.0	4.1	3.9	2.4	2.3
51 Post and communications	128	197	207	221	266	285	11.4	11.4	5.0	7.0	3.7	1.4
52 Commerce	128	181	192	206	258	306	16.1	9.1	5.9	7.0	4.6	3.5
53 Restaurants	132	182	193	207	252	296	11.7	8.3	6.3	7.0	4.0	3.3
54 Finance and insurance	133	172	179	188	221	252	11.8	6.5	4.5	5.1	3.2	2.7
55 Real estate, and social services	133	186	196	205	254	310	11.7	8.7	5.3	4.7	4.4	4.0
56 Health care, sports and social w	132	187	200	212	266	319	11.7	9.1	6.7	5.9	4.7	3.7
57 Education, culture, arts, movie	133	189	203	210	257	304	11.8	9.2	7.0	3.7	4.1	3.4
58 Scientific research and polytech	133	173	181	190	229	260	11.7	6.8	4.7	4.9	3.8	2.6
59 Public administration and other	133	184	181	189	225	258	11.8	8.4	-1.5	4.2	3.5	2.8

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Employment (in 10,000)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
Total	58364	62138	62732	62879	65263	67415	2.1	1.6	1.0	0.2	0.7	0.7
1 Agriculture	32718	33420	33562	33275	32471	31745	0.8	0.5	0.4	-0.9	-0.5	-0.5
2 Coal mining	696	828	868	899	1077	1245	1.7	4.4	4.8	3.6	3.7	2.9
3 Crude petroleum and natural ga	116	164	177	186	236	283	8.1	8.9	7.9	5.0	4.9	3.7
4 Ferrous ore mining	51	39	37	36	37	32	3.7	-6.1	-5.6	-3.8	0.8	-3.0
5 Non-ferrous ore mining	88	94	94	93	96	95	3.4	1.7	-0.3	-0.9	0.8	-0.2
6 Non-metal minerals mining and	237	284	290	292	302	295	1.7	4.7	1.9	0.8	0.7	-0.5
7 Logging and transport of timber	72	84	88	91	115	144	0.5	4.2	4.1	4.0	4.6	4.8
8 Food processing and manufactu	555	612	617	621	629	559	3.2	2.5	0.8	0.6	0.3	-2.3
9 Beverages	205	264	276	285	302	288	5.7	6.6	4.4	3.3	1.2	-1.0
10 Tobacco manufacture	39	52	54	55	60	61	5.0	7.3	2.8	2.8	1.7	0.2
11 Textiles	1009	822	805	786	848	841	2.4	-5.0	-2.1	-2.4	1.5	-0.2
12 Wearing apparel	388	421	445	445	453	410	3.7	2.1	5.6	0.1	0.3	-2.0
13 Leather, fur and their products	211	300	310	314	324	324	6.5	9.2	3.2	1.4	0.6	0.0
14 Sawmills and bamboo etc. prod	94	111	116	120	141	163	3.7	4.2	4.7	3.3	3.3	2.8
15 Furniture	85	83	84	84	90	90	0.1	-0.5	0.9	0.3	1.2	0.0
16 Paper and paper products	240	282	289	292	310	318	4.4	4.1	2.6	1.2	1.2	0.5
17 Printing industries	142	192	205	216	259	291	3.0	7.8	6.9	5.1	3.7	2.4
18 Culture, education, and sports a	107	168	174	176	197	220	9.4	12.0	3.1	1.5	2.3	2.2
19 Petroleum refineries and coking	93	121	133	144	232	355	8.8	6.9	9.6	8.2	10.0	8.9
20 Chemical industries	532	745	802	836	1001	1144	3.9	8.8	7.6	4.3	3.7	2.7
21 Medicines	123	145	153	159	174	173	7.0	4.1	5.4	3.7	1.8	0.0
22 Chemical fibers	62	82	87	90	104	113	8.3	7.2	5.3	3.6	3.0	1.6
23 Rubber products	116	146	153	158	189	222	3.8	5.9	4.8	3.8	3.6	3.2
24 Plastic products	236	243	242	242	247	224	2.8	0.7	-0.2	0.0	0.4	-1.9
25 Building materials and non-me	1311	1633	1602	1575	1625	1638	2.5	5.6	-1.9	-1.7	0.6	0.2
26 Primary iron and steel manufac	442	476	488	495	563	618	5.0	1.9	2.6	1.4	2.6	1.9
27 Primary non-ferrous metals ma	137	171	170	170	208	266	5.4	5.6	-0.4	0.0	4.1	5.1
28 Metal products	450	570	588	602	683	754	3.1	6.1	3.2	2.3	2.6	2.0
29 Machinery	1002	1031	1040	1054	1092	1180	0.1	0.7	0.9	1.4	0.7	1.6
30 Transportation equipment	440	533	549	564	607	606	4.2	4.9	3.0	2.6	1.5	0.0
31 Electric machinery and equipm	389	432	427	423	427	388	4.6	2.7	-1.2	-0.9	0.2	-1.9
32 Electronic and communication	226	316	326	339	422	482	4.5	8.7	3.4	3.9	4.5	2.7
33 Instrument, meters and office m	109	112	114	114	119	117	3.3	0.6	1.7	0.3	0.9	-0.3
34 Manufacture, n.e.c.	400	407	409	410	407	353	3.7	0.4	0.6	0.2	-0.1	-2.8
35 Electricity, steam and hot wate	203	238	252	263	326	387	4.8	4.0	5.7	4.7	4.4	3.5
36 Gas utility	20	21	22	23	23	20	8.7	1.6	4.1	3.6	0.4	-2.8
37 Water	38	53	56	59	75	88	7.2	8.1	7.0	5.6	4.7	3.2
38 Construction	3188	3443	3481	3491	3511	3441	6.7	1.9	1.1	0.3	0.1	-0.4
39 Railway transportation	276	290	296	301	336	378	3.8	1.2	2.1	1.5	2.2	2.4
40 Highway transportation	657	821	870	894	1088	1275	5.8	5.7	6.0	2.7	4.0	3.2
41 Water transportation	209	262	278	292	377	471	5.4	5.9	6.0	5.0	5.3	4.5
42 Air transportation	20	23	25	26	32	38	5.1	4.6	4.4	4.7	4.7	3.4
43 Pipeline transportation	3	4	4	5	7	9	2.5	5.0	9.4	7.5	7.4	6.8
44 Post and communications	122	136	141	145	167	188	3.7	2.7	3.7	2.8	2.8	2.5
45 Commerce	3668	4181	4345	4468	5259	6070	7.1	3.3	3.9	2.8	3.3	2.9
46 Restaurants	587	582	592	595	599	564	6.2	-0.2	1.8	0.5	0.1	-1.2
47 Finance and insurance	713	733	764	788	930	1070	7.6	0.7	4.2	3.0	3.4	2.9
48 Real estate, and social services	840	1068	1140	1205	1543	1908	4.0	6.2	6.8	5.7	5.1	4.3
49 Health care, sports and social w	564	599	623	645	715	781	0.0	1.5	4.1	3.5	2.1	1.8
50 Education, culture, arts, movie	1436	1714	1813	1813	2034	2415	1.8	4.5	5.8	0.0	2.3	3.5
51 Scientific research and polytech	634	559	559	558	563	551	-0.5	-3.1	0.1	-0.3	0.2	-0.4
52 Public administration and other	2066	2028	1697	1670	1632	1725	3.4	-0.5	-16.3	-1.6	-0.5	1.1

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Private Consumption (100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	14811	21128	23016	24917	34694	47619	7.0	9.3	8.9	8.3	6.8	6.5
1 Farming	2192	2387	2455	2490	2674	2675	-1.8	2.2	2.9	1.4	1.4	0.0
2 Forestry	34	46	48	50	57	66	1.6	8.1	4.5	3.5	2.9	2.8
3 Livestock	1659	2449	2614	2770	3593	4656	6.6	10.2	6.7	6.0	5.3	5.3
4 Fishing	466	798	872	946	1361	1887	14.3	14.4	9.4	8.5	7.5	6.7
5 Coal mining	67	80	84	88	108	133	2.1	4.5	5.0	5.5	4.0	4.4
6 Crude petroleum and natural ga	1	1	1	1	1	2	-2.9	6.0	7.7	9.0	5.5	4.1
7 Ferrous ore mining	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
8 Non-ferrous ore mining	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
9 Non-metal minerals mining and	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
10 Logging and transport of timbe	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
11 Food processing and manufactu	1588	2140	2293	2435	3304	4191	6.0	7.7	7.1	6.2	6.3	4.9
12 Beverages	731	1272	1426	1569	2312	3290	15.0	14.9	12.0	10.0	8.1	7.3
13 Tobacco manufacture	460	738	805	863	1115	1416	9.1	12.5	9.1	7.2	5.3	4.9
14 Textiles	690	968	1052	1138	1543	2174	7.8	8.8	8.7	8.3	6.3	7.1
15 Wearing apparel	619	968	1078	1195	1819	2689	16.5	11.8	11.4	10.9	8.8	8.1
16 Leather, fur and their products	269	425	477	531	815	1224	21.4	12.1	12.1	11.5	8.9	8.5
17 Sawmills and bamboo etc. prod	39	68	77	87	134	209	13.5	15.0	14.2	12.7	8.9	9.4
18 Furniture	146	218	243	269	405	597	16.9	10.5	11.7	10.9	8.5	8.1
19 Paper and paper products	53	80	89	98	141	212	11.8	10.8	11.4	10.9	7.4	8.6
20 Printing industries	1	3	3	3	6	8	40.7	15.8	14.5	13.9	10.3	7.8
21 Culture, education, and sports a	62	103	117	132	208	320	18.7	13.7	13.5	13.1	9.6	8.9
22 Petroleum refineries and coking	18	29	33	37	56	80	10.7	12.7	13.0	12.9	8.4	7.5
23 Chemical industries	185	252	276	304	433	655	8.2	8.0	9.7	10.0	7.3	8.6
24 Medicines	253	404	445	488	663	932	29.7	12.4	10.2	9.6	6.4	7.0
25 Chemical fibers	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
26 Rubber products	88	126	139	152	217	328	7.7	9.5	9.6	9.6	7.4	8.7
27 Plastic products	125	190	211	234	352	538	13.5	11.2	11.1	10.9	8.5	8.9
28 Building materials and non-me	121	163	176	191	262	356	10.7	7.7	8.2	8.3	6.5	6.3
29 Primary iron and steel manufac	11	19	22	25	39	62	11.5	15.3	14.9	14.0	9.7	9.6
30 Primary non-ferrous metals ma	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
31 Metal products	277	392	431	476	704	996	14.1	9.0	10.0	10.3	8.2	7.2
32 Machinery	33	46	51	56	80	110	12.9	9.1	9.9	9.9	7.4	6.7
33 Railway Equipment	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
34 Motor vehicles	2	9	12	15	40	77	18.3	55.1	33.2	29.5	20.8	14.3
35 Ships, boats	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
36 Aerospace	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
37 Transportation equipment, n.e.	242	315	337	360	448	516	10.5	6.8	7.0	6.8	4.5	2.9
38 Electric machinery and equipm	537	794	890	994	1565	2376	17.4	10.3	12.1	11.7	9.5	8.7
39 Electronic and communication	581	883	996	1117	1749	2759	22.5	11.0	12.8	12.2	9.4	9.5
40 Instrument, meters and office m	54	79	89	98	150	229	13.4	10.0	11.8	11.3	8.8	8.7
41 Manufacture, n.e.c.	194	310	349	392	619	931	18.5	12.4	12.8	12.2	9.6	8.5
42 Electricity, steam and hot wate	138	200	221	245	356	490	10.0	9.7	10.3	11.1	7.8	6.6
43 Gas utility	40	70	80	93	154	228	23.5	14.8	14.5	15.2	10.6	8.2
44 Water	17	25	28	31	47	64	16.3	10.3	11.2	12.3	8.3	6.5
45 Construction	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0
46 Railway transportation	51	59	63	66	81	102	-1.8	3.7	5.3	5.5	4.2	4.6
47 Highway transportation	320	503	562	626	955	1422	10.9	12.0	11.8	11.3	8.8	8.3
48 Water transportation	13	20	22	24	37	55	7.6	11.0	11.4	11.1	8.8	8.0
49 Air transportation	11	19	22	25	42	66	29.3	15.2	14.6	14.0	11.1	9.5
50 Pipeline transportation	0	0	0	0	0	0	-5.4	4.0	5.8	7.1	4.2	3.5
51 Post and communications	51	53	58	63	87	120	22.7	1.4	8.8	7.5	6.7	6.7
52 Commerce	848	1197	1318	1444	2118	2983	14.1	9.0	10.0	9.6	8.0	7.1
53 Restaurants	349	521	569	612	843	1118	5.2	10.5	9.2	7.6	6.6	5.8
54 Finance and insurance	26	45	52	59	94	142	17.8	15.0	14.2	13.4	9.8	8.6
55 Real estate, and social services	457	671	739	815	1180	1642	17.4	10.1	10.1	10.3	7.7	6.8
56 Health care, sports and social w	366	513	564	618	854	1126	-2.1	8.8	10.0	9.5	6.7	5.7
57 Education, culture, arts, movie	327	475	527	588	868	1361	10.2	9.8	11.1	11.5	8.1	9.4
58 Scientific research and polytech	2	2	3	3	4	5	11.0	7.8	8.1	8.0	5.7	6.7
59 Public administration and other	0	0	0	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Private Consumption by Category – Rural Residents
(100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	863	1182	1269	1351	1722	2346	3.6	8.2	7.3	6.5	5.0	6.4
1 Grain	163	142	145	144	154	147	0.6	-3.5	2.1	-0.4	1.3	-0.8
2 Meat and vegetables	203	296	311	325	392	509	2.2	10.0	5.1	4.5	3.8	5.4
3 Other food	92	154	168	180	232	313	6.4	13.6	9.6	7.1	5.2	6.1
4 Clothing	75	114	123	132	171	240	4.2	10.9	7.6	7.2	5.4	6.9
5 Housing maintainence and utiliti	114	128	132	136	154	184	-0.3	3.1	3.0	3.3	2.5	3.6
6 Household goods and services	59	104	118	130	181	266	9.1	15.4	12.8	10.6	6.8	8.0
7 Medicine and medical services	34	47	49	52	57	66	9.1	8.5	5.6	5.0	1.8	3.1
8 Transp. and telecom.	22	29	31	33	41	50	6.3	6.8	6.0	6.0	4.6	3.9
9 Culture, edu. and entertainment	84	132	150	170	265	453	20.6	12.1	13.3	13.5	9.3	11.3
10 Other goods and services	17	36	42	49	75	118	12.8	20.0	17.3	15.1	8.8	9.5

Private Consumption by Category – Urban Residents
(100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	2165	2854	3060	3267	4289	5241	6.8	7.1	7.2	6.8	5.6	4.1
1 Grain	123	122	121	121	129	136	-2.3	-0.1	-0.6	-0.4	1.3	1.1
2 Meat, poultry, and fats	315	421	448	472	608	728	5.8	7.5	6.3	5.3	5.2	3.7
3 Fish and aquatic products	74	115	124	132	181	227	4.1	11.7	7.6	6.8	6.4	4.7
4 Vegetables	109	161	172	182	238	286	3.4	10.3	6.7	5.8	5.6	3.7
5 Flavorings and sugar	29	41	43	45	57	68	5.0	9.0	5.9	5.1	4.8	3.4
6 Tobacco	66	100	109	117	153	184	13.0	11.0	8.5	7.3	5.5	3.8
7 Liquor and beverages	59	86	94	100	133	160	12.0	9.9	8.3	7.0	5.8	3.9
8 Fresh and dried fruits	95	139	150	159	211	255	5.5	10.0	7.4	6.4	5.8	3.9
9 Cake and dairy products	52	70	74	79	103	124	4.8	7.8	6.6	6.2	5.5	3.8
10 Dining out	92	125	135	143	190	232	7.0	8.0	7.5	6.4	5.8	4.1
11 Garments	199	262	284	306	412	514	10.3	7.1	8.3	7.8	6.2	4.5
12 Cloths and tailoring	59	77	82	87	108	129	9.1	6.8	6.2	5.9	4.6	3.6
13 Shoes, hats and socks	77	97	104	111	144	176	8.6	6.1	6.9	6.7	5.4	4.1
14 Appliances and furniture	136	148	155	161	198	239	9.6	2.1	4.5	4.3	4.2	3.8
15 Other household articles	87	128	144	160	238	319	13.4	10.3	11.9	11.5	8.2	6.1
16 Medicine and medical eq.	74	106	117	128	171	211	19.2	9.3	10.1	9.3	6.1	4.3
17 Transportation	55	79	88	98	141	182	14.5	9.6	11.5	11.0	7.6	5.2
18 Post and telecom.	55	54	58	61	76	95	33.5	-0.6	6.9	5.3	4.5	4.7
19 TV, VCR and Piano	70	79	83	88	110	132	5.2	3.2	4.9	5.3	4.6	3.7
20 Education and child care	78	105	114	124	162	195	6.0	7.8	8.6	8.7	5.5	3.8
21 Sports and entertainment	28	30	31	32	37	42	-4.0	1.4	2.4	3.0	3.0	2.4
22 Housing	56	66	71	76	103	128	9.3	4.1	6.7	8.1	6.3	4.4
23 Utilities	85	121	133	149	209	264	14.0	9.4	10.3	11.5	7.0	4.8
24 Jewelry, make-up and others	93	120	129	138	177	214	5.7	6.6	7.3	7.1	5.1	3.9

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Investment (100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
Total	12071	15689	16915	17989	24794	33204	9.8	6.8	7.8	6.3	6.6	6.0
1 Agriculture	400	632	631	627	801	1035	0.0	12.1	-0.1	-0.7	5.0	5.2
2 Coal mining	193	217	224	231	256	296	-1.3	3.0	3.4	2.8	2.1	2.9
3 Crude petroleum and natural ga	291	338	355	375	493	692	1.6	3.8	5.2	5.4	5.7	7.0
4 Ferrous ore mining	31	20	23	25	46	59	2.1	-10.3	13.4	12.7	12.5	5.2
5 Non-ferrous ore mining	29	38	36	40	49	56	-1.6	6.9	-6.5	11.9	4.4	2.7
6 Non-metal minerals mining and	43	44	46	47	54	64	7.2	0.9	3.0	2.6	2.9	3.3
7 Logging and transport of timber	8	11	12	13	19	29	-10.6	8.6	9.1	8.9	8.5	8.6
8 Food processing and manufactu	202	266	299	306	386	483	11.0	7.1	12.2	2.6	4.7	4.6
9 Beverages	91	107	109	110	121	140	8.7	4.4	1.9	0.7	1.9	3.0
10 Tobacco manufacture	57	94	104	113	164	242	20.9	13.0	11.1	8.3	7.8	8.1
11 Textiles	321	357	372	370	431	496	8.7	2.7	4.3	-0.5	3.1	2.9
12 Wearing apparel	97	114	128	130	166	204	18.6	4.3	11.6	2.2	5.0	4.1
13 Leather, fur and their products	57	47	50	52	64	80	17.1	-4.6	6.7	3.8	4.4	4.5
14 Sawmills and bamboo etc. prod	43	40	42	44	55	69	13.9	-1.8	5.4	4.1	4.6	4.8
15 Furniture	19	19	19	20	25	30	11.8	0.1	1.5	3.2	4.0	3.9
16 Paper and paper products	97	97	98	101	120	143	13.8	-0.1	1.4	3.0	3.5	3.7
17 Printing industries	48	62	67	72	103	147	14.8	6.4	8.6	6.3	7.6	7.3
18 Culture, education, and sports a	30	38	40	39	55	75	12.9	6.3	4.6	-1.5	7.0	6.4
19 Petroleum refineries and cokin	115	162	178	189	276	394	14.5	8.9	9.9	6.1	7.8	7.4
20 Chemical industries	429	487	509	518	655	834	11.0	3.2	4.7	1.8	4.8	4.9
21 Medicines	68	88	94	99	121	157	14.8	6.9	6.4	5.2	4.2	5.4
22 Chemical fibers	114	162	184	195	285	402	11.9	9.1	13.7	6.2	7.9	7.1
23 Rubber products	47	59	63	66	89	118	14.3	5.9	6.5	5.1	6.0	5.9
24 Plastic products	119	133	146	152	211	290	14.2	2.8	9.4	3.9	6.8	6.6
25 Building materials and non-me	443	469	485	519	683	890	12.6	1.4	3.3	7.2	5.6	5.4
26 Primary iron and steel manufac	368	319	333	350	424	490	10.2	-3.5	4.3	5.1	3.9	2.9
27 Primary non-ferrous metals ma	116	150	158	168	217	274	12.9	6.6	5.6	6.3	5.2	4.8
28 Metal products	145	181	191	206	299	423	15.7	5.7	5.9	7.6	7.8	7.2
29 Machinery	281	320	326	326	429	531	10.2	3.3	1.9	-0.2	5.7	4.3
30 Transportation equipment	232	248	267	293	393	516	18.6	1.7	7.5	9.7	6.1	5.6
31 Electric machinery and equipm	155	177	187	191	258	341	12.1	3.3	5.5	2.3	6.2	5.7
32 Electronic and communication	161	249	295	321	481	720	13.7	11.5	18.4	8.9	8.4	8.4
33 Instrument, meters and office m	32	38	42	44	57	72	15.2	4.7	10.7	5.4	5.3	4.5
34 Manufacture, n.e.c.	49	60	60	59	81	107	11.3	5.4	-0.7	-1.4	6.7	5.7
35 Electricity, steam and hot wate	997	1610	1785	1971	3040	4054	15.9	12.7	10.9	10.4	9.1	5.9
36 Gas utility	46	55	57	60	68	77	19.6	4.5	3.6	4.1	2.5	2.6
37 Water	80	108	117	125	172	232	25.9	7.8	8.3	7.1	6.5	6.2
38 Construction	223	189	196	213	271	347	15.3	-4.1	3.8	8.4	4.9	5.1
39 Railway transportation	389	459	508	516	643	806	7.7	4.2	10.6	1.7	4.5	4.6
40 Highway transportation	383	861	1024	1195	2051	3359	16.1	22.5	19.0	16.7	11.4	10.4
41 Water transportation	322	624	724	835	1542	2126	11.0	18.0	16.0	15.3	13.1	6.6
42 Air transportation	107	159	171	183	285	419	30.7	10.5	7.3	7.0	9.3	8.0
43 Pipeline transportation	2	9	10	10	14	18	-5.6	41.2	5.1	2.3	6.7	5.7
44 Post and communications	454	730	833	938	1601	2532	30.3	12.6	14.2	12.6	11.3	9.6
45 Commerce	910	1107	1235	1296	1613	1942	15.9	5.0	11.6	5.0	4.5	3.8
46 Restaurants	10	13	14	15	20	27	7.7	6.7	7.4	8.0	6.6	6.1
47 Finance and insurance	134	202	229	247	395	589	22.8	10.7	13.7	7.7	9.8	8.3
48 Real estate, and social service	2023	2351	2439	2533	3042	3794	8.1	3.8	3.7	3.9	3.7	4.5
49 Health care, sports and social w	113	139	147	152	171	198	8.2	5.3	5.7	3.6	2.4	2.9
50 Education, culture, arts, movie	228	260	260	266	291	341	3.6	3.3	0.2	2.1	1.9	3.2
51 Scientific research and polytec	151	180	184	186	214	249	3.6	4.5	2.0	1.0	2.8	3.1
52 Public administration and othe	567	790	809	838	994	1196	6.1	8.6	2.4	3.7	3.5	3.8

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Imports (100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	6170	8337	9245	10238	14897	21481	11.4	7.8	10.9	10.7	7.8	7.6
1 Farming	85	108	113	120	137	148	-1.9	6.3	4.9	6.2	2.7	1.5
2 Forestry	24	26	28	30	36	43	3.7	1.8	5.7	7.4	4.3	3.3
3 Livestock	23	26	26	26	25	23	8.5	3.3	0.6	0.6	-1.0	-1.9
4 Fishing	4	11	13	17	42	97	61.5	29.1	24.2	25.3	20.3	18.1
5 Coal mining	2	2	2	2	2	2	-6.8	3.0	1.5	0.6	-0.8	-1.3
6 Crude petroleum and natural ga	74	133	153	176	338	594	118.0	15.8	15.4	14.7	14.0	11.9
7 Ferrous ore mining	51	93	104	115	161	223	24.1	16.4	11.6	10.4	7.0	6.7
8 Non-ferrous ore mining	6	6	6	6	6	6	2.1	2.0	0.0	0.2	0.5	-0.8
9 Non-metal minerals mining and	10	16	18	20	28	37	7.4	12.4	11.4	9.7	7.2	6.1
10 Logging and transport of timbe	25	27	29	31	36	41	-1.3	1.9	6.7	6.5	3.3	2.6
11 Food processing and manufactu	185	328	371	415	705	1111	15.9	15.5	12.9	12.0	11.2	9.5
12 Beverages	26	46	51	57	85	123	16.7	15.3	11.9	10.7	8.6	7.6
13 Tobacco manufacture	16	20	20	20	17	15	5.1	5.3	1.4	0.9	-2.9	-3.3
14 Textiles	681	930	1024	1126	1749	2621	15.6	8.1	10.1	10.0	9.2	8.4
15 Wearing apparel	28	70	82	99	208	401	38.4	26.2	17.7	20.5	16.0	14.0
16 Leather, fur and their products	168	207	235	266	458	755	26.7	5.4	13.5	12.9	11.5	10.5
17 Sawmills and bamboo etc. prod	62	73	75	77	84	87	6.9	3.9	3.4	2.7	1.7	0.8
18 Furniture	24	37	41	47	74	112	13.1	12.0	11.3	12.8	9.6	8.8
19 Paper and paper products	159	242	271	302	495	781	15.4	11.2	11.9	11.5	10.4	9.5
20 Printing industries	12	17	18	20	27	34	3.4	9.4	9.1	8.9	6.2	4.8
21 Culture, education, and sports a	23	41	46	53	80	122	11.6	16.1	13.2	13.3	8.9	8.8
22 Petroleum refineries and coking	128	220	248	278	479	773	44.6	14.5	12.6	11.9	11.5	10.0
23 Chemical industries	655	885	985	1091	1595	2230	8.9	7.8	11.3	10.8	7.9	6.9
24 Medicines	37	71	81	94	164	278	21.0	17.7	15.3	15.1	11.8	11.2
25 Chemical fibers	61	87	93	99	112	121	6.2	9.2	6.7	6.6	2.5	1.5
26 Rubber products	12	23	26	30	48	77	12.5	16.4	13.6	14.4	10.2	9.9
27 Plastic products	2	6	7	8	19	40	26.8	26.8	21.3	23.5	17.6	16.0
28 Building materials and non-me	54	96	107	119	183	279	9.9	15.7	11.5	11.5	9.0	8.8
29 Primary iron and steel manufac	390	366	351	345	229	169	0.2	-1.6	-4.0	-1.8	-7.8	-5.9
30 Primary non-ferrous metals ma	104	137	144	149	149	156	4.9	6.9	5.2	3.4	0.1	0.9
31 Metal products	81	118	127	136	178	229	16.0	10.0	7.2	7.1	5.6	5.2
32 Machinery	1142	1406	1683	1980	2815	3807	17.0	5.3	19.8	17.6	7.3	6.2
33 Railway Equipment	5	3	2	2	1	0	-14.3	-13.8	-11.0	-15.7	-16.8	-16.7
34 Motor vehicles	304	493	553	615	1074	1790	11.5	12.9	12.1	11.1	11.8	10.7
35 Ships, boats	47	69	78	88	138	204	5.3	10.5	12.3	12.7	9.5	8.0
36 Aerospace	110	161	174	187	279	399	30.5	9.9	8.2	7.5	8.3	7.4
37 Transportation equipment, n.e.	12	18	19	20	21	22	-6.7	9.6	5.6	5.1	0.8	1.3
38 Electric machinery and equipm	325	459	490	522	690	905	21.7	9.0	6.8	6.4	5.8	5.6
39 Electronic and communication	686	841	889	947	1181	1535	15.9	5.2	5.7	6.5	4.5	5.4
40 Instrument, meters and office m	122	132	138	147	174	214	1.9	1.9	4.7	6.4	3.5	4.2
41 Manufacture, n.e.c.	204	281	313	350	559	858	14.9	8.4	11.2	12.0	9.8	8.9
42 Electricity, steam and hot wate	5	9	10	11	15	21	2.2	14.1	9.7	8.9	7.7	6.5

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Net Exports (100 million yuan in 1992 prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
1 Farming	118	119	124	130	188	248	0.0	0.2	4.2	4.7	7.7	5.7
2 Forestry	-18	-21	-23	-25	-30	-35	0.0	3.5	8.4	8.8	3.9	3.2
3 Livestock	24	28	29	30	40	52	0.0	3.4	4.7	3.0	6.1	5.0
4 Fishing	23	24	21	20	11	-29	0.0	0.1	-10.0	-7.1	-11.1	0.0
5 Coal mining	45	46	45	46	59	69	0.0	0.5	-1.4	1.0	5.1	3.2
6 Crude petroleum and natural ga	29	-6	-22	-41	-154	-359	0.0	0.0	289.7	84.4	30.6	18.4
7 Ferrous ore mining	-50	-93	-103	-114	-160	-222	0.0	16.5	11.6	10.5	7.0	6.8
8 Non-ferrous ore mining	6	8	8	8	16	26	0.0	6.0	3.7	5.1	13.5	10.7
9 Non-metal minerals mining and	27	37	37	39	62	87	0.0	7.9	0.1	5.7	9.5	7.1
10 Logging and transport of timbe	-22	-24	-26	-28	-33	-37	0.0	2.7	8.1	7.1	3.1	2.4
11 Food processing and manufactu	209	201	185	180	139	-14	0.0	-0.9	-7.9	-2.6	-5.1	0.0
12 Beverages	13	3	-1	-4	-18	-40	0.0	-29.8	0.0	330.3	34.6	17.0
13 Tobacco manufacture	20	18	19	20	33	47	0.0	-2.4	2.4	6.4	10.4	7.3
14 Textiles	412	506	493	515	599	707	0.0	5.2	-2.5	4.5	3.0	3.4
15 Wearing apparel	857	1286	1395	1505	2209	2854	0.0	10.7	8.5	7.9	8.0	5.3
16 Leather, fur and their products	326	479	486	492	570	585	0.0	10.1	1.5	1.2	3.0	0.5
17 Sawmills and bamboo etc. prod	-48	-52	-54	-55	-52	-45	0.0	1.9	3.4	1.5	-1.0	-2.8
18 Furniture	126	194	200	209	331	493	0.0	11.4	3.1	4.8	9.6	8.3
19 Paper and paper products	-35	-65	-88	-110	-226	-423	0.0	17.1	34.8	25.3	15.6	13.4
20 Printing industries	-4	-3	-4	-4	4	26	0.0	-6.8	16.1	1.4	0.0	44.2
21 Culture, education, and sports a	102	126	125	125	172	235	0.0	5.3	-0.7	0.0	6.6	6.5
22 Petroleum refineries and coking	-62	-137	-163	-190	-373	-651	0.0	22.0	19.5	16.3	14.5	11.8
23 Chemical industries	-382	-470	-550	-623	-863	-1152	0.0	5.3	16.9	13.2	6.7	5.9
24 Medicines	30	22	16	11	-8	-55	0.0	-7.1	-27.5	-33.7	0.0	46.9
25 Chemical fibers	-60	-86	-92	-98	-111	-119	0.0	9.2	6.8	6.7	2.5	1.5
26 Rubber products	25	27	26	25	31	46	0.0	2.0	-4.2	-5.2	4.2	8.4
27 Plastic products	128	201	210	225	354	527	0.0	12.0	4.9	7.0	9.5	8.3
28 Building materials and non-me	79	106	105	111	184	276	0.0	7.6	-0.8	5.6	10.8	8.4
29 Primary iron and steel manufac	-315	-243	-223	-204	-4	174	0.0	-6.3	-8.3	-8.6	-53.4	0.0
30 Primary non-ferrous metals ma	-26	-24	-27	-23	53	134	0.0	-1.9	12.8	-17.1	0.0	20.2
31 Metal products	119	213	230	256	514	945	0.0	15.7	8.1	10.9	15.0	12.9
32 Machinery	-868	-1003	-1264	-1533	-2186	-2993	0.0	3.7	26.0	21.2	7.4	6.5
33 Railway Equipment	15	15	15	15	14	13	0.0	-0.6	-1.0	-1.4	-1.0	-2.2
34 Motor vehicles	-282	-461	-520	-579	-1026	-1727	0.0	13.1	12.6	11.5	12.1	11.0
35 Ships, boats	-23	-39	-48	-58	-103	-164	0.0	13.3	24.1	20.8	12.2	9.8
36 Aerospace	-103	-151	-165	-178	-267	-385	0.0	10.1	9.4	7.8	8.5	7.6
37 Transportation equipment, n.e.	25	34	35	46	70	95	0.0	7.4	5.3	29.0	9.0	6.2
38 Electric machinery and equipm	57	147	142	147	295	534	0.0	26.9	-3.6	3.7	14.9	12.6
39 Electronic and communication	-175	39	74	107	617	1418	0.0	0.0	87.2	45.6	41.9	18.1
40 Instrument, meters and office m	-45	-3	-1	2	60	128	0.0	-50.3	-74.3	0.0	108.8	16.5
41 Manufacture, n.e.c.	210	334	342	342	402	437	0.0	12.3	2.6	0.0	3.3	1.7
42 Electricity, steam and hot water	7	-2	-3	-5	-11	-17	0.0	0.0	72.8	41.3	18.6	9.8

Table 43 – Details of The Benchmark Forecast of the Chinese Economy (cont.)

Total Value-Added (100 million yuan in current prices)

	1994	1998	1999	2000	2005	2010	84-94	94-98	98-99	99-00	00-05	05-10
TOTAL	44318	80350	90036	100235	162286	252817	20.0	16.0	12.1	11.3	10.1	9.3
1 Farming	4525	7241	8064	8992	12459	16596	11.6	12.5	11.4	11.5	6.7	5.9
2 Forestry	347	550	611	682	975	1373	10.9	12.2	11.1	11.7	7.4	7.1
3 Livestock	1767	3259	3673	4128	5562	7071	17.0	16.5	12.7	12.4	6.1	4.9
4 Fishing	622	1276	1460	1675	2554	3684	24.0	19.7	14.4	14.7	8.8	7.6
5 Coal mining	430	995	1177	1213	2188	3628	15.9	23.3	18.3	3.0	12.5	10.6
6 Crude petroleum and natural ga	757	1447	1639	1628	2574	4003	20.7	17.6	13.3	-0.7	9.6	9.2
7 Ferrous ore mining	54	82	87	85	124	166	18.8	11.3	5.9	-2.6	7.9	6.0
8 Non-ferrous ore mining	91	161	175	183	273	386	20.8	15.4	8.6	4.5	8.4	7.2
9 Non-metal minerals mining and	279	487	538	563	803	1084	16.4	15.0	10.5	4.5	7.4	6.2
10 Logging and transport of timbe	92	127	137	150	223	338	10.8	8.4	7.8	9.6	8.3	8.6
11 Food processing and manufactu	1167	2313	2641	3055	5417	9176	25.6	18.6	14.2	15.6	12.1	11.1
12 Beverages	403	840	969	1094	1804	2976	23.4	20.2	15.3	12.9	10.5	10.5
13 Tobacco manufacture	619	1144	1283	1459	2153	3360	19.4	16.6	12.1	13.7	8.1	9.3
14 Textiles	1500	2255	2443	2682	3966	5745	18.7	10.7	8.3	9.8	8.1	7.7
15 Wearing apparel	527	976	1109	1239	2006	3053	25.5	16.7	13.7	11.7	10.1	8.8
16 Leather, fur and their products	303	502	554	620	935	1350	29.2	13.5	10.4	11.9	8.6	7.6
17 Sawmills and bamboo etc. prod	106	166	181	201	293	417	21.1	11.8	9.4	10.7	7.8	7.3
18 Furniture	167	242	259	273	368	470	17.3	9.7	7.1	5.6	6.1	5.0
19 Paper and paper products	302	488	533	576	791	1038	18.2	12.8	9.1	8.1	6.6	5.6
20 Printing industries	169	319	362	411	672	1017	19.0	17.2	13.7	13.4	10.4	8.6
21 Culture, education, and sports a	97	188	205	216	309	422	21.9	18.0	9.5	5.3	7.4	6.4
22 Petroleum refineries and coking	460	864	981	1086	1863	3253	16.7	17.1	13.5	10.7	11.4	11.8
23 Chemical industries	1031	1958	2210	2456	3859	5770	17.1	17.4	12.9	11.1	9.5	8.4
24 Medicines	291	631	741	833	1471	2511	22.6	21.4	17.4	12.4	12.1	11.3
25 Chemical fibers	147	284	321	355	569	854	23.9	17.9	12.9	10.5	9.9	8.5
26 Rubber products	172	305	341	365	547	801	13.5	15.4	11.7	7.1	8.4	7.9
27 Plastic products	337	624	696	779	1259	1943	21.9	16.6	11.5	12.0	10.1	9.1
28 Building materials and non-me	1611	3018	3341	3610	5684	8755	22.0	17.0	10.7	8.1	9.5	9.0
29 Primary iron and steel manufac	1485	2473	2744	2993	4998	8651	24.6	13.6	11.0	9.1	10.8	11.6
30 Primary non-ferrous metals ma	336	564	611	667	1094	1863	21.5	13.8	8.2	9.2	10.4	11.2
31 Metal products	777	1271	1389	1539	2331	3588	22.5	13.1	9.2	10.8	8.7	9.0
32 Machinery	1600	2468	2638	2736	3742	5071	16.8	11.4	6.9	3.7	6.5	6.3
33 Railway Equipment	74	131	152	159	254	416	24.3	15.5	15.8	4.5	9.9	10.3
34 Motor vehicles	654	1366	1588	1702	2832	4328	24.2	20.2	16.3	7.2	10.7	8.9
35 Ships, boats	69	137	154	174	310	487	24.2	18.7	12.9	12.7	12.3	9.4
36 Aerospace	45	96	109	116	215	391	24.1	21.1	13.6	6.6	13.1	12.7
37 Transportation equipment, n.e.c	175	377	436	456	768	1241	24.3	21.1	15.8	4.6	11.0	10.1
38 Electric machinery and equipm	771	1237	1335	1453	2090	2873	22.2	12.5	7.9	8.8	7.5	6.6
39 Electronic and communication	570	1146	1277	1414	2375	3721	23.8	19.1	11.5	10.7	10.9	9.4
40 Instrument, meters and office m	207	317	341	359	484	612	18.1	11.2	7.5	5.4	6.1	4.8
41 Manufacture, n.e.c.	794	1338	1485	1682	2716	4254	27.7	13.9	11.0	13.3	10.1	9.4
42 Electricity, steam and hot wate	842	2229	2604	2884	5041	8178	18.8	27.6	16.8	10.8	11.8	10.2
43 Gas utility	10	22	25	29	48	70	20.2	22.1	17.2	14.0	10.8	7.7
44 Water	62	171	204	221	392	629	22.5	28.7	19.8	8.2	12.1	9.9
45 Construction	2901	4949	5509	5885	9031	14736	21.0	14.3	11.3	6.8	8.9	10.3
46 Railway transportation	493	903	988	1113	1671	2249	12.5	16.3	9.4	12.6	8.5	6.1
47 Highway transportation	1036	2076	2411	2815	5322	9042	27.0	19.0	16.1	16.8	13.6	11.2
48 Water transportation	331	721	845	1015	2210	4095	22.6	21.5	17.3	20.1	16.8	13.1
49 Air transportation	112	232	265	309	568	962	36.7	20.1	14.3	16.5	13.0	11.1
50 Pipeline transportation	16	23	25	29	45	70	14.6	8.9	11.0	13.2	9.8	9.1
51 Post and communications	442	1169	1377	1659	3357	5504	38.5	27.5	17.8	20.4	15.1	10.4
52 Commerce	4187	7984	9067	10497	18475	29258	23.4	17.5	13.6	15.8	12.0	9.6
53 Restaurants	721	1216	1367	1555	2502	3815	21.6	14.0	12.4	13.8	10.0	8.8
54 Finance and insurance	1512	2584	2915	3345	5779	9414	27.0	14.3	12.8	14.7	11.6	10.2
55 Real estate, and social services	2193	4289	4886	5538	10025	17306	25.4	18.3	13.9	13.3	12.6	11.5
56 Health care, sports and social w	452	782	891	1017	1701	2586	23.9	14.7	14.1	14.1	10.8	8.7
57 Education, culture, arts, movie	924	1761	2046	2284	3949	6730	21.4	17.5	16.2	11.6	11.6	11.3
58 Scientific research and polytech	709	1080	1181	1303	1995	2810	26.8	11.1	9.4	10.3	8.9	7.1
59 Public administration and other	1447	2496	2439	2683	4265	6629	27.3	14.6	-2.3	10.0	9.7	9.2

CHAPTER X :

THE IMPACT OF CHINA'S ACCESSION TO THE WTO --

AN APPLICATION OF MUDAN

In the previous chapter, I have presented a basic forecast of the Chinese economy under the assumption that China stays outside the WTO. In this chapter, I will demonstrate the use of MuDan by applying the model to evaluate the impact of China's accession to the World Trade Organization (WTO).

In order to join the WTO, China has to negotiate with the WTO members on trade liberalization and market access to China. Since the late 1980s, China has made a number of market accession offers consisting of numerous concessions and commitments in reducing tariff and non-tariff barriers (NTBs) and in reforming the trade system and trade regulations to conform to international standard practices. Because China's commitments for WTO accession include complex trade and investment liberalization measures, a comprehensive evaluation on China's offers is beyond the scope of this study. Therefore, the present study is focused on the implications of China's offers on reducing tariffs and non-tariff barrier in the tradable goods sectors. The assumptions on the tariff reduction offers for this study have been based on a recent Chinese proposal[22] that was published by the United States Trade Representative (USTR, 1999).

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[22] In April 1999, the United States Trade Representative unilaterally issued a press release on China's market accession "commitments" (USTR, 1999). China immediately disputed the contents, claiming that many of the so-called Chinese commitments in the press release were actually U.S. proposals and had never been accepted by China. The focus of this study is not on whether or not China made the commitments as published in USTR (1999), but on what impact they would have on the Chinese economy had China made these commitments. For ease of discussion, it is assumed China had made the offer as published in USTR (1999).

The organization of this chapter is as follows. First, I will provide a summary of China's tariff rates and import structure. Next, I provide a brief review on the process of China's accession to the WTO, followed by a survey of the literature on quantitative studies on China's accession to the WTO. Finally, I will describe the assumptions on the simulation scenarios, present the simulation results, and discuss the policy implications of the simulations.

China's Tariff Rates and Import Structure

The base-year tariff rates in this study use the import-weighted averages of China's nominal tariff rates in 1994. They are constructed based on the 1996 version of the Trade Analysis and Information System (TRAINS) database. The TRAINS database was created by the United Nations Conference on Trade and Development (UNCTAD, 1996), providing tariff information for 1993/1994 at the 8-digit HS level and trade data for 1993. A detailed discussion on this aggregation can be found in Wang (1999).

Table 44 displays a summary of China's tradable goods sectors in terms of output, imports, nominal tariff rates, and tariff equivalent NTBs. Both output and imports were valued at domestic 1992 prices. Tariff rates were for 1994, and tariff equivalent NTBs were for 1995.

Table 44 – China's Import Structure, Tariff Rates and Tariff Equivalent NTBs in 1994

(in percentage)

	Sector	Output / Total Output	Imports / Domestic Use	Imports / Total Imports	Nominal Tariff Rate	Tariff Equivalent NTBs**
1	Farming	6.61	1.42	1.43	47.7	
2	Forestry	0.54	4.70	0.39	24.4	
3	Livestock	3.46	0.72	0.38	14.9	
4	Fishing	0.95	0.46	0.06	22.7	
5	Coal mining	0.86	0.20	0.02	4.8	45.7
6	Crude petroleum and natural gas	0.91	9.12	0.94	1.0	45.7
7	Ferrous ore mining	0.12	31.40	0.70	0.8	3.3
8	Non-ferrous ore mining	0.22	2.83	0.13	1.2	5.7
9	Non-metal minerals mining and mining, n.e.c	0.71	1.61	0.16	4.2	5.7
10	Logging and transport of timber and bamboo	0.16	14.63	0.35	6.6	
11	Food processing and manufacturing	4.21	5.05	3.00	51.2	2.7
12	Beverages	1.19	2.39	0.42	40.6	2.7
13	Tobacco manufacture	0.85	2.11	0.28	64.9	2.7
14	Textiles	5.25	15.47	10.52	23.7	24.3
15	Wearing apparel	1.93	3.02	0.45	31.9	18.4
16	Leather, fur and their products	1.22	21.01	2.17	12.6	18.4
17	Sawmills and bamboo etc. products	0.39	15.45	1.12	13.1	32.5
18	Furniture	0.67	4.82	0.43	15.7	32.5
19	Paper and paper products	1.15	14.61	2.72	13.2	
20	Printing industries	0.59	2.14	0.18	8.5	
21	Culture, education, and sports articles	0.39	8.96	1.42	22.6	
22	Petroleum refineries and coking products	0.86	15.00	2.25	8.1	15.0
23	Chemical industries	3.97	16.25	10.18	13.4	3.3
24	Medicines	0.91	4.56	0.64	10.3	3.3
25	Chemical fibers	0.59	10.20	0.92	16.2	3.3
26	Rubber products	0.64	2.21	0.21	13.3	3.3
27	Plastic products	1.44	0.18	0.03	19.7	3.3
28	Building materials and non-metallic minerals	4.24	1.40	0.90	17.5	
29	Primary iron and steel manufacturing	3.21	11.96	4.60	9.6	15.9
30	Primary non-ferrous metals manufacturing	0.99	11.20	1.58	7.1	
31	Metal products	2.25	4.14	1.16	14.0	15.9
32	Machinery	5.07	20.68	19.00	13.7	5.1
33	Railway Equipment	0.23	2.55	0.09	9.1	
34	Motor vehicles	2.10	13.77	5.43	52.8	26.3
35	Ships, boats	0.25	18.48	0.81	8.2	
36	Aerospace	0.12	52.88	2.02	3.9	
37	Transportation equipment, n.e.c.	0.68	2.07	0.51	19.0	
38	Electric machinery and equipment	2.65	13.71	5.27	14.2	7.8
39	Electronic and communication equipment	2.02	33.88	12.39	15.1	5.6
40	Instrument, meters and office machinery	0.57	21.53	2.06	13.5	5.6
41	Manufacture, n.e.c.	2.01	12.46	2.61	1.7	
42	Electricity, steam and hot water	1.44	0.40	0.09	3.0	
	Sum	68.62		100.00		
	Average		9.88		17.9	

** Tariff equivalent non-tariff barriers (NTBs), taken from Li and Wang (1998), are for 1995.

Column 1 in Table 44 displays sectoral output as a percentage of total output in 1994, showing the relative size of each sector's imports and output. As shown in the first column, Farming, Textiles, and Machinery were among the largest producers, each accounted for more than 5% of total output. Some of the large producers were also large importers, as is evident from Column 3, which displays the sectoral imports as a percentage of total imports. Machinery was the largest importer, accounting for 19% of the total imports in 1992. Import shares of Electronic and communication equipment, Textiles, and Chemicals also were among the largest, and each accounted for more than 10% of the total imports. Although these four sectors accounted for only 16% of the total domestic output, their combined imports accounted for more than 52% of the total.

The market penetration of imports, expressed as a ratio of imports to total domestic use, is displayed in Column 2, and it shows the degree of the dependency of a particular sector to imports: the higher the ratio, the stronger the reliance of the sector on imports. According to Column 2, Aerospace was most dependent on imports. In 1994, 53% of its total domestic supply was sourced from foreign countries. Electronic and communication equipment (33.9%) and Ferrous ore mining (31.4%) also displayed significant dependency on imports. Overall, half of the forty-two tradable goods sectors displayed a penetration ratio of just 5% or less, but were responsible for more than 50% of total output of tradable goods in 1994. Sectors that showed the least dependency on imports included Plastic products (0.2%), Coal mining (0.2%), Electricity, steam and hot water (0.4%), and Fishing (0.5%).

Column 4 displays import-weighted nominal tariff rates, which were aggregated from the 6-digit Harmonized System-based TRAINS data for 1994[23]. The overall import-weighted nominal tariff rate for 1994 was 17.9%, and the median tariff rate among the tradable sectors was 13.5%. It is evident from the table that imports of natural resources or raw materials tended to have lower tariff rates than those of final consumption goods, and products of heavy industries tended to incur lower tariff rates than those of light industries. For example, Ferrous ore mining (0.8%), Crude petroleum and natural gas (1.0%), Non-ferrous ore mining (1.2%), and Manufacture, n.e.c. (1.7%) were among the sectors with the lowest tariff rates. In contrast, Tobacco products (64.9%), Motor vehicles (52.8%), Food processing and manufacturing (51.2%), Farming (47.7%), and Beverages (40.6%) displayed the highest nominal tariff rates. Most sectors displayed nominal tariff rates between 10% to 15%. It should be emphasized that the nominal tariff rates shown in Table 44 were not the actual collection rates, which were significantly lower than China's nominal tariff rates. Table 45 shows the China's actual aggregate collection rate, computed as the ratio of tariffs to imports. As shown in the table, the actual rate declined considerably from 14.7% in 1981 to 2.6% in 1995, and stayed relatively flat afterwards. Among the factors contributing to the decline were trade liberalization and tariff exemptions. As China reduced nominal tariff rates, actual collection rates fell, *ceteris paribus*. As important as the trade liberalization, however, was the existence of a very high level of tariff exemptions, including primarily duty exemption on intermediate inputs and processing trade. According to the World Bank (1994), tariff exemptions for export processing with supplied or imported materials amounted to 78% of the total estimated

[23] TRAINS used most recently available tariff rates, 1994 for China. However, tariff rates for earlier years may be used for some categories if 1994 data was not available.

concessional imports in 1991. Equipment imported with foreign investment accounted for another 15% of total. Other factors also contributed to the nominal-actual collection gap, including smuggling and duty exemptions on imports of the government and imports used for priority projects.

Table 45 – China's Actual Duty Collection Rates

Year	Imports (billion yuan)	Tariffs (billion yuan)	Collected Tariff Rate
1981	36.77	5.40	14.7%
1982	35.75	4.75	13.3%
1983	42.18	5.39	12.8%
1984	62.05	10.31	16.6%
1985	125.78	20.52	16.3%
1986	149.83	15.16	10.1%
1987	161.42	14.24	8.8%
1988	205.51	15.50	7.5%
1989	219.99	18.15	8.3%
1990	257.43	15.90	6.2%
1991	339.87	18.73	5.5%
1992	444.33	21.28	4.8%
1993	598.62	25.65	4.3%
1994	996.01	27.27	2.7%
1995	1104.77	29.18	2.6%
1996	1155.74	30.18	2.6%
1997	1180.58	31.95	2.7%

Because historical nominal tariff rates are not readily available, a historical comparison of the nominal-actual rate gap is difficult to make. Based on statistical data in Table 44, however, it appears that tariff exemptions were still at a very significant level. In 1994, for example, the nominal rate was 17.9% while the actual collection rate was 2.7%, indicating a nominal-actual collection gap of 660%. In other words, the actual, collected tariff revenue accounted for only 15% of the nominal rate times the tax base. Beside the variances in the nominal-actual collection gap over the years, there were also significant variations of the nominal-actual tariff rate gap among different sectors. For example, Li and Wang (1998) reported that the nominal-actual rate gap in 1995 for wearing apparel was 9200% while the gap for other transportation equipment was only 310%.

The last column in Table 44 shows some of China's tariff equivalent NTBs, which are taken directly from Li and Wang (1998). Notable in the column is that the Motor vehicles sectors appears to have very significant tariff equivalent NTBs in addition to tariffs, which were next to tariffs on tobaccos among all Chinese industries. It should be noted that, due to the differences in the level of aggregation, the 52.8% tariff rate in our study is only half of the tariff rates on more narrowly defined automobile sectors in some other sources. The NTBs in the automobile industry included strict import quotas and the requirements on the percentage of domestic components in automobiles manufactured by Sino-foreign joint ventures.

China's Road to the WTO: A Brief Review

This section provides a brief review of China's market access commitments and the major barriers to China's WTO accession. More detailed studies on this topic can be found in Li and Wang (1998), Zhao (1998), Tait and Li (1997), Bach et al. (1996), Wang (1997), and Yang (1996).

China was an original member of the General Agreement on Tariffs and Trade (GATT) when it was first established in 1947. In 1950, China's membership was withdrawn by Taiwan. In 1982, China was granted observer status; four years later, China initiated the campaign to resume its contracting status in the GATT. In 1987, a Working Party was established to examine China's status, and held its first meeting. However, the efforts of resuming China's contracting status fell short, and China missed the opportunity of becoming an original member of the WTO, which succeeded the GATT in January 1995. At the request of China, the original China Working Party of the GATT continues its work as a WTO Working Party on the accession of China.

China's bid to the WTO is still an on-going process. There are many unresolved issues faced by the Chinese government in its negotiations with the WTO member countries, and some of the issues are of fundamental importance. The following text provides a summary of progress and obstacles to China's WTO accession.

China's Developing Economy Status

One of the most fundamental issues related to China's accession to the WTO is whether China should make market access commitments similar to a developing economy or to a developed economy. China has insisted, based on its low per capita income, large agrarian economy, and underdeveloped manufacturing and service sectors, that it should be admitted as a developing economy and its market access commitments should be comparable to other developing countries rather than to developed economies. Developed countries, however, have argued that, because of the huge size of the Chinese economy, China is no typical developing economy and should make commitments similar to a developed economy.

Under various GATT and WTO agreements, developing economies are subject to less stringent rules in their trade policies and have pledged less significant market access commitments. Under the GATT rules, for example, developing countries are allowed to pledge less significant commitments on reducing quantitative restrictions of trade in the case of severe current account imbalances, and to maintain high protection for their "infant" industries. Under the General Agreement on Trade in Services (GATS), developing countries may open fewer service sectors than developed economies. Therefore, maintaining the developing country status upon accession is advantageous to China, allowing it to commit less significant trade liberalization measures and to pursue trade reform gradually in keeping pace with overall economic reform. Such a gradualist approach, by the way, has been crucial throughout China's reform process and is often credited for the success of China's reform.

China's status as a developing country is not an issue. However, the significant size, rapid growth and transitional nature of the Chinese economy have caused uneasiness in the developed economies. They are concerned that admitting China into the WTO as a developing economy may grant undue competitive advantages to China, as China would have easier access to foreign market while China's domestic market is not easily accessible to them. In addition, many developed countries see China as one of the largest untapped markets in the world, and are eager to maintain and expand market access to China's domestic market. China's commitments of trade liberalization similar to a developed economy would ensure the accessibility to China's domestic market.

There have been attempts to reach a compromise on this issue. For example, some suggest to nominally admit China's developing economy status while taking away from it most of the benefits that are enjoyed by other developing countries at accession. Others suggest setting special criteria or rules for China's accession. However, most of these attempts appear discriminating in nature and have been rejected by China.

Safeguards

The rapid expansion of China's labor-intensive products such as textiles and wearing apparel has fueled the fear of some major trading nations that China's trade expansion will hurt the interests of some of their domestic producers. To minimize the potential disruption to their domestic markets, and for political considerations, some developed countries have insisted in including a special safeguard provision in China's Protocol of Accession.

Several suggestions have been proposed regarding such a provision, including setting certain quantitative limits or conditions for China's trade expansion, and allowing importing countries to impose other discriminatory measures against Chinese exports on the basis of market disruption or a modified version of "serious" injury. Because the GATT has already had safeguard provisions, China has strongly opposed a China-specific safeguard provision on the ground that such a provision is discriminating against China as a new member. China is also concerned that the special safeguard provision would severely restrict China's most dynamic exports such as textiles and wearing apparel and would significantly reduce China's benefits from the WTO accession.

Anti-dumping and Subsidies

There has been an increasing number of anti-dumping cases against China in the United States and the European Union (EU) during the last decade. In determining the existence and assessing the margins of dumping, third country prices have often been used. China has opposed these practices, contending that these third country prices differ substantially from China's domestic costs. China's trading partners, however, want to continue these practices. They are concerned that the Chinese government's subsidies to state enterprises and bailing out of loss-making state enterprises have granted unfair advantages to state enterprises. Therefore, Chinese enterprises are still vulnerable to countervailing charges against them.

Agriculture Market Access

Agriculture is a special and important segment of the Chinese economy. The agriculture sector remains one of the largest segments of the economy, accounting for 18% of total GDP in 1998. Furthermore, the agriculture sector absorbs about half of China's labor force. In addition, China has adopted and intends to retain a self-sufficient policy on food supply. Because of China's large population, a small disruption in the agriculture sector may easily be magnified into a serious crisis to the society. Therefore, maintaining the stability in the agriculture sector has been a major concern to the Chinese government throughout China's reform process, including reform in foreign trade.

China's position on agriculture market access has been to maintain state monopoly and keep quotas on key agricultural imports. However, China's proposal has met strong opposition from major agricultural exporting nations including the U.S., Canada, and Australia, who want the state monopoly eliminated and its place taken by tariffication except in particularly sensitive sectors such as wheat, corn, rice, cotton, and soybean oil. In these sensitive sectors, China is allowed under WTO rules to implement a tariff-rate quota (TRQ) system. Under such a TRQ system, imports up to the quota level are charged a minimal tariff and imports above that level a high tariff. To adopt the system, however, China has to negotiate with the major agricultural exporting nations to set the procedure on how to determine the base year quota and the growth mechanism of the quota. In addition, China is pressured to reduce tariffs in other agricultural sectors and eliminate altogether non-tariff barriers such as "unscientific" sanitary and phytosanitary (SPS) restrictions on agricultural products.

Industrial Sectors

China has made several tariff-binding offers for industrial products. In April 1998, the Chinese WTO delegation announced that China would reduce its arithmetic mean of tariffs for industrial products to 10% by the year 2005. In April 1999, according to the USTR memorandum, China agreed to reduce average tariffs from the 24.6% average in 1997 to 9.44%, which would represent a 56% cut from applied rates in 1998 and a 71% reduction since 1994 when market access negotiations started. Furthermore, USTR indicated that China agreed to bind its entire tariff schedule, i.e. not to raise tariffs in the future above the bound level, and to implement two thirds of the tariff cuts by 2003 with the balance being phased in by 2005 with a limited number of exceptions. As the USTR memo indicated, such a binding offer was almost unprecedented.

There are other issues yet to be resolved. China's main trading partners demanded that China participate in the Uruguay Round zero-for-zero tariff reduction and tariff harmonization agreed by the U.S., Canada, the EU and Japan. Sectors covered by the zero-for-zero tariff reduction include pharmaceuticals, construction equipment, medical equipment, steel, furniture, beer, agricultural equipment and distilled equipment, and steel; tariff harmonization at 6.5% or lower was agreed on chemicals only. China resisted such demands on the ground that these tariff reductions and harmonization were proposed for developed economies and that, as a developing country, it did not have to join the initiative.

China also was pushed to open the high technology, automobile, and chemicals sectors. Upon the insistence of developed countries such as the U.S., China offered several major tariff reductions in these sectors (USTR, 1999). In the high technology sector, China offered to reduce tariffs from present levels averaging 13.3% to zero for semiconductors, computers, telecommunications equipment, and other information technology products. Most of these tariff eliminations would be phased in by 2003 with some exceptions until 2005. In the auto sector, China agreed to reduce tariffs from the current 80-100% levels to 25% in 2005, with the cuts phased in equally each year. The tariff restrictions in the auto industry would be augmented by quotas, which would be progressively eliminated by 2005. Tariffs on auto parts would be reduced to an average of 10%.

The chemicals industry was another sector that had drawn intense pressure from the developed economies for market access. According to USTR (1999), China agreed to reduce its tariffs for 70% of chemicals to the levels of other WTO members, generally at 5.5% and 6.5% from its present levels of up to 35%. China also agreed to reduce tariffs on wood and paper products from current levels of 12-18% for wood and 15-25% for paper to levels between 5% and 7.5%. China agreed in principle to implement the early voluntary sectoral liberalization initiative of APEC now under consideration in the WTO when the WTO accepts these sectors for implementation. Sectors covered by the initiative included forest products, environmental goods and services, energy and energy equipment, fish, toys, gems and jewelry, and medical equipment and scientific instruments (USTR, 1999).

Services

Trade in Services was not a topic in the GATT multilateral talks in the Uruguay Round, and opening up of service markets had never been a precondition in accepting a new member in the GATT framework. It was only after the General Agreement on Trade in Services (GATS) was reached in the Uruguay Round that the negotiation on market accession of trade in services became one of the central issues in the accession negotiations. Some dominant WTO members had taken China's offer in the service sectors as a precondition for further negotiation. Although the demand for opening up the service markets covered a broad array of service sectors, the primarily focuses were on financial and telecommunications services.

The negotiation of the financial market access commitments included opening of banking, insurance and securities. As described in Chapter II, China has made serious efforts to reform the banking sector in order to establish a modern financial system that is consistent with China's modernization drive. One of the most important steps that China has taken is to introduce gradually foreign competition in the financial sector. In the long run, the opening of the financial sector is not only inevitable to meet China's WTO accession requirements, but also necessary to serve China's own interests in developing a healthy financial system. In fact, China has started making progress. By the end of 1997, foreign financial institutions had set up 544 representative offices and established 170 operational entities (Li and Wang, 1998). Given the relatively short history of China's modernization drive in the financial sector, which did not start until the mid-1980s, the progress was significant.

China at present has placed strict restrictions on foreign companies' entry to the Chinese market despite its intention to open the financial sector. In general, the national treatment has not been granted to foreign companies, and there are strict restrictions on market entry standards and on types of products that can be offered by foreign companies. In addition, there are geographic and numeric limitations that further restrict the operation of foreign companies to certain regions and, in the case of insurance, that only a certain number of licenses are granted to foreign companies.

China appeared to have made a strong commitment to opening the insurance market. According to USTR (1999), China agreed to award licenses solely on the basis of prudential criteria, to permit foreign property and casualty firms to insure large-scale risks nationwide immediately upon accession, and to eliminate all geographic limitations for further licenses over five years. China also agreed to expand the scope of activities for foreign insurers, allow majority ownership, remove onerous joint venture requirements on foreign life insurers, and phase out internal branching restrictions. Although these were tentative agreements, they signal a significant concession on China's part in this lucrative sector.

In the banking sectors, China's commitments were limited so far. China was asked to liberalize investment and to grant full rights for foreign banks to handle both local and foreign currency business transactions and to serve both Chinese and foreign customers. It was unlikely, however, that such demand will be met as a prerequisite condition for the WTO entry. While the number of foreign banks allowed to handle Chinese currency business and the number of regions in which foreign banks can conduct such business are likely to expand notably upon China's accession to the WTO, such expansion probably is due more to increased demand than to foreign pressure. As pointed out in Chapter II, China's banking system is marred by low efficiency, poor asset quality, frequent government interference with banks' operations, and reliance on administrative controls rather than market instruments such as the interest rate in managing the national economy. Therefore, China's policy makers have taken a firm and clear stand on cautiously opening the financial sector in order to avoid a major financial crisis. Although one may argue that the problems in the banking sector are exactly the causes calling for immediately action to introduce foreign competition, such hasty action is against China's gradualism reform principle and is unlikely to be adopted.

China has actively sought to list domestic companies in international stock markets in order to raise foreign capital. However, since it is not likely that China will make its domestic currency fully convertible under the capital account in the near future, it is unrealistic to expect China to open the domestic securities market to foreign investors. Besides, given that China has been credited for stabilizing the regional economy by maintaining the value of its currency in the last two years, it appears counterproductive to require China to abandon its fixed exchange rate regime as a prerequisite for the WTO membership. Therefore, China's concession in this area seems dubious.

China's telecommunications sector is monopolized by the state. A duopoly structure is maintained within the industry, and China Telecom and China Unicom, both state-owned, are the two dominant players. Because there is no specific law to regulate the telecommunications market, the telecommunications bureaucracies such as the former Ministry of Post and Telecommunications (MPT) have wide discretion to apply arbitrary and discriminatory standards toward potential competitors both at home and abroad. At present, China severely restricts sales of telecommunications services and allows no foreign investment in telecommunication services even though both China Telecom and China Unicom are enthusiastic about absorbing foreign capital to develop their own networks and expand their domestic market shares. Therefore, it surprised almost everyone that China reportedly agreed, for the first time, to open its telecommunications sector, both to the scope of services and to direct investment in telecommunications business. According to USTR (1999), China agreed to phase out all geographic restrictions for paging and mobile/cellular services in 4 to 5 years and for domestic wireline services in 6 years. China also agreed to open all telecommunications services in Beijing, Shanghai and Guangzhou, the most lucrative markets in China, immediately upon accession. Furthermore, China agreed to allow 49% foreign investment in all services and 51% foreign ownership for value added and paging services in 4 years.

China has made significant concessions in the distribution sector. At present, foreign companies are not allowed to distribute products other than those made in China, or to own or manage distribution networks, wholesaling outlets or warehouses.

According to USTR (1999), however, China made a comprehensive commitment on distribution. In particular, China agreed to phase out all restriction on distribution services within three years. Even in the most sensitive and protected sectors, China agreed to provide distribution rights in five years.

Summary

It is evident from this brief review that China has made strong commitments to the WTO accession. Furthermore, China's overall commitments have been at par or above what is normally required for developing countries. Given the unexpectedly significant concessions that China reportedly made recently, the time seems ripe for China to become a member of the world trade organization.

Quantitative Studies on China's Accession to the WTO

There are a number of quantitative studies in the literature on evaluating the impact of China's accession to the WTO, including Nyhus (1999)[24], Li and Wang (1998), Wang (1997), Bach et al. (1996), and Yang (1996). Most of these studies are based on CGE models. A particularly popular CGE model is the model of the Global Trade Analysis Project (GTAP), a multi-region CGE model (Hertel, 1997). In fact, except for Nyhus' study, all others of the aforementioned studies are at least partially based on various versions of the GTAP model.

Li and Wang (1998) used two models in the analysis. The first was a 41-sector dynamic single country CGE model, and the second is a 17-region, 19-sector recursive

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[24] Nyhus (1999) used an earlier, slightly different version of this MuDan model to simulate China's entry into the WTO. While benefited from some discussions with him, this study is conducted independent of his. The two studies differ on assumptions on the values of exogenous variables and trade liberalization measures, but share many basic conclusions.

dynamic version of the GTAP model. They found that China would gain significantly in economic efficiency when China joins the WTO. According to their estimates, China's average GDP growth would be one percentage higher when it joins the WTO than when it is not a member. Furthermore, they found that efficiency gains were not evenly distributed among industries. Highly protected agricultural sectors and some of the capital-intensive industries such as automobile and instruments would contract significantly while the labor-intensive sectors such as textiles and clothing would gain most from China's WTO entry.

Wang (1997) used a 12-region, 14-sector GTAP model. He found that, by including China and Taiwan in the WTO, total world trade could increase by as much as $78 billion. Net exports of labor-intensive products from China could increase dramatically and demand for capital goods would go up. As a result, competition in the world labor-intensive goods market would stiffen, prices for textiles and apparel would decline, and prices for capital goods would increase.

Bach et al. (1996) evaluated two schedules of tariff bindings offered by China in negotiations on entry to the WTO. They found that the impact of China's unilateral trade liberalization on the Chinese economy in the absence of the Uruguay round would lower output levels for primary agriculture, due to a reallocation of resources into the expanding manufacturing sectors. They found a negative effect on the output of the highly protected textiles sector while wearing apparel would benefit from lower costs of imported inputs. Overall, the light manufacturing industries would benefit from lower input costs and the machinery and equipment and heavy manufacturing sectors would contract. On the other hand, the Uruguay Round without liberalization occurring in China would increase China's output of primary agriculture as a result of contraction in a number of other sectors and price increases in the world market. Textiles and wearing apparel would lose market opportunities to the exporters that are

WTO members, as they would benefit from the phase-out of the Multi-Fiber Arrangement (MFA) while countries without a WTO membership would not. Overall, light manufacturing industries would benefit from increased market access in the Uruguay Round while transport, machinery and equipment and heavy manufacture would contract, supporting the often held view that China remains a high cost producer of these products. The combination of China's trade liberalization and the Uruguay round reinforced results in the other scenarios, with positive impact on the light industry and negative impact on transport, machinery and equipment and heavy manufacturers.

Yang (1996) used a 32-commodity, 6-region GTAP model to simulate China's accession to the WTO with the commitments of a developing or a developed economy. Three scenarios were simulated by the model. The first two scenarios differed only in the depth of trade reform. In the China as a developing economy scenario, the tariff reduction was two-thirds of that in the China as a developed economy scenario. The third scenario was more interesting. In the third scenario, tariffs were cut to a maximum of 10%.

The simulation results in Yang (1996) suggest that trade liberalization has a significant impact on output in all scenarios. The WTO accession on agricultural sectors had mixed results. Output of paddy rice, wheat, non-grain crops, and other livestock would gain while other agricultural sectors would lose. In non-agricultural sectors, the mining sector would contract while the textiles and wearing apparel sectors would gain. The apparel sector would be the biggest winner with value added expanding by as much as 335% in 2005. However, all other manufacturing sectors would contract. Heavy industry would be the hardest hit with output falling by 10-23%.

Simulation Design and Assumptions on the Values of Exogenous Variables

As described earlier, China has made a series of trade liberalization offers since the early 1980s. China's latest, and the most significant concession package for the WTO entry, was offered during the Sino-US bilateral negotiations on tariff reduction prior to Premier Zhu's visit in 1999 (USTR, 1999). Although many China observers agreed that China seemed to have stretched the limit to make a generous offer in an attempt to strike a deal during Premier Zhu's visit, the U.S. rejected the offer and demanded more concessions. China has since withdrawn the offer, arguing that, because the April-1999 package was a limited-time offer and the two sides failed to reach an agreement on time, the offer is no longer available. That argument, however, is not accepted by the U.S. It seems reasonable to expect that when China and the U.S. finally reach an agreement, the terms won't be much different from those in USTR (1999). Hence, it appears appropriate to use USTR (1999) as a basis for China's trade liberalization measures to evaluate the impact of China's WTO accession on the Chinese economy.

USTR (1999) contains an extensive body of market accession measures, including tariff reduction, quota and tariff-quota systems, and non-tariff measures, and it covers all sectors of the economy, including agriculture, industry, and services. However, an extensive analysis on the impact of USTR (1999) on the Chinese economy is beyond the scope of this study. This study has primarily focused on the impact of tariff and NTB reductions in agriculture and industry. The tariff reduction schedule contained in the USTR memorandum is simplified and translated into MuDan sectors. This simplified tariff reduction schedule and assumptions on the removal of certain NTBs are then used as a basis for this study. To estimate the impact of the removal of certain NTBs, I have used the tariff equivalent NTBs estimated by Li and Wang (1998).

Table 46 is a summary of China's trade liberalization offers for agricultural and industrial products as published in USTR (1999). Some of the market access measures would be implemented immediately upon accession, as shown in the column "Upon Access". Others have specific phase-in periods, as shown by the years 2004, 2005, and 2006, which indicate the time by which these measures would be implemented. For most sectors, the phase-in periods end in 2005.

As China liberalizes the domestic market for foreign imports, foreign markets are expected to reduce the barriers for Chinese exports in return. Therefore, one of the reasons for China to join the WTO is easy access to foreign markets by Chinese exports. Since exports are exogenous to MuDan, certain assumptions on the behavior of foreign demand on Chinese exports have to be made in order to evaluate the full impact of China's WTO accession. This section describes the assumptions on exports as well as the assumptions on China's tariff reductions.

Table 46 –China's Market Access Measures in Agriculture and Industry as in USTR (1999)

Sectors	Tariff Rates or TRQ Import Quotas				
	Phase-in Period	Upon Accession	2004	2005	2006
Farming					
U.S. priority products			14.5%		
A. Average for agricultural products			17%		
Soybean		3%			
Meats	45%		12%		
Pork	20%		12%		
Poultry	20%		10%		
Cirtrus	40%		12%		
Grapes	30%		13%		
Apples	30%		10%		
Almonds	30%		10%		
Fish	over 20%			10%	
B. Tariff Rate Quota system					implemented
C. Sanitary and Phytosanitary restrictions		settled			
D. Export subsidies		eliminated			
II. Industrial Products					
A. Trading and distribution rights		progressively phased-in			
B. Overall Industrial Tariff Reductions					
Average (Note 1)	24.6%			9.44%	
U.S. Priority Products				7.1%	
C. US Priority Areas					
Information Technology Agreement (Note 2)				0.0%	
APEC sectors (Note 3)				25.0%	
Auto (Note 4)				25.0%	
Auto parts				10.0%	
Wood	12% - 18%			5% - 7.5%	
Paper	15% - 25%			5% - 7.5%	
Chemicals (Note 5)	up to 35%			5.5% - 6.5%	
Distilled sprits	61%			10%	
Wine	65%		20%		
Cheese	50%		12%		
Ice Cream	45%		19%		
D. Quotas and other Non-tariff Measures					
On U.S. priority products		elimінted			
On others				eliminated	

Notes:

1. Phase in 2/3 by 2003, all by 2005.
2. Information Technology Agreement (ITA) covers the following:
   semicoductors, computers, computer equipment, telecommunications equipment and other information technology products.
   Most are phased-in by 2003, all by 2005.
3. Phased in equally each year.
   Auto quotas phased out by 2005; in the interim, the base quota will be $6 bil., and will grow by 15% annually until elimination.
4. APEC (Asia-Pacific Economic Cooperation) sectors covers the following:
   forest products, environmental goods and services, energy and energy equipment, chemical harmonization, fish, toys, gem, and medical equipment and scientific instruments.
5. Covering 75% of chemicals.

1 Agriculture Quotas

According to USTR (1999), China agreed to reduce average tariffs for agricultural products to 17% by 2004. China also agreed to implement a tariff-rate quota system through multilateral negotiation, and to phase out other non-tariff barriers such as unscientific sanitary and phytosanitary restriction on agricultural products. In order to simulate the impact of reducing the NTB in agriculture, I have relied on exogenous assumptions as described below.

In MuDan, import demand is modeled in terms of the import share of domestic demand, which is defined as domestic output less exports plus imports. As a result of China's self-reliance policy on grain and agricultural product, China's import share of agricultural products was very low and showed a declining trend in the earlier 1990s. According to our estimates, the import share farming products fell from 3.7% in 1989 to 1.4% in 1994. In fact, the import share of Farm in our benchmark forecast will continue to fall, reaching 1.3% in 2000 and 0.8% in 2010. In order to simulate the impact of the increases in import quotas in the agriculture sector, I made an assumption that the import share of domestic demand in Farming would grow from 2000's level of 1.5% to 4.0% by 2005 and to remain at that level thereafter. Although this 4.0% import share is purely that of an assumption, the subsequent percentage increases of about 400% in agricultural imports resulted from this assumption are similar to the ones found in Li and Wang (1998). Therefore, this assumption appears reasonable.

2 Tariff Reductions

According to USTR (1999), China agreed to reduce average tariffs for industrial products by 61.6%, from the 24.6% in 1997 to 9.44%. Tariff reductions would be implemented by 2005 for most sectors.

Table 47 displays a simplified tariff reduction schedule that is used in the simulation. In determining the magnitude of tariff cuts for each sector, I have relied on two methods. The first method is used for sectors such as agriculture, forestry, food, paper, chemicals, and automobiles. For these sectors, the targeted tariff rates are specified directly because USTR (1999) was quite specific about them. The second method is used for all other sectors, and it involves specifying a uniform tariff reduction rate of 62%. The sectors whose tariffs are specified by the second method are indicated in Table 47 when a 62% in the "Targeted Tariff Reductions" column is present.

The assumption on the phase-in periods to implement the tariff cuts is simplified for the simulations as well. It is assumed that tariff cuts are implemented between 2000 and 2004 for agricultural sectors and between 2000 and 2005 for all others. Furthermore, it is assumed that tariff cuts will be implemented annually in equal proportion within the phase-in periods, and tariffs at the end of the phase-in period will be maintained through 2010. The assumed tariffs are displayed Table 48.

Table 47 – Assumptions on China's Tariff Reductions

(percent)

	Sector	Tariffs in 1994	Targeted Tariff Reductions	Targeted Tariffs
1	Farming	47.7		17.0
2	Forestry	24.4		5.0
3	Livestock	14.9		9.5
4	Fishing	22.7		10.0
5	Coal mining	4.8	62.0	1.8
6	Crude petroleum and natural gas	1.0	62.0	0.4
7	Ferrous ore mining	0.8	62.0	0.3
8	Non-ferrous ore mining	1.2	62.0	0.5
9	Non-metal minerals mining and mining, n.e.c.	4.2	62.0	1.6
10	Logging and transport of timber and bamboo	6.6		5.0
11	Food processing and manufacturing	51.2		20.0
12	Beverages	40.6		15.0
13	Tobacco manufacture	64.9	62.0	24.7
14	Textiles	23.7	62.0	9.0
15	Wearing apparel	31.9	62.0	12.1
16	Leather, fur and their products	12.6	62.0	4.8
17	Sawmills and bamboo etc. products	13.1	62.0	5.0
18	Furniture	15.7	62.0	6.0
19	Paper and paper products	13.2		6.0
20	Printing industries	8.5	62.0	3.2
21	Culture, education, and sports articles	22.6	62.0	8.6
22	Petroleum refineries and coking products	8.1	62.0	3.1
23	Chemical industries	13.4		6.0
24	Medicines	10.3		6.0
25	Chemical fibers	16.2		6.0
26	Rubber products	13.3		6.0
27	Plastic products	19.7		6.0
28	Building materials and non-metallic minerals	17.5	62.0	6.7
29	Primary iron and steel manufacturing	9.6	62.0	3.6
30	Primary non-ferrous metals manufacturing	7.1	62.0	2.7
31	Metal products	14.0	62.0	5.3
32	Machinery	13.7	62.0	5.2
33	Railway Equipment	9.1	62.0	3.5
34	Motor vehicles	52.8		25.0
35	Ships, boats	8.2	62.0	3.1
36	Aerospace	3.9	62.0	1.5
37	Transportation equipment, n.e.c.	19.0	62.0	7.2
38	Electric machinery and equipment	14.2	62.0	5.4
39	Electronic and communication equipment	15.1	62.0	5.7
40	Instrument, meters and office machinery	13.5	62.0	5.1
41	Manufacture, n.e.c.	1.7	62.0	0.6
42	Electricity, steam and hot water	3.0	62.0	1.1
	Average	16.9	60.5	6.7

Note: The Targeted Tariff Reductions column is blank if the Targeted Tariffs are specified explicitly.

Table 48 - Assumptions on Import Tariffs

(percent)

	Sector	1994	2000	2001	2002	2003	2004	2005	2010
1	Farming	47.7	41.6	35.4	29.3	23.1	17.0	17.0	17.0
2	Forestry	24.4	20.5	16.6	12.8	8.9	5.0	5.0	5.0
3	Livestock	14.9	13.8	12.7	11.7	10.6	9.5	9.5	9.5
4	Fishing	22.7	20.2	17.6	15.1	12.5	10.0	10.0	10.0
5	Coal mining	4.8	4.3	3.8	3.3	2.8	2.3	1.8	1.8
6	Crude petroleum and natural gas	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4
7	Ferrous ore mining	0.8	0.7	0.6	0.6	0.5	0.4	0.3	0.3
8	Non-ferrous ore mining	1.2	1.1	1.0	0.8	0.7	0.6	0.5	0.5
9	Non-metal minerals mining and mining, n.e.c.	4.2	3.8	3.3	2.9	2.5	2.0	1.6	1.6
10	Logging and transport of timber and bamboo	6.6	6.3	6.1	5.8	5.5	5.3	5.0	5.0
11	Food processing and manufacturing	51.2	46.0	40.8	35.6	30.4	25.2	20.0	20.0
12	Beverages	40.6	36.3	32.1	27.8	23.5	19.3	15.0	15.0
13	Tobacco manufacture	64.9	58.2	51.5	44.8	38.1	31.4	24.7	24.7
14	Textiles	23.7	21.3	18.8	16.4	13.9	11.5	9.0	9.0
15	Wearing apparel	31.9	28.6	25.3	22.0	18.7	15.4	12.1	12.1
16	Leather, fur and their products	12.6	11.3	10.0	8.7	7.4	6.1	4.8	4.8
17	Sawmills and bamboo etc. products	13.1	11.7	10.4	9.0	7.7	6.3	5.0	5.0
18	Furniture	15.7	14.1	12.5	10.8	9.2	7.6	6.0	6.0
19	Paper and paper products	13.2	12.0	10.8	9.6	8.4	7.2	6.0	6.0
20	Printing industries	8.5	7.6	6.7	5.9	5.0	4.1	3.2	3.2
21	Culture, education, and sports articles	22.6	20.3	17.9	15.6	13.3	10.9	8.6	8.6
22	Petroleum refineries and coking products	8.1	7.3	6.4	5.6	4.8	3.9	3.1	3.1
23	Chemical industries	13.4	12.2	10.9	9.7	8.5	7.2	6.0	6.0
24	Medicines	10.3	9.6	8.9	8.2	7.4	6.7	6.0	6.0
25	Chemical fibers	16.2	14.5	12.8	11.1	9.4	7.7	6.0	6.0
26	Rubber products	13.3	12.1	10.9	9.7	8.4	7.2	6.0	6.0
27	Plastic products	19.7	17.4	15.1	12.9	10.6	8.3	6.0	6.0
28	Building materials and non-metallic minerals	17.5	15.7	13.9	12.1	10.3	8.5	6.7	6.7
29	Primary iron and steel manufacturing	9.6	8.6	7.6	6.6	5.6	4.6	3.6	3.6
30	Primary non-ferrous metals manufacturing	7.1	6.4	5.6	4.9	4.2	3.4	2.7	2.7
31	Metal products	14.0	12.6	11.1	9.7	8.2	6.8	5.3	5.3
32	Machinery	13.7	12.3	10.9	9.5	8.0	6.6	5.2	5.2
33	Railway Equipment	9.1	8.2	7.2	6.3	5.3	4.4	3.5	3.5
34	Motor vehicles	52.8	48.2	43.5	38.9	34.3	29.6	25.0	25.0
35	Ships, boats	8.2	7.4	6.5	5.7	4.8	4.0	3.1	3.1
36	Aerospace	3.9	3.5	3.1	2.7	2.3	1.9	1.5	1.5
37	Transportation equipment, n.e.c.	19.0	17.0	15.1	13.1	11.1	9.2	7.2	7.2
38	Electric machinery and equipment	14.2	12.7	11.3	9.8	8.3	6.9	5.4	5.4
39	Electronic and communication equipment	15.1	13.5	12.0	10.4	8.9	7.3	5.7	5.7
40	Instrument, meters and office machinery	13.5	12.1	10.7	9.3	7.9	6.5	5.1	5.1
41	Manufacture, n.e.c.	1.7	1.5	1.3	1.2	1.0	0.8	0.6	0.6
42	Electricity, steam and hot water	3.0	2.7	2.4	2.1	1.8	1.5	1.1	1.1
	Average	17.9						6.7	

3 Import Prices

For this study, import prices are exogenously given, and China is assumed to be a price taker on all imports. For simplicity, the world prices are assumed to be unaffected by China's entry to the WTO. Import prices for both the benchmark forecast and the simulations are taken from the February 1999 version of forecast by the INFORUM international model system, and the same set of world prices in terms of U.S. dollars is used in both the benchmark and alternative forecasts. Since import prices in MuDan are price indexes rather than actual levels, the domestic import price indexes for the benchmark and alternative forecasts have the following simple relationship:

$$p_{i,t}^{a} = \frac{1+r_{i,t}^{a}}{1+r_{i,t}^{b}} * p_{i,t}^{b} \qquad (1)$$

where $p^{a}{}_{i,t}$ and $p^{b}{}_{i,t}$ are import prices in the domestic market for product i in year t, and $r^{a}{}_{i,t}$ and $r^{b}{}_{i,t}$ are tariff rates, with superscripts *b* and *a* indicating the benchmark and alternative forecasts.

4 Elimination of Non-Tariff Barriers (NTBs)

To estimate the impact of the removal of some of the NTBs, I used the estimations of Li and Wang (1998) on Tariff equivalent NTBs. For simplicity, I assumed complete elimination of the NTBs on the sectors for which a value of tariff equivalent NTBs is present. All tariff equivalent NTBs for these sectors are reduced by equal proportion, or one sixth of the original value per year, to zero from 2000 to 2005 during the simulations.

Unlike *ad valorem* tariffs, NTBs do not directly change domestic prices of imports. To quantitatively simulate the impact of the elimination of the NTBs on a product, I have used a factor, which I will call the NTB price reduction factor, to reduce the import price of the product when computing import demand on the product. However, the import price as used elsewhere in the model, such as in computing the import price index or the cost of imported materials, will not be changed.

The NTB price reduction factor $m^{a}_{i,t}$, which will be applied to import price $p^{a}_{i,t}$ only in computing import demand, is computed as follows:

$$m^{a}_{i,t} = \left(\frac{1 + r^{a}_{i,t} + x^{a}_{i,t}}{1 + r^{b}_{i,t} + x^{b}_{i,t}} \right) \bigg/ \left(\frac{1 + r^{a}_{i,t}}{1 + r^{b}_{i,t}} \right) \tag{2}$$

where $r^{a}_{i,t}$ and $r^{b}_{i,t}$ are tariff rates, and $x^{a}_{i,t}$ and $x^{b}_{i,t}$ are tariff equivalent NTBs, with superscripts *b* and *a* indicating the benchmark and alternative forecasts.

5 The Multi-Fiber Arrangement (MFA)

The Multi-Fiber Arrangement, which was initially made in 1974, provides rules for imposing quotas on textiles and clothing when surges of imports cause market disruptions in importing countries. In recent years, the MFA has been used by a number of developed countries, including the EU, the U.S., Canada, Norway, Finland, and Austria, to impose quotas almost exclusively on imports from developing countries.

The demolition of the MFA was regarded as one of the most important trade liberalization agreements reached in the Uruguay Round. Under the Uruguay Round Agreement on Textiles and Clothing, the quota restrictions will be gradually phased out over a ten-year period, starting in 1995, through increases in the growth rates of MFA quotas and progressive integration of textile and clothing items into the GATT system. However, the most restrictive measures will survive until near the end of the ten-year period. While a non-WTO exporting country may enjoy increases in MFA quotas during the ten-year period, it may continue to face export quotas even after the abolition of the MFA quotas, as the abolition will apply only to the WTO members. Therefore, unless China becomes a WTO member, the full benefit of the MFA elimination will not be available to China.

There are a number of factors limiting China's potential gains from the MFA abolition with or without China's entry to the WTO. Because each importing country is free to choose the products it will integrate during the transition period, quotas for certain Chinese exports can become very restrictive during the transition period. Furthermore, exporting countries are restricted by importing countries with various degrees on quota growth. For example, Hong Kong is the most restricted supplier of the U.S. and the EU, and quotas on its exports will increase by only about 6.1% by the end of the ten-year period. For less restricted suppliers such as Sri Lanka and Colombia, the quota growth can reach as much as 50% by the end of the period. Because of China's large base of export volume, quota growth for Chinese exports is likely to be small.

In addition to the restrictive quota growth, China's exports can be negatively affected by many other actions imposed by the importing countries. For example, importing countries can impose a "temporary" quota on the exporting country during the transition period if certain imports are deemed to have caused actual or potential damage to a domestic industry. Importing countries may also adopt certain safeguard mechanisms to protect again a surge in imports. Therefore, there is ample room for negotiation on what quota growth will be used for Chinese exports and what protective mechanism will be instituted against Chinese exports. Assumptions on the MFA quota growth for China are described in the next section.

6 Exports and Simulation Scenarios

By joining the WTO, China has the potential to benefit from the implementation of Uruguay Round trade liberalization and from securing access to important foreign markets such as the U.S. market. However, because China's exports rely heavily on labor intensive products, particularly textiles and wearing apparel, which are constrained by slow quota growth as specified by the MFA, the potential for increases in China's exports as a result of China's WTO accession may hinge on a small number of sectors. In fact, most studies have identified increases in exports in textiles and wearing apparel as the most important source for China's welfare gains from the WTO accession. (See Wang, 1997; Bach et al., 1996; and Yang, 1996) Since exports are exogenous to MuDan, I have made explicit assumptions on changes in exports so that the simulations can be done independent of the INFORUM international model system. Furthermore, the differences in assumptions on exports are used as the basis for designing the different simulation scenarios.

In order to gauge the impact of tariff reduction on Chinese exports, I have conducted a counter-factual analysis.[25] By assuming the price elasticity of Chinese exports with respect to the tariffs that are imposed on Chinese exports by foreign countries to be 1.0, I have computed the percentage increase of Chinese exports when China's trading partners remove their tariffs. The calculation starts from the tariff and trade data in the TRAINS database on the 6-digit Harmonized System (HS) level. The results are aggregated into the 4-digit SITC products and then converted into the MuDan sectors. A summary of the calculation is presented in Table 49, which also includes the changes in imports due to total removal of tariffs on Chinese imports. In

[25] Data were provided by Qing Wang, who conducted a similar analysis for the U.S. economy (Wang, 1999).

computing the import changes, price elasticity of imports with respect to tariffs is also assumed to be 1.0. A more detailed discussion can be found in Wang (1999).

According to our calculation, if both China and its trading partners removed all the tariffs, Chinese imports would go up by 12.8% while exports would increase by only 4.5%. The difference in the magnitudes of the percentage changes reflects the fact that China's domestic protection against imports was much higher than the protections that Chinese exports encountered in other countries. The result makes sense intuitively since the main export markets for Chinese products were developed countries, which usually had lower tariffs than developing countries such as China. It should be noted, however, that the results in Table 49 are based on tariffs only, and non-tariff barriers have not been taken into account in the calculation.

Table 49 – Changes in China's Imports and Exports Due to Elimination of Tariffs in Trading Partners

	Sector	China's Imports in 1994 (US$ mil.)	Changes in Imports due to Elimination of Tariffs (%)	China's Exports in 1994 (US$mil)	Changes in Exports due to Elimination of Tariffs by China's Trading Partners (%)
1	Farming	1,786.1	21.4	3,447.7	12.4
2	Forestry	489.1	20.0	95.6	5.0
3	Livestock	469.4	10.6	772.8	1.7
4	Fishing	70.0	16.2	472.8	0.9
5	Coal mining	23.9	-	598.7	0.6
6	Crude petroleum and natural gas	1,175.0	1.2	1,730.1	-
7	Ferrous ore mining	875.3	0.1	3.4	0.1
8	Non-ferrous ore mining	164.3	0.5	196.8	0.4
9	Non-metal minerals mining and mining, n.e.c.	195.0	0.4	629.7	1.1
10	Logging and transport of timber and bamboo	433.1	4.8	53.3	0.4
11	Food processing and manufacturing	3,746.6	27.6	6,327.9	5.9
12	Beverages	528.9	23.6	536.5	5.0
13	Tobacco manufacture	344.5	40.0	497.1	2.1
14	Textiles	13,141.8	19.3	18,436.0	6.2
15	Wearing apparel	556.4	20.8	14,553.5	7.2
16	Leather, fur and their products	2,708.1	11.2	8,104.1	7.9
17	Sawmills and bamboo etc. products	1,401.7	9.9	228.3	1.0
18	Furniture	540.3	15.5	2,824.3	1.0
19	Paper and paper products	3,401.9	10.3	3,360.8	1.7
20	Printing industries	221.1	7.8	129.4	0.5
21	Culture, education, and sports articles	1,768.5	18.8	9,004.4	1.2
22	Petroleum refineries and coking products	2,814.7	9.6	1,186.0	3.2
23	Chemical industries	12,710.9	9.4	4,605.5	5.1
24	Medicines	801.8	10.0	1,091.5	1.6
25	Chemical fibers	1,143.4	10.0	12.0	8.1
26	Rubber products	260.4	12.1	831.5	7.3
27	Plastic products	40.2	20.0	1,857.4	8.1
28	Building materials and non-metallic mineral products	1,120.1	13.5	2,399.8	4.6
29	Primary iron and steel manufacturing	5,744.0	9.7	1,314.7	2.4
30	Primary non-ferrous metals manufacturing	1,977.7	6.9	1,302.5	0.6
31	Metal products	1,452.2	10.3	3,197.6	2.9
32	Machinery	23,730.1	10.8	3,893.8	2.8
33	Railway Equipment	110.8	4.3	354.7	0.5
34	Motor vehicles	6,779.3	29.1	307.9	3.0
35	Ships, boats	1,012.6	10.0	285.6	0.2
36	Aerospace	2,518.4	-	48.8	3.6
37	Transportation equipment, n.e.c.	635.6	18.1	1,237.2	2.3
38	Electric machinery and equipment	6,577.3	11.5	6,569.9	1.1
39	Electronic and communication equipment	15,472.1	11.2	9,395.9	2.0
40	Instrument, meters and office machinery	2,572.1	12.0	1,578.0	3.1
41	Manufacture, n.e.c.	3,264.9	0.4	887.4	5.5
	Total	124,779.6	12.8	114,360.8	4.5

Note: Trade volumes are not adjusted to China's national accounts. Both trade volumes and tariffs are based on the 1994 figures.
Source: UNCTAD (1996) and Author's calculation.

The estimated change in exports due to elimination of tariffs in Table 49 are used in defining the simulation scenarios. Two possible scenarios are analyzed in this study. The first is a conservative or pessimistic scenario, and the second can be regarded as the expected, normal scenario. Assumptions for the two scenarios are as follows:

Scenario I (S-I): Trade Liberalization and Restrictive MFA Quota Growth

In this scenario, China implements all trade liberalization commitments, including opening the agricultural market, reducing tariffs, and removing NTBs. Trade liberalization in other countries is also implemented, resulting in an increases in demand for Chinese products. Consequently, China's exports in the benchmark forecast for each industry are increased by a percentage, which equals a factor times the percentage change in exports in Table 49. This factor increases from 0.1 for 2000 to 0.40 for 2005 and remains at that level thereafter. The factor can be interpreted roughly as the magnitude of the average tariff reduction by China's trading partners from the base year tariff level, and a 40% reduction of tariffs is assumed to approximate what is to be expected from the Uruguay Round of trade liberalization. (See, for example, Martin and Winters, 1995.)

The growth of textile and clothing exports in this scenario is rather small. Extra growths of 0.5% for textiles and 0.6% for clothing per year from their respective bases are assumed starting 2000. By 2005, exports of textiles increase 2.4% of the benchmark, and clothing exports increase 2.6%. No extra growth is assumed for exports after 2005.

The slow growth of China's MFA quotas in this scenario is similar to the growth of 0.6% per year from 1995 to 2004 for Hong Kong, which faces the most restrictive quota growth to the United States and the EU (Martin and Winters, 1995.)

Scenario II (S-II): Trade Liberalization and Moderate MFA Quota Growth

This scenario maintains all the assumptions in S-I, including trade liberalization measures and increases in exports, except that of the MFA quota growth. In this scenario, China's exports of textiles and wearing apparel will increase by an extra 1.2 percentage points per year from the benchmark (MFA) level from 2000 to 2004. This quota growth doubles the growth in S-I. By the end of the MFA phase-out period in 2004, China's textile and clothing exports will be 6.1% higher than the benchmark. Furthermore, in the post-MFA period of 2005 to 2010, China's exports of textiles and wearing apparel will be 2.0 percentage faster than the growth in the benchmark. Therefore, China's exports of textiles and clothing in 2010 will be 12.7% higher than in the benchmark level.

The 6.1% increase of China's MFA quotas is about the same as the percentage increase for Hong Kong. Since the 6.1% quota growth for Hong Kong is accumulated in a ten-year period while that for China is accumulated in five years, our assumption on China's annual quota growth is twice as fast as Hong Kong's. The extra 1.2% per year quota growth is low relative to other studies. For example, Li and Wang (1998) assumed extra 5% per year for textiles and 6.2% per year for apparel. However, their assumption seems over-optimistic. Given China's large base of textile and clothing exports, a large increase in China's exports would require either a significant growth in foreign demand or a major disruption in other exporting countries. The former is unlikely, as estimates on increases in world exports of textiles and apparel tend to be relatively small (for example, Wang, 1997). The latter is politically difficult. Therefore, a relatively conservative quota growth is assumed. However, the magnitude of the export growth should not materially change our conclusions.

The Impact of China's WTO Accession – A Quantitative Assessment

Macroeconomic Effects of China's WTO Accession

Table 50 summarizes the macroeconomic aspect of the simulation results on China's WTO accession. For each variable in the table, the results for 2000, 2005, and 2010 are shown. The first column of the data show the benchmark forecast for the variable in 2000. The next two columns of data, shown as percentage deviations from the benchmark forecast, are the simulation results of the S-I and S-II scenarios in 2000. The 2005 and 2010 results are similarly presented.

The simulation results in Table 50 clearly indicate that China would benefit from the accession to the WTO. In the S-I scenario in which China joins the WTO with restrictive MFA quota growth, China's real GDP increases 1.9%, private consumption increases 6.1%, rural and urban per-capita incomes increase 8.9% and 3.8%, respectively, all compared to the benchmark in 2010. Furthermore, employment would go up 1.2%, or equivalently, about 8 million new jobs will be created as a result of China's WTO entry. In the S-II scenario, GDP goes up 4.5%, private consumption increases 10.7%, rural and urban per-capita income increase 18.7% and 10.6%, respectively. Because imports increase faster than exports, however, China's trade surplus in both scenarios will shrink significantly.

Comparing the simulation results for 2000, 2005, and 2010, we find that China would gain from the entry to the WTO more in the long term than in the short run. When China joins the WTO in 2000, GDP would decline slightly. Even in 2005 when trade liberalization is completed, GDP would still be slightly less than the benchmark in the S-I scenario, and up only 0.4% in the S-II scenario. Private consumption would go up by 2.0% or 2.6% depending on the assumptions.

Table 50 – Macroeconomic Results of China's WTO Accession

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in levels or percentage; S-I, S-I, S-II in percentage change from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
Values in 1992 prices, 100M yuan									
Gross Domestic Product	52890	-0.1	-0.1	74221	-0.1	0.4	101322	1.9	4.5
Private Consumption	24917	0.0	0.0	34694	2.0	2.6	47619	6.1	10.7
Consumption of Rural Households	11917	-0.1	0.0	15641	2.0	3.2	21931	8.9	14.6
Consumption of Urban Households	13000	0.0	0.0	19053	1.9	2.2	25689	3.8	7.3
Public Consumption (*)	6488	0.0	0.0	8758	0.0	0.0	11822	0.0	0.0
Total Fixed Investment	17989	-0.1	0.0	24794	0.1	0.5	33204	1.8	3.6
Inventory Investment	2372	0.0	0.1	3716	-0.4	0.4	5573	2.1	4.9
Net exports	1316	-2.7	-1.6	2452	-30.6	-29.9	3296	-50.3	-60.1
Exports (*)	11555	0.4	0.6	17349	1.8	3.5	24778	1.8	6.6
Imports	-10238	0.8	0.9	-14897	7.2	9.0	-21481	9.8	16.8
Other final demand (*)	-193	0.0	0.0	-193	0.0	0.0	-193	0.0	0.0
Deflators, 1992=100:									
GDP	190	-0.2	-0.1	219	-7.5	-4.2	250	-9.9	-5.3
Rural private consumption	178	-0.3	-0.2	194	-7.7	-4.1	208	-9.5	-4.5
Urban private consumption	198	-0.3	-0.1	229	-7.7	-4.1	260	-9.2	-3.9
Fixed asset investment	188	-0.3	-0.2	214	-7.5	-4.6	246	-10.1	-6.6
Other data									
Total income, 100M yuan									
Rural, nominal	24130	-0.4	-0.2	35201	-5.4	0.1	52835	1.2	13.4
Rural, real	13540	-0.1	0.0	18128	2.5	4.4	25403	11.9	18.7
Urban, nominal	28412	-0.3	-0.2	47579	-5.6	-1.2	72586	-4.1	6.3
Urban, real	14332	0.0	0.0	20788	2.3	3.0	27878	5.6	10.6
Income per capita, yuan									
Rural, nominal	2736	-0.4	-0.2	3875	-5.4	0.1	5652	1.2	13.4
Rural, real	1535	-0.1	0.0	1996	2.5	4.4	2718	11.9	18.7
Urban, nominal	7140	-0.3	-0.2	10712	-5.6	-1.2	14809	-4.1	6.3
Urban, real	3602	0.0	0.0	4680	2.3	3.0	5687	5.6	10.6
Employment (millions)	629	-0.1	0.0	653	0.1	0.6	674	1.2	1.3
GDP/Employment (yuan/person)	8411	0.0	0.0	11372	-0.2	-0.1	15030	0.7	3.2
Values in current prices, 100M yuan									
Gross Domestic Product	100235	-0.4	-0.2	162286	-7.5	-3.8	252817	-8.2	-1.0
Private Consumption	47385	-0.3	-0.2	75457	-5.9	-1.6	116164	-4.0	5.7
Rural private consumption	21230	-0.4	-0.2	30710	-5.9	-1.0	46942	-1.2	9.7
Urban private consumption	26156	-0.2	-0.1	44746	-5.9	-2.0	69222	-5.9	2.9
Investment	33876	-0.4	-0.2	53087	-7.3	-4.2	81720	-8.4	-3.3
Exports	21610	-0.3	-0.1	38548	-6.8	-3.2	64398	-8.4	-1.3
Imports	-19250	-0.7	-0.6	-36540	-2.7	-1.0	-66609	-0.7	5.6
Value added, current prices, 100M yuan									
Depreciation	14273	0.0	0.0	21988	-5.5	-3.7	31535	-10.8	-5.1
Wages	37723	-0.3	-0.1	58422	-5.4	-1.2	84213	-4.4	6.1
Profits	33865	-0.7	-0.4	56837	-11.4	-6.1	89672	-13.3	-6.3
Taxes	14375	-0.1	-0.1	25039	-5.4	-4.9	47397	-3.4	-0.9

* - exogenous

Our results in 2005 are low compared to other studies on the subject (for example, Yang, 1996 and Li and Wang, 1998). For example, Li and Wang (1998) estimated that China's gains from the WTO entry would amount to 1.5% of their base forecast of GDP in 2005. In contrast, our study predicts a GDP increase of only 0.4% in S-II, or a contraction of –0.1% in S-I. The large gains in their study, however, are probably crucially dependent on their assumption on the MFA quota growth. In their study, quota growths for textiles and clothing are 5.0% and 6.2%, respectively while this study assumes only 1.2%. Another possible cause for the differences is the timing of the trade liberalization. Other studies tend to assume an earlier starting year, 1998 for Li and Wang (1998), for example, than the 2000 starting year for this study.

The simulation results on changes in income and consumption of rural and urban residents indicate that there will be a larger increase in income for rural residents than for urban residents. Implicitly, it suggests that the negative impact on rural income caused by the trade liberalization in the agriculture sector seems rather limited. These findings differ from those of Li and Wang (1998). In their study, urban household income would go up by 4.56% while rural household income would fall by 2.05. As a result, private consumption would increase only 0.6% compared to their base forecast. In contrast, in S-II, real consumption and income for rural residents will increase 3.2% and 4.4%, respectively, and those for urban residents will go up by 2.2% and 3.0%, respectively.

A number of factors may have contributed to the significantly positive effects of China's WTO accession on rural residents in this study. As shown in Table 50, China's WTO entry would result in a reduction in inflation, an improvement in labor productivity, an increase in employment, and expansion of overall economic activities. Lower prices reduce production costs and strengthen purchasing power. An increase in labor productivity, which is evident from the increases in the GDP employment ratio, would have a positive impact on labor income and profits. An increase in employment, or a tighter labor market, would also favorably affect wage increases. The impact would be felt by not just non-agricultural sectors, but the agricultural sector as well. As we found in the personal income equations in Chapter VIII, non-agricultural wages and profits account for about a significant portion of rural income. In fact, according to our estimates, about one quarter of the rural income is explained by income from non-agricultural sectors during the historical period[26]. Because profits and wages in non-agricultural sectors are predicted to grow faster than agricultural wages and profits in the forecast period, the portion of rural income from non-agricultural sectors becomes more important in the future than in the past. Therefore, the spillover effect on rural labor income from the growth in non-agricultural sectors may be large enough to offset any negative effect that a disruption in agricultural output may have on rural income. Of course, this is not to say that certain segments of the rural residents would not be negatively affected. Indeed, farmers competing directly with imports would likely suffer. Nevertheless, we find that the negative impact of China's WTO entry on agriculture and rural residents in Li and Wang (1998) may have been overestimated. However, we cannot rule out the possibility that differences on the assumptions of the trade liberalization measures in the agriculture sector may have played a large role. By the way, employment in the agricultural sector and rural residents are not equivalent in our model, but it is not clear whether such a distinction exists in Li and Wang (1998).

In the longer term (by 2010), China's benefits from the WTO entry are much more significant than in the shorter term (by 2005). In the more optimistic scenario (S-

[26] In the rural income equation, the coefficient on non-agricultural wage is 0.13, and the mean of non-agricultural wage is 5138. The product of 0.13 and 5138 is equal to 683. Similarly, product of the coefficient on non-agricultural profits, 0.17, and the mean, 5341, gives 899. The sum of the two is divided by the mean of rural income, 6157, resulting a ratio of 26%.

II), GDP would increase 4.5% compared to the 0.4% gain in 2005, and private consumption would increase more than 10% compared to the 2.6% gain in 2005. The GDP growth is apparently dampened by the worsening trade balances, as the percentage increases in imports (9.0% in 2005 and 16.8% in 2010 in S-II) almost triple the percentage increases in exports (3.5% in 2005 and 6.6% in 2010). This disproportional increase in imports is due to the stimulating effect of exports on domestic economic activities and of increased income, which would induce more demand on imports.

The comparison of the shorter- and longer-term results has a clear policy implication. While China eventually benefits from the WTO entry, the economy needs time to adjust. During the adjustment period, the GDP growth may become slower for an extended period of time, the nominal income may actually fall, unemployment may increase, and the trade balance may deteriorate significantly. It may be not until several years after the completion of the trade liberalization that the full benefits from the trade liberalization would be realized. Therefore, policy makers need to be aware of the duration and the difficulties of the adjustment process, and should not be too anxious about the adjustment cost of trade liberalization during the transition period. A negative backlash of the sentiment against the trade liberalization may lead to a premature termination of the reform, and therefore deny the long-term benefits that may be realized from the trade reform.

The difference between the S-II and S-I results can be loosely interpreted as a result of the MFA quota elimination. According to our simulation, the MFA quota elimination and subsequent increases in foreign demand on Chinese exports of textiles and wearing apparel would result in increases of GDP by 258 billion yuan, personal consumption by 215 billion yuan, and investment by 60 billion yuan in 2010. Our analysis seems to agree with previous studies (Bach et al., 1996; Yang, 1996; and Li and Wang, 1998) in that the MFA quota elimination is a significant factor in determining the impact of China's WTO accession. Although I have assumed a relatively moderate MFA quota growth, the magnitude of gains from the MFA growth appears to be greater than have been suggested by previous studies. Even in the relatively pessimistic scenario in which textile and clothing exports have very modest growth, our conclusion that China's WTO accession is beneficial in terms of GDP and consumption growth remains unchanged. However, our study also suggests that the increase in employment from the MFA factor seems fairly limited.

The Industrial Impact of China's WTO Accession

While the macroeconomic result suggest that China would benefit from the WTO accession under right terms, it reveals little on the impact of the WTO accession on domestic industries. Most likely, benefits of some industries would be at the expense of others. Therefore, it is important to look at the industrial details when assessing the impact of the WTO accession on the Chinese economy. In this section, I present a discussion on the effects of China's WTO accession on sectoral output, employment and imports.

Table 51 displays the change in gross output as a result of China's WTO entry. Once again, we find that the time path of output adjustments is very important. At the beginning when the trade liberalization just started, many industries would experience a minor contraction while total industrial output has either an insignificant change (-0.1% in S-I) or none at all (in S-II). By the time when trade liberalization is completed in 2005, a number of sectors still suffer contractions with various degrees. In the S-I scenario, sectors incurring significant contractions include Forestry, Furniture, Primary iron and steel, Motor vehicles, Electronic and communication equipment, and Instrument meters and office machinery. Output in each of these sectors decrease at least 1.0% from their bases. Similar output contractions would happen in the S-II scenarios although the magnitudes are different. In capital intensive industries such as Motor vehicles, Electronic and communication equipment, and Instrument, meters and office machinery, the percentage decreases in output are larger in S-II than in S-I. In contrast, labor-intensive consumer product industries such as textiles, clothing, food, beverage and tobacco products, and leather products would experience significant output growth.

Our findings that the consumer product industries tend to expand while capital product industries tend to contract by the time when trade liberalization is just completed are similar to those in Bach (1995) and Li and Wang (1998) except on the magnitudes. Consumer product industries would benefit from cheaper imports of intermediates and increases in demand due to increases in personal income. The output contraction in motor vehicles, electronic and communication equipment, instrument, meters and office machinery sectors suggest that China remains a less competitive producer of these goods.

Table 51 – Impacts of China's WTO Accession on Output

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in levels; S-I and S-II in percentage change from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
Total output, I-O sectors, constant prices									
TOTAL	153325	-0.1	0.0	226472	-0.1	0.5	322714	2.0	4.7
1 Farming	9311	-0.1	-0.1	13067	-0.6	-0.3	17869	-1.3	1.8
2 Forestry	729	-0.1	0.0	1024	-1.8	-1.5	1432	-1.3	0.8
3 Livestock	5753	-0.1	0.0	8340	1.5	2.1	11741	3.3	7.5
4 Fishing	1712	-0.1	-0.1	2536	1.0	1.0	3560	1.7	4.5
5 Coal mining	1276	-0.1	-0.1	1899	0.0	0.5	2718	2.4	4.8
6 Crude petroleum and natural gas	1547	-0.1	-0.1	2458	-0.6	-0.2	3674	0.8	3.2
7 Ferrous ore mining	146	-0.8	-0.7	234	-0.5	-1.5	342	4.5	2.2
8 Non-ferrous ore mining	302	-0.2	-0.1	452	0.1	0.1	636	2.9	3.5
9 Non-metal minerals mining and minin	1222	-0.1	-0.1	1984	-0.1	0.3	3032	2.0	3.9
10 Logging and transport of timber and b	182	-0.1	-0.1	232	0.7	0.8	295	3.4	4.7
11 Food processing and manufacturing	6899	0.1	0.1	10349	0.9	1.0	14604	1.3	3.7
12 Beverages	2224	0.0	0.0	3325	1.9	2.6	4796	5.0	9.4
13 Tobacco manufacture	1367	0.0	0.0	1813	1.8	2.4	2358	4.5	8.7
14 Textiles	7789	0.1	0.5	11096	1.2	4.1	15460	3.5	12.9
15 Wearing apparel	3067	0.1	0.5	4499	0.9	4.3	6136	3.2	13.9
16 Leather, fur and their products	1602	0.3	0.3	2313	2.3	2.8	3235	4.8	7.1
17 Sawmills and bamboo etc. products	642	-0.2	-0.2	994	-0.6	-0.1	1478	2.7	5.1
18 Furniture	966	-0.3	-0.2	1390	-1.3	-0.9	1955	1.7	3.5
19 Paper and paper products	1763	0.0	0.0	2596	0.5	1.0	3700	3.3	5.4
20 Printing industries	1099	-0.1	0.0	1806	0.3	0.8	2807	2.6	4.8
21 Culture, education, and sports articles	569	0.0	0.0	842	0.5	0.7	1220	3.4	4.7
22 Petroleum refineries and coking produ	1476	-0.1	0.0	2343	-0.2	0.3	3519	1.7	4.2
23 Chemical industries	6703	-0.1	0.0	10655	0.2	0.7	16204	2.5	5.0
24 Medicines	1642	0.0	0.0	2484	1.5	2.2	3641	5.2	9.1
25 Chemical fibers	1082	0.0	0.2	1782	0.8	2.6	2755	3.5	9.6
26 Rubber products	984	-0.2	-0.1	1476	-0.9	-0.5	2162	2.2	4.1
27 Plastic products	2494	0.0	0.0	3979	0.5	1.0	6053	3.2	5.7
28 Building materials and non-metallic n	6590	-0.1	0.0	9902	0.0	0.4	14285	2.1	3.8
29 Primary iron and steel manufacturing	4006	-0.7	-0.6	5402	-2.7	-2.7	7007	0.4	1.2
30 Primary non-ferrous metals manufactu	1141	-0.2	-0.1	1518	0.2	0.1	1936	3.3	3.6
31 Metal products	3383	-0.1	-0.1	5053	-0.1	0.3	7319	2.0	3.7
32 Machinery	7627	-0.1	-0.1	11687	-0.9	-0.5	17046	0.9	2.8
33 Railway Equipment	298	-0.1	-0.1	392	-0.1	0.4	506	2.8	5.8
34 Motor vehicles	4183	-0.7	-0.7	7132	-7.7	-8.2	11239	-5.6	-6.7
35 Ships, boats	441	0.0	0.0	706	1.1	0.9	969	4.0	3.8
36 Aerospace	184	0.0	0.1	281	-0.7	-0.1	414	0.2	2.6
37 Transportation equipment, n.e.c.	1000	0.0	0.0	1401	0.8	1.1	1858	2.7	4.9
38 Electric machinery and equipment	4283	-0.2	-0.1	6672	-0.6	-0.2	9959	2.7	4.3
39 Electronic and communication equipm	3683	-0.5	-0.4	6109	-1.7	-2.0	9681	4.4	3.9
40 Instrument, meters and office machine	840	-0.3	-0.3	1208	-1.0	-1.1	1663	2.9	3.2
41 Manufacture, n.e.c.	3413	0.0	0.1	5222	1.5	1.8	7601	4.8	6.3
42 Electricity, steam and hot water	2531	-0.1	-0.1	4100	0.1	0.6	6253	2.6	5.1
43 Gas utility	125	0.0	0.0	208	1.9	2.6	314	6.0	10.9
44 Water	237	-0.1	0.0	385	0.5	1.0	586	3.0	5.9
45 Construction	12839	-0.1	0.0	17589	0.2	0.5	23480	1.7	3.5
46 Railway transportation	642	0.0	0.0	767	0.5	1.2	911	2.5	5.7
47 Highway transportation	2751	-0.1	0.0	4146	0.5	1.1	6012	3.3	6.5
48 Water transportation	729	0.0	0.1	1072	0.5	1.3	1520	2.3	5.5
49 Air transportation	396	0.1	0.3	639	0.8	1.9	971	2.2	5.6
50 Pipeline transportation	33	-0.1	0.0	48	-0.1	0.4	69	1.9	4.4
51 Post and communications	971	-0.1	0.0	1613	0.1	0.6	2508	2.0	4.1
52 Commerce	9686	-0.1	0.0	13315	0.2	0.8	17724	2.7	5.6
53 Restaurants	1865	0.0	0.0	2536	0.9	1.0	3404	1.6	3.0
54 Finance and insurance	4323	-0.1	-0.1	6721	-0.2	0.3	9959	2.2	4.9
55 Real estate, and social services	3705	-0.1	0.0	5336	0.5	1.1	7448	3.1	5.9
56 Health care, sports and social welfare	1102	0.0	0.0	1519	1.2	1.8	2038	3.9	7.3
57 Education, culture, arts, movie and an	1566	-0.1	0.0	2162	0.6	1.6	3076	5.3	8.5
58 Scientific research and polytechnic ser	1195	0.0	0.0	1498	0.0	0.3	1869	0.8	1.8
59 Public administration and others	3010	0.0	0.0	4162	-0.1	-0.1	5707	0.1	0.2

An important difference between this study and several previous studies lies in the time horizon. While other studies usually stopped at 2005, our study continues to 2010. The simulation results in our study suggest that the impact of China's WTO entry on industrial output may be very different in the longer term than in the short term. When we look at China's industrial output beyond 2005, in 2010 in this case, only a handful of industries are still suffering from an output contraction, including Farming and Forestry in the S-I scenario, and Motor vehicles in both scenarios. For all other industries, output is at a higher level than in the benchmark by 2010. Therefore, we find that the impact of China's WTO entry on industrial output is much more positive in the long term than have been suggested in the shorter-term results. Looking only at the short term impact can be misleading.

The impact of China's WTO entry on the Motor vehicles sector is negative in both scenarios. Therefore, we find that the reduction of tariff and non-tariff barriers would lead to significant contractions in the industry. Furthermore, a stronger economy (S-II) seems to lead to larger contraction in the industry. This seems counter intuitive. However, a closer examination of the simulation results provides an answer. Recall that, in order to estimate domestic demand on foreign imports, MuDan uses import share of domestic demand, which equals output plus imports less exports. The import share is explained by a time trend and the relative foreign to domestic prices. In both scenarios S-I and S-II, import prices for Motor vehicles are assumed to be the same. However, domestic price levels are higher in the stronger economy (S-II) than in S-I. Furthermore, the price elasticity of the import share for Motor vehicles is relatively large at –2.0. Therefore, even a small change in relative prices may lead to a large change in the import share. Consequently, the import share for Motor vehicles is larger in S-II than in S-I. Our simulation results show that the import share for Motor vehicles will be 1.8% higher in S-II than in S-I in 2010. Import shares for Motor vehicles and a selected number of other sectors that show a change in the import share of at least 0.5-percentage points are shown in Table 52.

Table 52 – Impact of China's WTO Entry on Import Shares

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in percentage; S-I, S-II in deviations from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
Import Shares (%)									
34 Motor vehicles	12.9	0.4	0.4	13.2	4.2	4.7	13.8	3.8	5.3
15 Wearing apparel	6.3	0.2	0.2	9.1	2.6	2.9	12.2	2.8	4.2
1 Farming	1.3	0.2	0.2	1.1	1.7	1.7	0.8	3.2	3.2
2 Forestry	3.9	0.0	0.0	3.5	1.5	1.5	2.9	3.1	3.1
18 Furniture	6.2	0.3	0.3	6.9	2.4	2.6	7.7	2.1	2.8
29 Primary iron and steel manufacturing	8.2	0.5	0.5	4.2	2.2	2.5	2.5	1.1	1.9
39 Electronic and communication equipm	26.5	0.4	0.4	21.5	1.9	2.6	18.6	-0.3	1.8
40 Instrument, meters and office machine	17.5	0.3	0.3	15.2	1.2	1.8	14.0	-0.2	1.4
21 Culture, education, and sports articles	11.8	0.0	0.0	12.0	0.3	0.6	12.4	-0.1	0.9
4 Fishing	1.0	0.1	0.1	1.7	0.3	0.4	2.7	0.5	0.8
38 Electric machinery and equipment	12.6	0.1	0.1	10.8	0.6	0.7	9.6	0.1	0.7
35 Ships, boats	17.6	0.0	0.0	17.1	-0.8	-0.3	18.0	-2.3	-0.7
41 Manufacture, n.e.c.	11.4	0.0	0.0	11.6	-0.7	-0.5	12.0	-1.6	-0.8
10 Logging and transport of timber and b	14.6	0.0	0.0	13.7	-0.9	-0.6	12.4	-1.7	-0.8

The simulation results on output indicate that output of Farming and Motor vehicles may be negatively affected while that of Textiles and Wearing apparel may incur the largest expansions. However, the output results alone do not explain how other industries will be affected by these sectors. The next two tables provide answers to the inter-industrial dependencies. Table 53 lists main users of these products, and Table 54 displays main suppliers in making these products. In both tables, we display only the sectors that experience a change of at least 3% in uses of the product or in the value they supply to the concerned product.

Table 53 – Changes in the Use of Farming, Textiles, Wearing Apparel and Motor Vehicles

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in 100M yuan in 1992 prices; S-I, S-II in deviations from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
	Seller: 1 Farming								
Buyers:									
1 Farming	1025	-2	-1	1500	-9	-5	2140	-29	39
3 Livestock	1176	-1	0	1779	27	37	2612	86	196
11 Food process & manufacturing	2251	1	2	3523	32	34	5184	68	192
12 Beverages	536	0	0	836	16	22	1257	63	118
14 Textiles	708	1	3	1052	12	44	1528	54	197
SUM: Intermediate	6666	-1	4	10160	91	151	14878	314	872
Consumption of Rural Households	1366	1	1	1270	5	-5	1117	-24	-36
Consumption of Urban Households	1124	1	1	1404	29	19	1558	20	57
Imports	-120	-18	-18	-137	-220	-221	-148	-569	-593
Output	9311	-14	-10	13067	-80	-41	17869	-239	322
	Seller: 14 Textiles								
Buyers:									
14 Textiles	2684	4	13	3833	45	159	5349	188	689
15 Wearing apparel	1320	2	7	1941	18	83	2651	85	368
41 Industries n.e.c	407	0	0	624	9	11	910	43	57
SUM: Intermediate	5686	5	19	8308	73	261	11676	383	1240
Consumption of Rural Households	658	-1	-1	909	19	37	1371	162	260
Consumption of Urban Households	480	-1	-1	634	10	14	803	40	73
Export	1642	8	20	2347	56	195	3328	80	649
Imports	-1126	-1	-3	-1749	-36	-75	-2621	-153	-347
Output	7789	11	36	11096	129	459	15460	544	1991
	Seller: 15 Wearing apparel								
Buyers:									
52 Commerce	20	0	0	20	0	0	21	1	1
59 Public administration and others	6	0	0	7	0	0	7	0	0
SUM: Intermediate	202	0	0	222	0	2	247	6	13
Consumption of Rural Households	476	-1	-1	696	17	29	1084	134	214
Consumption of Urban Households	718	-2	-1	1123	18	24	1604	81	150
Export	1604	10	19	2417	68	201	3255	91	635
Imports	-99	-3	-3	-208	-63	-74	-401	-127	-209
Output	3067	4	15	4499	41	191	6136	196	852
	Seller: Motor vehicles to:								
Buyers:									
34 Motor vehicles	1542	-11	-11	2896	-223	-236	4890	-274	-325
47 Highway transportation	351	0	0	582	3	7	904	30	58
52 Commerce	251	0	0	380	1	3	541	15	30
55 Real estate and social services	77	0	0	122	1	1	182	6	11
59 Public administration and others	149	0	0	228	0	0	334	0	1
SUM: Intermediate	3394	-13	-12	5893	-220	-220	9444	-167	-114
Fixed investment	1095	-1	0	1780	2	8	2738	39	78
Imports	-615	-15	-16	-1074	-298	-335	-1790	-468	-675
Output	4183	-31	-29	7132	-549	-582	11239	-630	-748

According to Table 53, changes in output in the Farming sector appear mainly due to changes in intermediate demand by other consumer product industries, which include Livestock, Food processing and manufacturing, Beverages, and Textiles. Since the import share of Farming is fixed by assumption at 4% in 2010, a large enough increase in domestic demand would almost for sure lead to expansion of domestic production. Given the significant increases in demand by other industries, the increase in output of Farming in 2010 naturally follows.

In the Textiles sector, the increase in textile exports accounts for only one third of the total increase in domestic production. The intermediate use of the Textiles industry appears slightly more important than exports in driving the expansion of the industry, and it also accounts for one third of the increase in domestic production in 2010. The intermediate demand by the Wearing apparel sector and the final demand by rural households together explain the remaining increase in domestic output.

For Wearing apparel, the expansion seems clearly driven by increases in export demand. However, increases in personal consumption demand on wearing apparel also are responsible for the industry's expansion.

For the Motor vehicles sector, it seems obvious that the increase in imports is the culprit for the contraction of the industry, as both intermediate and final demand on motor vehicles are on the rise while the industry suffers a contraction.

Table 54 displays the industries that are affected most by the rise or fall of the Farming, Textiles, Wearing apparel, and Motor vehicles industries. For both the Textiles and Motor vehicles industries, a change in their output will require a significant change in demand of their own products. For Farming, the Chemicals industry appears to be more importantly affected than any other industries. For Wearing apparel, the industry affected most by its change in output is the Textiles industry. Obviously, these results merely reflect the I-O coefficients. However, they are interesting because they reveal the interdependencies of industries.

Table 54 – Industries Most Affected by Changes in Output in Farming, Textiles, Wearing Apparel and Motor Vehicles

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in 100M yuan in 1992 prices; S-I, S-II in deviations from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
	Buyer: Farming								
Sellers:									
1 Farming	1025	-2	-1	1500	-9	-5	2140	-29	39
23 Chemical industries	1337	-2	-1	1946	-12	-6	2735	-37	49
SUM: Intermediate	3779	-6	-4	5452	-34	-17	7636	-102	138
	Buyer: 14 Textiles								
Sellers:									
1 Farming	708	1	3	1052	12	44	1528	54	197
3 Livestock	606	1	3	941	11	39	1397	49	180
14 Textiles	2684	4	13	3833	45	159	5349	188	689
23 Chemical industries	231	0	1	341	4	14	489	17	63
25 Chemical fibres	634	1	3	980	11	41	1450	51	187
52 Commerce	528	1	2	679	8	28	866	30	111
SUM: Intermediate	6312	9	29	9184	107	380	13021	458	1677
	Buyer: 15 Wearing apparel								
Sellers:									
3 Livestock	277	0	1	444	4	19	645	21	90
14 Textiles	1320	2	7	1941	18	83	2651	85	368
41 Industries n.e.c	114	0	1	179	2	8	256	8	36
52 Commerce	261	0	1	346	3	15	432	14	60
SUM: Intermediate	2373	3	12	3515	32	150	4832	155	671
	Buyer: 34 Motor Vehicles								
Sellers:									
26 Rubber products	164	-1	-1	277	-21	-23	434	-24	-29
28 Building materials and other non-meta	77	-1	-1	138	-11	-11	225	-13	-15
29 Primary iron and steel manufacturing	173	-1	-1	261	-20	-21	371	-21	-25
32 Machinery	411	-3	-3	735	-57	-60	1198	-67	-80
34 Motor vehicles	1542	-11	-11	2896	-223	-236	4890	-274	-325
38 Electric machinery and instrument	92	-1	-1	158	-12	-13	252	-14	-17
52 Commerce	228	-2	-2	351	-27	-29	507	-28	-34
54 Finance and insurance	117	-1	-1	208	-16	-17	339	-19	-23
SUM: Intermediate	3159	-23	-22	5633	-434	-460	9180	-515	-611

Finally, I report the simulation results on net exports and employment. Table 55 displays changes in net exports by sector. As shown in the table, the reduction of tariffs and non-tariff barriers lead to net imports for all but a handful of industries. Industries having the largest surge in the value of net imports include Motor vehicles, Farming, Electronic equipment, Machinery, and Food processing and manufacturing. A handful of industries will have a positive net export. The most significant ones are Textiles, and Wearing apparel. This widespread worsening of trade balances may potentially cause a balance of payment problem. While macroeconomic policy should be preferred instrument in dealing with the external imbalances, trade policies such as the balance payment provisions in China's WTO protocols may be needed to provide a last resort in case there is severe external imbalances.

The simulation results on the impact of China's WTO entry on employment are reported in Table 56. Industries with the largest percentage increases in employment in 2010 include Textiles (10.4%), Wearing apparel (9.3%), Tobacco (7.8%), Gas utilities (7.3%), and Beverages (6.0%). However, the Motor vehicles sector suffered the worst percentage loss with a reduction of employment by 6.7% in 2010. Industries gaining the most number of jobs include Agriculture (3.3 million), Commerce (1.4 million), Education, culture and entertainment (1.1million) and Textiles (0.9 million). Sectors with the most number of job losses include the Government (0.5 million) and Transportation (0.4 million).

Table 55 – The Impact of China's WTO Entry on Net Exports

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in levels; S-I, S-II in deviation from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
Net exports, I-O sectors, constant prices									
TOTAL	1316	-36	-21	2452	-749	-733	3296	-1657	-1980
1 Farming	130	-15	-15	188	-204	-205	248	-550	-573
2 Forestry	-25	0	0	-30	-15	-16	-35	-47	-49
3 Livestock	30	-6	-6	40	-25	-26	52	-61	-65
4 Fishing	20	-2	-2	11	-9	-10	-29	-22	-34
5 Coal mining	46	0	0	59	0	0	69	0	0
6 Crude petroleum and natural gas	-41	0	0	-154	-12	-14	-359	-51	-67
7 Ferrous ore mining	-114	0	0	-160	5	2	-222	7	-6
8 Non-ferrous ore mining	8	0	0	16	0	0	26	0	0
9 Non-metal minerals mining and minin	39	0	0	62	0	0	87	1	-2
10 Logging and transport of timber and b	-28	0	0	-33	2	1	-37	5	1
11 Food processing and manufacturing	180	3	3	139	-40	-40	-14	-142	-175
12 Beverages	-4	0	0	-18	-2	-3	-40	-7	-15
13 Tobacco manufacture	20	0	0	33	-2	-3	47	-3	-4
14 Textiles	515	7	16	599	20	120	707	-74	302
15 Wearing apparel	1505	7	17	2209	5	126	2854	-35	425
16 Leather, fur and their products	492	5	4	570	25	20	585	-3	-33
17 Sawmills and bamboo etc. products	-55	-1	-1	-52	-5	-6	-45	-7	-11
18 Furniture	209	-2	-2	331	-25	-28	493	-35	-51
19 Paper and paper products	-110	0	0	-226	2	-3	-423	-12	-45
20 Printing industries	-4	0	0	4	0	0	26	1	-1
21 Culture, education, and sports articles	125	0	0	172	-1	-4	235	-2	-17
22 Petroleum refineries and coking produ	-190	1	0	-373	-5	-7	-651	-37	-57
23 Chemical industries	-623	1	1	-863	6	-11	-1152	-15	-118
24 Medicines	11	0	0	-8	-1	-3	-55	-10	-27
25 Chemical fibers	-98	0	-1	-111	-4	-9	-119	-3	-19
26 Rubber products	25	0	0	31	2	0	46	3	-6
27 Plastic products	225	1	1	354	10	9	527	16	10
28 Building materials and non-metallic n	111	1	1	184	6	2	276	14	-8
29 Primary iron and steel manufacturing	-204	-20	-21	-4	-113	-132	174	-76	-134
30 Primary non-ferrous metals manufactu	-23	0	0	53	9	4	134	19	3
31 Metal products	256	-1	-1	514	-10	-13	945	-7	-22
32 Machinery	-1533	4	3	-2186	-19	-30	-2993	-146	-222
33 Railway Equipment	15	0	0	14	0	0	13	0	0
34 Motor vehicles	-579	-15	-16	-1026	-298	-335	-1727	-467	-674
35 Ships, boats	-58	0	0	-103	6	1	-164	24	2
36 Aerospace	-178	0	0	-267	0	-2	-385	-8	-18
37 Transportation equipment, n.e.c.	46	0	0	70	0	0	95	1	-2
38 Electric machinery and equipment	147	-2	-2	295	-31	-45	534	-34	-111
39 Electronic and communication equipn	107	-8	-8	617	-87	-132	1418	-41	-259
40 Instrument, meters and office machine	2	-2	-2	60	-11	-18	128	0	-31
41 Manufacture, n.e.c.	342	3	3	402	54	39	437	120	34
42 Electricity, steam and hot water	-5	0	0	-11	0	0	-17	0	-1

Table 56 – The Impact of China's WTO Entry on Employment

Base: Benchmark forecast
S-I: WTO entry with restrictive MFA quota growth on Chinese exports.
S-II: WTO entry with moderate MFA quota growth on Chinese exports.
(Base in levels; S-I, S-II in deviation from Base)

	2000			2005			2010		
	Base	S-I	S-II	Base	S-I	S-II	Base	S-I	S-II
Total employment, 10,000 people									
Total	62879	-55	-30	65263	72	360	67415	814	848
1 Agriculture	33275	-39	-24	32471	70	184	31745	94	326
2 Coal mining	899	0	0	1077	-1	3	1245	22	13
3 Crude petroleum and natural gas	186	0	0	236	-2	-1	283	0	-2
4 Ferrous ore mining	36	0	0	37	0	-1	32	1	0
5 Non-ferrous ore mining	93	0	0	96	0	0	95	2	0
6 Non-metal minerals mining and minin	292	0	0	302	-1	0	295	4	1
7 Logging and transport of timber and ba	91	0	0	115	1	1	144	4	2
8 Food processing and manufacturing	621	0	0	629	5	6	559	5	-1
9 Beverages	285	0	0	302	6	8	288	14	17
10 Tobacco manufacture	55	0	0	60	1	2	61	4	5
11 Textiles	786	0	1	848	10	36	841	31	88
12 Wearing apparel	445	0	2	453	4	16	410	10	38
13 Leather, fur and their products	314	0	0	324	7	9	324	15	9
14 Sawmills and bamboo etc. products	120	0	0	141	-1	0	163	4	3
15 Furniture	84	0	0	90	-1	-1	90	1	1
16 Paper and paper products	292	0	0	310	1	2	318	9	6
17 Printing industries	216	0	0	259	0	1	291	5	0
18 Culture, education, and sports articles	176	0	0	197	0	1	220	5	1
19 Petroleum refineries and coking produ	144	0	0	232	-1	0	355	4	2
20 Chemical industries	836	0	0	1001	-1	4	1144	19	5
21 Medicines	159	0	0	174	2	3	173	7	8
22 Chemical fibers	90	0	0	104	1	2	113	3	6
23 Rubber products	158	0	0	189	-2	-1	222	3	0
24 Plastic products	242	0	0	247	1	2	224	6	3
25 Building materials and non-metallic m	1575	0	0	1625	-3	2	1638	22	-7
26 Primary iron and steel manufacturing	495	-3	-2	563	-15	-15	618	0	-11
27 Primary non-ferrous metals manufactu	170	0	0	208	-1	-1	266	12	2
28 Metal products	602	0	0	683	-1	1	754	11	3
29 Machinery	1054	-1	-1	1092	-15	-10	1180	7	-13
30 Transportation equipment	564	-2	-1	607	-30	-30	606	-24	-41
31 Electric machinery and equipment	423	0	0	427	-4	-2	388	9	0
32 Electronic and communication equipm	339	-1	-1	422	-9	-10	482	19	1
33 Instrument, meters and office machine	114	0	0	119	-1	-1	117	3	0
34 Manufacture, n.e.c.	410	0	0	407	4	6	353	13	5
35 Electricity, steam and hot water	263	0	0	326	0	1	387	10	8
36 Gas utility	23	0	0	23	0	1	20	1	1
37 Water	59	0	0	75	0	1	88	2	2
38 Construction	3491	-2	-1	3511	3	16	3441	47	15
39 Railway transportation	301	0	0	336	2	4	378	9	10
40 Highway transportation	894	-1	0	1088	5	12	1275	39	43
41 Water transportation	292	0	0	377	2	5	471	9	11
42 Air transportation	26	0	0	32	0	1	38	1	1
43 Pipeline transportation	5	0	0	7	0	0	9	0	0
44 Post and communications	145	0	0	167	0	1	188	3	2
45 Commerce	4468	-3	-1	5259	7	38	6070	137	135
46 Restaurants	595	0	0	599	5	6	564	8	0
47 Finance and insurance	788	0	0	930	-3	2	1070	18	5
48 Real estate, and social services	1205	-1	0	1543	7	16	1908	53	51
49 Health care, sports and social welfare	645	0	0	715	9	13	781	28	33
50 Education, culture, arts, movie and an	1813	-1	0	2034	10	28	2415	106	112
51 Scientific research and polytechnic ser	558	0	0	563	0	1	551	3	-6
52 Public administration and others	1670	0	0	1632	-2	-2	1725	-3	-45

Conclusions

Through a simulation analysis using the MuDan model, we find that China would benefit from a WTO membership. The longer the term, the larger the benefits. In particular, elimination of MFA quotas and expansion of foreign demand on Chinese exports of textiles and wearing apparel are very important in determining the benefits from the WTO accession. Under a favorable scenario in which China can achieve modest growth in exports of textiles and wearing apparel, this analysis finds that China's GDP would increase by 4.5% in 2010. The combination of lower costs of imports and expansion of exports would lead to a significant increase in personal income and employment opportunities. However, China's trade surplus would significantly shrink, as imports would outgrow exports when both China and its trading partners fulfill the trade liberalization commitments. Except in the textiles and wearing apparel industries, however, almost all other industries would experience a net increase in imports. To avoid a possible balance of payment crisis, macroeconomic policies are necessary to maintain a stable economic environment so that trade liberalization can be carried out and the potential gains can be realized.

While trade liberalization in the agriculture sector may lead to minor contraction in the agriculture sector, rural residents would benefit greatly from China's entry to the WTO. Significant increases in real income and consumption will result.

The impact of China's WTO accession would not be evenly distributed among industries. Furthermore, the dynamic time path of economic adjustment is important. Although many industries may initially suffer output disruptions, trade liberalization benefits most industries in the longer term. Analysis focusing only on shorter-term impact may be misleading.

While labor intensive and consumer product industries tend to benefit from China's WTO accession, capital intensive industries may suffer contractions, particularly in the initial period. However, our simulation results suggest that in the motor vehicle industry, the most protected sector in the Chinese economy prior to trade liberalization, output will be substantially negatively affected, and the industry will not recover even after an extended period of time.

It should be emphasized that there are many limitations of this study, as a number of simplified assumptions have been made. Therefore, the results should be interpreted accordingly. In determining foreign demand on China's exports, for example, the dynamic impact of the export prices has been overlooked. Similarly, it may be too simplistic to assume China to be price taker in the international market, as China is an important player in the international market for textile and clothing products. By using this MuDan model in connection with the INFORUM international system, Nyhus (1999) conducted a separate study on the impact of China's WTO entry on the Chinese economy. While different assumptions are made on tariff and non-tariff reductions, the two studies share many similar basic conclusions. In particular, his conclusion of a 4.0% increase in GDP in 2010 when China joins the WTO is very close to the 4.5% GDP increase that this study finds.

CHAPTER XI :

CONCLUSIONS AND DIRECTIONS FOR FURTHER WORK

This study is about construction and application of MuDan, a multisectoral dynamic macroeconomic model of the Chinese economy. It is built with the input-output techniques and extensive use of regression analysis. Through the modeling exercise, I have gained and hope to have conveyed to the reader some understanding of China's economic development in the last two decades. This understanding shaped the specification of equations and construction of the model. In addition, I have demonstrated the use of the model in forecasting and by conducting a simulation analysis to evaluate the impact of China's accession to the World Trade Organization.

The strengths of the MuDan model lie in its bottom-up approach in constructing the model, its reliance on historical time series, and its extensive use of regression analysis. By employing the bottom-up approach, the model determines macroeconomic aggregates by summing up individually modeled sectoral and commodity level results, and therefore can provide richer simulation results than can models relying on a top-down approach. The time-series based regression analysis enables the model not only to predict the economy at some future date, but also to provide a time path of economic variables.

MuDan employs two consumption demand systems, one for rural and the other for urban residents. Each of the two demand systems uses a nonlinear specification on the price, income, and a time trend as explanatory variables and is estimated through a system of equations for all consumption categories, which include 10 categories for rural residents and 24 for urban residents. This non-linear specification allows substitutions and complementarities among categories, providing rich and more realistic simulation results than more commonly used linear specifications such as the AIDS system.

The investment functions in MuDan use the specification of a simple accelerator model, which includes an acceleration term, a replacement term, and a time trend. Several “priority” investment sectors were uncovered during the estimation of the investment functions, leading to the creation of a vector of investment policy control variables that can be used to quantify investment priorities.

MuDan’s import share equations use the relative price of foreign imports to domestic production as the primary explanatory variables. Sectoral imports are determined simultaneously with sectoral output through an iterative process.

In the productivity functions, efforts are made to explore the possible link between investment and productivity through the buildup of capital stock. The results, however, are mixed with limited success for simulation.

MuDan distinguishes four types of value-added components: wages, profits, depreciation and taxes. Two aggregate wage equations are specified with inflation and the unemployment rate as explanatory variables. The aggregate productivity for non-agricultural sectors is used as an additional variable in the non-agricultural wage equation. Sectoral profits respond to output expansion and the labor market conditions. Depreciation is explained by capital stock. Taxes per unit of real output are modeled with exogenous trends. While wages and profits are linked to personal income, depreciation and taxes are used only to determine the output prices.

MuDan is probably the only multisectoral dynamic macroeconomic model of the Chinese economy with significant disaggregation that is in active use. The sectoral details involved in the MuDan model are unprecedented. Therefore, MuDan can be used for applications where other China models are inadequate.

One of the most challenging tasks in building the MuDan model is to collect and process the data. Because the significant detail in the model, an extensive body of time series data is needed. Given the developing nature of China's statistical system and the reforming economy, the routine problems that have been encountered during the process of constructing the model include inconsistent national account information, unavailable sectoral detail, and ever changing statistical coverage and classification systems. Keeping up with the changing statistical system proves to be difficult, as evidenced from the fact that this study uses historical data only up to 1994. Because of a major shift in statistical classifications for data after 1994 and lack of pre-1995 data under the new classification, utilizing more recent data would involve converting the pre-1995 data into the new system, re-balancing the macroeconomic and sectoral data, and re-estimating the equations in the model. Because of time involved in the process, it seems that such an effort is better left for further work, and the update should be given a top priority.

The changing structure of the Chinese economy poses another challenge. As the Chinese economy moves away from central planning toward a market oriented system, the regime changes may discount the relevance of information contained in historical time series. On the other hand, the development of a market-oriented economic system also brings opportunities for improving equation specifications and model performance, as economic variables such as the interest rate and unemployment become more relevant and may play a more important role in connecting different components of the model.

The extensive body of data from the 1995 Industrial Census provides a possible direction for improving the current version of the model. Because many of the sectoral data in the current version of MuDan were compiled from many different sources, reconciliation of data from different sources was a major concern. The 1995 Industrial

Census data not only supply a consistent set of data, but also provide a link between the time series of data under the old and the new classifications. They also can help reconcile the differences in historical data from various sources.

One of the weaknesses of the model, as it stands now, is its lack of an autonomous converging mechanism. That is, the role of labor supply as a real anchor and the money supply as a nominal anchor of the model is rather weak. Although the urban and rural savings rates, through a link with the unemployment rate, can stabilize the model, there is no other real or nominal anchor that is strong enough to balance demand and supply to help the model converge. I have estimated an interest rate equation, and used the interest rate to influence the savings behavior. I have also used the unemployment rate to explain variables such as profits and wages. However, these links are weak in the model because historically, these variables had not played the purported role and, therefore, evidences in historical time series to support these relationships might not be strong. As the model incorporates more recent data that reflect the increasingly market oriented economy, it may be easier to establish the classical role of money and labor supply conditions as the nominal and real anchors and to find the support from the newly added data. The establishment of such an anchoring mechanism should be a high priority for further work.

Another direction for further work is to elucidate the price formation mechanism. Because of the advancement in transforming the Chinese economy into a market oriented system, the time seems right to clarify on the relationship between investment, capital stock, potential output, and prices. Theoretically, it is relatively easy to specify a relationship between the labor market conditions and prices. For example, the unemployment rate has a negative impact on wages, which feed into prices. Similarly, it is also easy to specify a positive relationship between the capacity utilization and profits: higher capacity utilization translates into higher profits, which also feed into prices. Attempts have been made to establish these relationships in the current version of MuDan. For example, in the aggregate wage rate equations, the unemployment rate is used to explain the aggregate wage rates. Due to lack of data on capacity utilization, however, profits as a markup over the full cost is determined by change in current output and the inverse of unemployment rate. One possible improvement would be to make the profits depend positively on the capital-output ratio. Another would be to construct complete production functions to project labor and capital requirements. However, any satisfactory solution depends on the acquisition of data on wages and profits, and on disaggregated investment and capital stock. The newly available data from the 1995 Industrial Census may help shed lights on these aspects.

Building the MuDan model is a continuing process. Both the databases and the equation specifications are constantly being improved as new information and new economic theory become available. As a multisectoral dynamic macroeconomic model, MuDan can provide a consistent framework to analyze economic issues that have both macro and industrial consequences. Therefore, MuDan can be a useful tool for assisting government and business in making economic planning and business decisions.

APPENDIX A :

DEFINITION OF MUDAN SECTORS

MuDan's Output Sectors

MuDan's output sectors are defined based on the 1994 version of China's Standard Industrial Classification and Codes for National Economic Activities ("SICC") and the 1992 I-O tables. In most cases, the mapping from the I-O sectors to the MuDan sectors involves simply aggregations. That is, one or several I-O sectors are mapped to one single MuDan sector. However, because the 1992 I-O table was based on a hybrid of the 1984 and 1994 versions of SICC, the mapping for some I-O sectors involves more than aggregations. In these cases, one I-O sector has to be disaggregated into several sub-sectors, and each sub-sector is mapped into a MuDan sector.

Table A.1 defines the MuDan sectors in terms of the SICC codes, and describes the mapping from the 1992 I-O sectors to the MuDan sectors. The first two columns in Table A.1 show the sector numbers and titles of MuDan sectors. The third column, marked as I-O Sector, shows the sector number in the 1992 I-O table. The column marked as SICC94 shows the 1994 version SICC codes, and the column marked as SICC84 shows the 1984 version SICC codes. Any special notes are indicated in the last column.

Table A.1 – Definition of MuDan Sectors

	Sector number and title	I-O Sector	SICC 94	SICC 84	Special Notes
1	Farming	011	011	011	
		014	019	019	Note 1
2	Forestry	012	02	03	
3	Livestock	013	03	04	Note 1
4	Fishing	015	04	05	
5	Coal mining	02	06	08	
6	Crude petroleum and natural gas	03	07	09	
7	Ferrous ore mining	041	08	10	
8	Non-ferrous ore mining	042	09	11	
9	Non-metal minerals mining and mining, n.e.c.	051	10	12	
		052	(103)	13	Note 2
			11	14	Note 3
10	Logging and transport of timber and bamboo	053	12	15	
11	Food processing and manufacturing	061	13	17	
			14	18	
			(1498)	1934	Note 4
		064	(131pt)	21	Note 5
12	Beverages	062	15	19	Notes 6 and 7
				[1934]	1934_84C => 1498_94C
13	Tobacco manufacture	063	16	20	
14	Textiles	07	17	22	
15	Wearing apparel	081	18	24	
16	Leather, fur and their products	082	19	25	
17	Sawmills and bamboo etc. products	091	20	26	
18	Furniture	092	21	27	
19	Paper and paper products	101	22	28	
20	Printing industries	102	231	29	
			232		Note 8
21	Culture, education, and sports articles	103pt	24	30	
22	Petroleum refineries and coking products	12	251	34	
				[3489pt]	3489pt_84C => 3487_94C
			252		
			253		
		13001	257	351	
23	Chemical industries	141	26	36	
				37	
24	Medicines	142	27	38	
25	Chemical fibers	143	28	40	
26	Rubber products	144	29	41	
				42	
27	Plastic products	145	30	43	
				44	

Table A.1 – Definition of MuDan Sectors (Cont.)

	Sector number and title	I-O Sector	SICC 94	SICC 84	Special Notes
28	Building materials and non-metallic mineral products, n.e.c.	15pt	31	45	
				[4552]	4552_84C => 4351_94C
				[4553]	4553_84C => 4353_94C
				46	
29	Primary iron and steel manufacturing	161	32	48	
30	Primary non-ferrous metals manufacturing	162	33	49	
31	Metal products	17pt	34	51	
				52	
				[5215]	5215_84C => 4355_94C
			(3487)	3489pt	
32	Machinery	18pt	35	53	
			36	54	
		[18006pt]		[547]	547_84C => 425_94C
		[18005pt]		[5481]	5481_84C => 3740_94C
		[18005pt]		[5483]	5483_84C => 4260_94C
		[18005pt]		[5484]	5484_84C => 4254_94C
				55	
		23000pt	(358)	(558pt)	Repair
		23000pt	(368)	(558pt)	Repair
33	Railway Equipment	19001	371	561	
		23000pt	3781	5681	Repair
34	Motor vehicles	19002	372	562	
		23000pt	3782	5682	Repair
35	Ships, boats	19003	376	565	
		23000pt	3785	5684	Repair
36	Aerospace	19004	377	567	
		23000pt	3786	5685	Repair
37	Transportation equipment, n.e.c.	19009	373	563	
		18005pt	374	5481	Bicycles
			375	564	
			379	569	
		23000pt	3783 - 84	5683	Repair
			3789	5689	
38	Electric machinery and equipment	20	40	58	
		23000pt	(408)	(588)	Repair
39	Electronic and communication equipment	21	41	60	
				61	
		23000pt	(418)	(618)	Repair
40	Instrument, meters and office machinery	22	42	63	
		18006pt	(425pt)	547	Office machinery
		18005pt	(4254)	5484	Cameras
		18005pt	(426)	5483	Watches and clocks
		23000pt	(428)	(638)	Repair

Table A.1 – Definition of MuDan Sectors (Cont.)

	Sector number and title	I-O Sector	SICC 94	SICC 84	Special Notes
41	Manufacture, n.e.c.	24	43	66	
		10300pt	(431)	31	
			(4351)	4552	
			(4353)	4553	
			(4355)	5215	
		13002pt	(4392)	3530pt	
42	Electricity, steam and hot water	11	44	33	
43	Gas utility	13002pt	45	352	
44	Water	054	46	16	
45	Construction	25	47	69	
			48	70	
			49	71	
46	Railway transportation	26101	52pt	731pt	Note 9
			575pt	736pt	
		29001	52pt	731pt	
47	Highway transportation	26102	53pt	732pt	Note 9
			571		
			575pt	736pt	
			58		
		29002	53pt	732pt	
48	Water transportation	26103	55pt	734pt	Note 9
			572		
			573		
			575pt	736pt	
		29003	55pt	734pt	
49	Air transportation	26104	56pt	735pt	Note 9
			574		
			575pt	736pt	
		29004	56pt	735pt	
50	Pipeline transportation	26105	54	733	
51	Post and communications	262	60	74	
52	Commerce	27201	61 - 65	75	
		27202			
		271pt		78	
		271pt	59	79	
53	Restaurants	28	67	77	
54	Finance and insurance	32	68	93	
			70	94	
55	Real estate, and social services	30	72 - 74	80	
			75 - 81	81 - 82	

Table A.1 – Definition of MuDan Sectors (Cont.)

	Sector number and title	I-O Sector	SICC 94	SICC 84	Special Notes
56	Health care, sports and social welfare	31101	85	84	
		31102	86	85	
		31103	87	86	
57	Education, culture, arts, movie and amusements	31201	89	87	
		31202	90	88	
			91	89	
58	Scientific research and polytechnic services	31302	05	07	
			50	76	
			51	06	
			82 - 84	83	
59	Public administration and others	33	94 - 99	95 - 99	

Notes: 1. Until recently, these activities were not reported according to the official classification system, but were included under subsidiary agricultural activity.
2. A number in parenthesis indicates a subcategory of an already mentioned category. For example, (103) indicates that this is a subcategory of the already mentioned category 10.
3. This output was not included in Mudan II
4. The gray areas are minor adjustments that are not planned.
5. A suffix "pt" indicates "part of". For example, 131pt means part of 131.
6. Square brackets [ ] indicate a subcategoriy deducted from a main category.
7. The suffix _84C indicates the 1984 classification of economic activity and the suffix _94C indicates the 1994 classification.
8. New in the 1994 classification.
9. Freight and passenger transport have been combined.

MuDan's Aggregate Sectors

In addition to the 59 sectors that are defined in the previous section, MuDan also uses 52 aggregate sectors primarily in employment and investment. The following table lists MuDan's aggregate sectors.

Table A.2 – MuDan's Aggregate Sectors

	Descriptions		Descriptions
1	Agriculture	27	Primary non-ferrous metals manufacturing
2	Coal mining	28	Metal products
3	Crude petroleum and natural gas production	29	Machinery
4	Ferrous ore mining	30	Transportation equipment
5	Non-ferrous ore mining	31	Electric machinery and instrument
6	Non-metal minerals, and mining n.e.c.	32	Electronic and communication equipment
7	Logging and transport of timber and bamboo	33	Instrument, meters and other measuring equipment
8	Food process & manufacturing	34	Industries n.e.c
9	Beverages	35	Electricity, steam and hot water production and supply
10	Tobacco manufacture	36	Gas production and supply
11	Textiles	37	Production and supply of water
12	Wearing apparel	38	Construction
13	Leather, fur and their products	39	Railway transportation
14	Sawmills and bamboo etc. products	40	Highway transportation
15	Furniture	41	Water transportation
16	Paper and paper products	42	Air transportation
17	Printing industries	43	Pipeline transportation
18	Cultural, education, sports articles	44	Communications
19	Petroleum refineries and coking products	45	Commerce
20	Chemical industries	46	Restaurants
21	Medicines	47	Finance and insurance
22	Chemical fibres	48	Real estate management and social services
23	Rubber products	49	Health care, sports and social welfare
24	Plastic products	50	Education, culture, arts, radio, film and television
25	Building materials and other non-metallic mineral products	51	Scientific research and polytechnical services
26	Primary iron and steel manufacturing	52	Public administration and others

APPENDIX B :

CONCORDANCE BETWEEN THE SITC AND MUDAN SECTORS

In order to construct the exports and imports time series for MuDan based on the World Trade Database (WTD), a mapping scheme between the SITC codes and MuDan sectors is established. Table B.1 presents the concordance between the SITC codes and MuDan sectors.

In Table B.1, the first two columns list the SITC codes and titles. The third column indicates the MuDan sector number, and the fourth column specifies the percentage of the SITC code that goes to the MuDan sector. If a particular SITC code is split into several MuDan sectors, the MuDan sector number and the percentage continue on the next row. For example, imports or exports classified by the SITC code 034X Fresh fish, chilled or frozen, are simply assumed to include half frozen and half chilled fish. In the MuDan sectoring scheme, chilled fish is in 4 Fishing while frozen fish is in 11 Food processing and manufacturing. Therefore, exports and imports under 034X are evenly divided into MuDan sectors 4 and 11 under this mapping schedule.

It should be noted that in the mapping schedule, some SITC codes correspond to MuDan sectors 60 and 61. Since MuDan has only 59 sectors, sectors 60 Household machinery and 61 Office machinery are in fact only used here as intermediate sectors in constructing exports and imports series. The two sectors are later split into MuDan sectors 32 Machinery, 37 Transportation equipment n.e.c., and 40 Instruments, meters and office machinery based on additional information on these sectors.

Table B.1 – Concordance between the SITC and MuDan Sectors

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
0011	Animals of the bovine species,incl.buffaloes,live	3	100
0012	Sheep and goats, live	3	100
0013	Swine, live	3	100
0014	Poultry, live (i.e., fowls, ducks, geese, etc.)	3	100
0015	Horses, asses, mules and hinnies, live	3	100
0019	Live animals of a kind mainly used for human food	3	100
001X	Live animals chiefly for food	3	100
0111	Meat of bovine animals, fresh, chilled or frozen	11	100
0112	Meat of sheep and goats, fresh, chilled or frozen	11	100
0113	Meat of swine, fresh, chilled or frozen	11	100
0114	Poultry,dead & edible offals ex.liver,fresh/frozen	11	100
0115	Meat of horses,asses,etc.,fresh,chilled,frozen	11	100
0116	Edible offals of animals in headings 001.1-001.5	11	100
0118	Other fresh,chilled,frozen meat or edible offals	11	100
011X	Meat,edible meat offals, fresh, chilled or frozen	11	100
0121	Bacon,ham & other dried,salted,smoked meat of swi.	11	100
0129	Meat & edib.offals,n.e.s.salt.in brine dried/smok.	11	100
012X	Meat & edible offals,salted,in brine,dried/smoked	11	100
0142	Sausages & the like,of meat,meat offal or blood	11	100
0149	Other prepared or preserved meat or meat offals	11	100
014X	Meat & edib.offals,prep./pres.,fish extracts	11	100
01XX	Meat and meat preparations	11	100
0223	Milk & cream,fresh,not concentrated or sweetened	3	100
0224	Milk & cream,preserved,concentrated or sweetened	11	100
022X	Milk and cream	11	100
0230	Butter	11	100
0240	Cheese and curd	11	100
0251	Eggs in shell	3	100
0252	Eggs not in shell	3	100
025X	Eggs and yolks,fresh,dried or otherwise preserved	3	100
02XX	Dairy products and birds'eggs	11	100
0341	Fish,fresh(live/dead)or chilled,excl.fillets	4	100
0342	Fish,frozen (excludind fillets)	11	100
0343	Fish fillets,fresh or chilled	11	100
0344	Fish fillets,frozen	11	100
034X	Fish,fresh (live or dead),chilled or frozen	4	50
		11	50
0350	Fish,dried,salted or in brinesmoked fish	11	100
0360	Crustaceans and molluscs,fresh,chilled,frozen etc.	4	20
		11	80
0371	Fish,prepared or preserved,n.e.s. including caviar	11	100
0372	Crustaceans and molluscs,prepared or preserved	11	100
037X	Fish,crustaceans and molluscs,prepar. Or preserv.	11	100
03XX	Fish,crustaceans,mollucs,preparations thereof	11	100
0411	Durum wheat,unmilled	1	100
0412	Other wheat (including spelt) and meslin,unmilled	1	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
041X	Wheat (including spelt) and meslin, unmilled	1	100
0421	Rice in the husk or husked,but not further prepar.	11	100
0422	Rice semi-milled or wholly milled, broken rice	11	100
042X	Rice	11	100
0430	Barley,unmilled	1	100
0440	Maize (corn),unmilled	1	100
0451	Rye,unmilled	1	100
0452	Oats,unmilled	1	100
0459	Buckwheat,millet,canary seed,grain sorghum etc.	1	100
045X	Cereals,unmilled (no wheat,rice,barley or maize)	1	100
0460	Meal and flour of wheat and flour of meslin	11	100
0470	Other cereal meals and flours	11	100
0481	Cereal grains,worked/prepared,(breakfast foods)	11	100
0483	Macaroni,spaghetti and similar products	11	100
0484	Bakery products (e.g.,bread,biscuits,cakes) etc.	11	100
0488	Malt extractprep.of flour etc,for infant food	11	100
048X	Cereal prepar. & preps. Of flour of fruits or veg.	11	100
04XX	Cereals and cereal preparations	11	100
0541	Potatoes,fresh or chilled,excl.sweet potatoes	1	100
0542	Beans,peas,lentils & other leguminous vegetables	1	100
0544	Tomatoes,fresh or chilled	1	100
0545	Other fresh or chilled vegetables	1	100
0546	Vegetables,frozen or in temporary preservative	11	100
054X	Vegetab.,fresh,chilled,frozen/pres.roots,tubers	11	100
0561	Vegetables,dried,dehydrated or evaporated	11	100
0565	Vegetables,prepared or preserved,n.e.s.	11	100
056X	Vegetab.,roots & tubers,prepared/preserved,n.e.s.	11	100
0571	Oranges,mandarins,clementines and other citrus	1	100
0572	Other citrus fruit,fresh or dried	1	50
		11	50
0574	Apples,fresh	1	100
0575	Grapes,fresh or dried	1	50
		11	50
0577	Edible nuts(excl.nuts used for the extract.of oil)	1	50
		2	50
0579	Fruit,fresh or dried, n.e.s.	1	100
057X	Fruit & nuts(not includ. Oil nuts),fresh or dried	1	100
0583	Jams,fruit jellies, marmalades,fruit puree,cooked	11	100
0585	Juicesfruit & veget.(incl.grape must) unfermented	12	100
0586	Fruit,temporarily preserved	11	100
0589	Fruit otherwise prepared or preserved,n.e.s.	11	100
058X	Fruit,preserved,and fruit preparations	11	100
05XX	Vegetables and fruit	11	100
0611	Sugars,beet and cane,raw,solid	11	100
0612	Refined sugars and other prod. Of ref. Beet/cane	11	100
0616	Natural honey	3	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
061X	Sugar and honey	11	100
0620	Sugar confectionery and other sugar preparations	11	100
06XX	Sugar,sugar preparations and honey	11	100
0711	Coffee,whether or not roasted or freed of caffeine	2	100
0712	Extracts,essences/concent.of coffee & chicory	12	100
071X	Coffee and coffee substitutes	12	100
0730	Chocolate & other food preptns. Containing cocoa	12	100
0741	Tea	12	100
0742	Mate	12	100
074X	Tea and mate	12	100
075A	Spices	11	100
07XX	Coffee,tea,cocoa,spices,manufactures thereof	12	100
0811	Hay and fodder,green or dry	1	100
0812	Bran,sharps & other residues derived from sifting	11	100
0813	Oil-cake & other residues (except dregs)	11	100
0814	Flours & meals,of meat/fish,unfit for human food	11	100
0819	Food wastes and prepared animal feeds,n.e.s	41	100
081X	Feed.stuff for animals(not incl.unmilled cereals)	11	100
091A	Margarine and shortening	11	100
0980	Edible products and preparations n.e.s.	11	100
09XX	Miscel.edible products and preparations	11	100
1110	Non alcoholic beverages,n.e.s.	12	100
1121	Wine of fresh grapes (including grape must)	12	100
1123	Beer made from malt (includ.ale,stout and porter)	12	100
1124	Spiritsliqueurs, other spirituous beverages,n.e.s	12	100
112X	Alcoholic beverages	12	100
11XX	Beverages	12	100
1211	Tobacco,not stripped	1	100
1212	Tobacco,wholly or partly stripped	13	100
1213	Tobacco refuse	13	100
121X	Tobacco,unmanufactured tobacco refuse	13	100
1222	Cigarettes	13	100
1223	Tobacco,manufactured (inc.smoking,chewing tobacco	13	100
122X	Tobacco manufactured	13	100
12XX	Tobacco and tobacco manufactures	13	100
2111	Bovine & equine hides (other than calf),raw	16	100
2112	Calf skins,raw (fresh,salted,dried,pickled/limed	16	100
2117	Sheep & lamb skins without the wool,raw(fresh etc)	16	100
2119	Hides and skins,n.e.s waste and used leather	16	100
211X	Hides and skins (except furskins), raw	16	100
2120	Furskins,raw (includ.astrakhan,caracul, etc.)	16	100
21XX	Hides,skins and furskins,raw	16	100
2222	Soya beans	1	100
2223	Cotton seeds	11	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
2224	Sunflower seeds	1	100
2225	Sesame (sesamum)seeds	1	100
2226	Rape and colza seeds	1	100
222X	Oil seeds and oleaginous fruit,whole or broken	1	100
2232	Palm nuts and palm kernels	2	100
2234	Linseed	1	100
2235	Castor oil seeds	1	100
2238	Oil seeds and oleaginous fruit. N.e.s.	1	100
223X	Oils seeds and oleaginous fruit, whole or broken	1	100
22XX	Oil seeds and oleaginous fruit	1	100
2320	Natural rubber latex nat.rubber & sim.nat.gums	2	100
2331	Synth.rubb.lat.synth.rubb.factice deriv.from oils	23	100
2332	Reclaimed rubberwaste & scrap of unhardened rubb.	41	100
233X	Synth.rubb.lat.synth.rubb.& Reclaimedwaste scrap	41	100
23XX	Crude rubber (including synthetic and reclaimed)	23	100
2440	Cork,natural,raw & waste (includ.in blocks/sheets)	41	100
2450	Fuel wood (excluding wood waste) and wood charcoal	18	100
2460	Pulpwood (including chips and wood waste)	18	100
2471	Sawlogs and veneer logs,of coniferous species	10	100
2472	Sawlogs and veneer logs,of non coniferous species	10	100
2479	Pitprops,poles,piling,posts & other wood in rough	17	100
247X	Other wood in the rough or roughly squared	17	100
2481	Railway or tramway sleepers (ties)of wood	17	100
2482	Wood of coniferous species,sawn,planed,tongued etc	17	100
2483	Wood of non-coniferous species,sawn,planed,tongued	17	100
248X	Wood,simply worked,and railway sleepers of wood	17	100
24XX	Cork and wood	17	100
2511	Waste paper,paperboardonly for use paper-making	41	100
2512	Mechanical wood pulp	19	100
2516	Chemical wood pulp,dissolving grades	19	100
2517	Chemical wood pulp,soda or sulphate	19	100
2518	Chemical wood pulp,sulphite	19	100
251X	Pulp and waste paper	41	100
2613	Raw silk (not thrown)	14	100
2614	Silk worm cocoons suitabl.for reeling & silk waste	14	100
261X	Silk	14	100
263A	Cotton	1	100
2640	Jute & other textile bast fibres,nes,raw/processed	1	100
265A	Vegetable textile fibres and waste of such fibres	1	100
266A	Synthetic fibres suitable for spinning	25	100
2681	Sheep's or lambs' wool,greasy or fleece-washed	3	100
2682	Sheep's or lambs'wool,degreased,in the mass	14	100
2683	Fine animal hair,not carded or combed	14	100
2685	Horsehair & other coarse animal hair (excl.wool)	14	100
2686	Waste of sheep's/lamb's wool or of other anim.hair	41	100
268X	Wool and other animal hair (excluding wool tops)	14	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
2690	Old clothing and other old textile articles rags	14	100
26XX	Textile fibres (except wool tops) and their wastes	14	100
271A	Fertilizers,crude	9	100
2731	Building and monumental stone not further worked	9	100
2732	Gypsum,plasters,limestone flux & calcareous stone	9	100
2733	Sands,natural,of all kinds,whether or not coloured	9	100
273X	Stone,sand and gravel	9	100
274A	Sulphur and unroasted iron pyrites	9	100
2771	Industrial diamonds,sorted,whether or not worked	9	100
2772	Natural abrasives,n.e.s.	9	100
277X	Natural abrasives,n.e.s (incl.industrial diamonds)	9	100
2782	Clay and other refractory minerals, n.e.s.	9	100
2783	Common saltrock sat,sea saltpur.sodium chrloride	9	100
2784	Asbestos	9	100
2785	Quartz,mica,felspar,fluorspar,cryolite & chiolite	9	100
2786	Slag,dross,scalings and similar waste,n.e.s.	9	100
2789	Minerals,crude, n.e.s.	8	100
278X	Other crude minerals	9	100
27XX	Crude fertilizers and crude materials (excl.coal)	9	100
2814	Roasted iron pyrites,whether or not agglomerated	7	100
2815	Iron ore and concentrates,not agglomerated	7	100
2816	Iron ore agglomerates (sinters,pellets,briquettes)	7	100
281X	Iron ore and concentrates	7	100
2820	Waste and scrap metal of iron or steel	7	100
2860	Ores and concentrates of uranium and thorium	8	100
2871	Copper ores & concentratescopper matte	8	100
2872	Nickel ores and concentratesnickel mattes etc.	8	100
2873	Aluminium ores and concentrates (includ.alumina)	8	100
2874	Lead ores and concentrates	8	100
2875	Zinc ores and concentrates	8	100
2876	Tin ores and concentrates	8	100
2879	Ores & concentrat.of other non-ferrous base metals	8	100
287X	Ores and concentrates of base metals, n.e.s.	8	100
2881	Ash & residues,contain.metals/metallic compounds	7	90
		30	10
2882	Other non-ferrous base metal waste and scrap,n.e.s	30	100
288X	Non-ferrous base metal waste and scrap, n.e.s.	41	100
2890	Ores & concentrates of precious metalswaste,scrap	8	100
28XX	Metalliferous ores and metal scrap	41	100
2911	Bones,horns,ivory,hooves,claws,coral,shells etc.	3	100
2919	Other materials of animal origin, n.e.s	3	40
		11	60
291X	Crude animal materials,n.e.s.	3	100
2922	Shellac,seed lac,stick lac,resins,gum-resins,etc.	1	100
2924	Plants,seeds,fruit used in perfumery,pharmacy	1	100
2925	Seeds,fruit & spores,nes,of a kind used for sowing	1	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
2926	Bulbs,tubers & rhizomes of flowering or of foliage	1	100
2927	Cut flowers and foliage	1	100
2929	Other materials of vegetable origin, n.e.s.	1	100
292X	Crude vegetable materials, n.e.s.	1	100
29XX	Crude animal and vegetable materials,n.e.s.	3	100
2XXX	Crude materials, inedible, except fuels	9	100
3221	Anthracite,whether/not pulverized,not agglomerated	5	100
3224	Peat,whether/not compres.into bales not agglomera.	5	100
322X	Coal,lignite and peat	5	100
3231	Briquet.ovoids & sim.solid fuels,of coal peat lig.	22	100
3232	Coke and semi-coke of coal of lignite or of peat	22	100
323X	Briquettescoke and semi-coke of coal,lignite/peat	22	100
32XX	Coal,coke and briquettes	5	100
3330	Petrol.oils & crude oils obt.from bitumin.minerals	22	10
		6	90
3341	Motor spirit and other light oils	22	100
3343	Gas oils	22	100
3344	Fuel oils,n.e.s.	22	100
3345	Lubricating petrol.oils & other heavy petrol.oils	22	100
334X	Petroleum products,refined	22	100
3351	Petroleum jelly and mineral waxes	22	100
3352	Mineral tars and products of their distillation	22	100
3353	Pitch & pitch coke obtain.from coal tar/miner.tars	22	100
3354	Petroleum bitumen,petrol.coke & bitumin.mixtur.nes	22	100
335X	Residual petroleum products,nes.& Relat.materials	22	100
33XX	Petroleum,petroleum products and related materials	22	100
341A	Gas,natural and manufactured	6	100
3510	Electric current	42	100
3XXX	Mineral fuels, lubricants and related materials	42	100
4111	Fats and oils of fish and marine mammals	11	100
4113	Animal oils,fats and greases,n.e.s	11	100
411X	Animal oils and fats	11	100
4232	Soya bean oil	11	100
4239	Other soft fixed vegetable oils	11	100
423X	Fixed vegetable oils,soft,crude,refined/purified	11	100
4241	Linseed oil	11	100
4243	Coconut (copra) oil	11	100
4249	Fixed vegetable oils,n.e.s	11	100
424X	Other fixed vegetable oils,fluid or solid,crude	11	100
42XX	Fixed vegetable oils and fats	11	100
4313	Fatty acids,acid oils,and residues	11	100
4314	Waxes of animal or vegetable origin	11	100
431X	Animal & vegetable oils and fats,processed & waxes	11	100
511A	Hydrocarbons nes,& their halogen.& Etc.derivatives	23	100
5121	Acyclic alcohols & their halogenated,derivatives	23	100
5123	Phenols & phen.-alco.& Their halogenat.derivatives	23	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
512X	Alcohols,phenols,phenol-alcohols,& their derivat.	23	100
513A	Carboxylic acids,& their anhydrides,halides,etc.	23	100
514A	Nitrogen-function compounds	23	100
515A	Organo-inorganic and heterocyclic compounds	23	100
5161	Ethers,alcohol peroxides,ether perox.,epoxides etc	23	100
5162	Aldehyde-,ketone-,& quinone-function compounds	23	100
5169	Organic chemicals,n.e.s	23	100
516X	Other organic chemicals	23	100
51XX	Organic chemicals	23	100
5221	Chemical elements	23	100
5222	Inorganic acids and oxygen compounds of non-metals	23	100
5224	Metallic oxides of zinc,chromium,manganese,iron,	23	100
5225	Oth.inorg.bases & metallic oxid.,hydroxid.& Perox.	23	100
522X	Inorganic chemical elements,oxides & halogen salts	23	100
5231	Metallic salts and peroxysalts of inorganic acids	23	100
5239	Inorganic chemical products,n.e.s	23	100
523X	Other inorganic chemicals	23	100
524A	Radio-active and associated materials	23	100
52XX	Inorganic chemicals	23	100
5331	Other colouring matter	23	100
5334	Varnishes and lacquersdistempers,water pigments	23	100
533X	Pigments,paints,varnishes & related materials	23	100
53XX	Dyeing,tanning and colouring materials	23	100
5411	Provitamins & vitamins,narural/reprod.by synthesis	24	100
5413	Antibiotics n.e.s.,not incl. In 541.7	24	100
5414	Vegetab.alkaloids,natural/reproduced by synthesis	24	100
5415	Hormones,natural or reproduced by synthesis	24	100
5416	Glycosidesglands or other organs & their extracts	24	100
5417	Medicaments(including veterinary medicaments)	24	100
5419	Pharmaceutical goods,other than medicaments	24	100
541X	Medicinal and pharmaceutical products	24	100
5513	Essential oils,concretes & absolutesresinoids	23	100
551X	Essential oils,perfume and flavour materials	23	100
5530	Perfumery,cosmetics and toilet preparations	23	100
5542	Organic surface-active agents,n.e.s.	23	100
5543	Polishes & creams,for footwear,furniture or floors	23	100
554X	Soap,cleansing and polishing preparations	23	100
55XX	Essential oils & perfume mat.toilet-cleansing mat	23	100
5621	Mineral or chemical fertilizers,nitrogenous	23	100
5622	Mineral or chemical fertilizers,phosphatic	23	100
5623	Mineral or chemical fertilizers,potassic	23	100
5629	Fertilizers,n.e.s.	23	100
562X	Fertilizers,manufactured	23	100
582A	Condensation,polycondensation & polyaddition prod.	23	100
583A	Polymerization and copolymerization products	23	100
584A	Regenerated cellulosecellulose nitrate,etc.	23	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
58XX	Artif.resins,plastic mat.,cellulose esters/ethers	23	100
591A	Disinfectants,insecticides,fungicides,weed killers	23	100
5921	Starches,inulin and wheat gluten	23	100
5922	Albuminoidal substancesglues	23	100
592X	Starches,inulin & wheat glutenalbuminoidal subst.	23	100
5981	Wood- and resin-based chemical products	23	100
5989	Chemical products and preparations,n.e.s.	23	100
598X	Miscellaneous chemical products,n.e.s.	23	100
59XX	Chemical materials and products,n.e.s.	23	100
5XXX	Chemicals and related products, n.e.s.	23	100
611A	Leather	16	100
612A	Manufactures of leather/of composition leather nes	16	100
6130	Furskins,tanned/dressed,pieces/cuttings of furskin	16	100
61XX	Leather,leather manuf.,n.e.s.and dressed furskisg	16	100
6210	Materials of rubber(e.g.,pastes,plates,sheets,etc)	23	100
625A	Rubber tyres,tyre cases,etc.for wheels	26	100
6282	Transmission,conveyor/elevator belts of rubber	26	100
6289	Other articles of rubber,n.e.s.	26	100
628X	Articles of rubber,n.e.s.	26	100
62XX	Rubber manufactures,n.e.s.	26	100
6341	Wood sawn lengthwise,sliced/peeled,but not prepar.	10	100
6342	Plywood consisting of sheets of wood	10	10
		17	90
6343	Improved wood and reconstituted wood	17	100
634X	Veneers,plywood,improved or reconstituted wood	17	100
6351	Wooden packing cases,boxes,crates,drums etc.	18	100
6353	Builders' carpentry and joinery	18	100
6359	Manufactured articles of wood,n.e.s.	18	100
635X	Wood manufactures,n.e.s.	18	100
63XX	Cork and wood manufactures (excl.furniture)	18	100
6411	Newsprint	19	100
6412	Printing paper & writing paper,in rolls or sheets	19	100
6413	Kraft paper and paperboard,in rolls or sheets	19	100
6415	Paper and paperboard,in rolls or sheets,n.e.s.	19	100
6416	Building board of wood pulp or of vegetable fibre	19	100
6417	Paper & paperboard,corrugated,creped,crinkled etc.	19	100
6418	Paper & paperboard,impregnat.coat.surface-coloured	19	100
6419	Converted paper and paperboard,n.e.s.	19	100
641X	Paper and paperboard	19	100
6421	Boxes,bags & oth.packing containers,of paper/papbd	19	100
6424	Paper and paperboard,cut to size or shape,n.e.s.	19	100
6428	Art.of paper pulp,paper,paperboard,cellu.wadding	19	100
642X	Paper and paperboard,cut to size or shape	19	100
64XX	Paper,paperboard,artic.of paper,paper-pulp/board	19	100
6512	Yarn of wool or animal hair (including wool tops)	14	100
6514	Yarn contain.85% by wgt.of synth.fibres,not f.sale	14	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
6517	Yarn of regenerated fibres,not for retail sale	14	100
6519	Yarn of text.fibres,n.e.s.,incl.yarn of glass fib.	14	100
651X	Textile yarn	14	100
6521	Cotton fabrics,woven,unbleached,not mercerized	14	100
6522	Cotton fabrics,woven,bleach.merceriz.dyed,printed	14	100
652X	Cotton fabrics,woven	14	100
6531	Fabrics,woven of continuous synth.textil.materials	14	100
6539	Pile & chenille fabrics,woven of man-made fibres	14	100
653X	Fabrics,woven,of man-made fibres	14	100
6542	Fabrics,woven,contain.85% of wool/fine animal hair	14	100
6549	Fabrics,woven,n.e.s.	14	100
654X	Textil.fabrics,woven,oth.than cotton/man-made fibr	14	100
655A	Knitted or crocheted fabrics	14	100
6560	Tulle,lace,embroidery,ribbons,& other small wares	14	100
6571	Felt & articl.of felt,nes,whether/not impregnated	14	100
6573	Coated/impregnated textile fabrics & products nes.	14	100
6575	Twine,cordage,ropes & cables.& Manufactur.thereof	14	100
6577	Wadding.textil.fabrics for use in machinery/plant	14	100
657X	Special textile fabrics and related products	14	100
6581	Sacks and bags,of textile materials	14	100
6583	Travelling rugs and blankets,not knitted/crocheted	14	100
6584	Bed linen,table linen,toilet & kitchen linen etc.	15	40
		14	60
6589	Other made-up articles of textile materials,n.e.s.	14	100
658X	Made-up articles,wholly/chiefly of text.materials	14	100
6591	Linoleum and similar floor coverings	14	100
6592	Carpets,carpeting and rugs,knotted	15	40
		14	60
659X	Floor coverings,etc.	14	100
65XX	Textile yarn,fabrics,made-upart.,related products	14	100
6611	Quicklime,slaked lime and hydraulic lime	28	100
6612	Portland cement,ciment fondu,slag cement etc.	28	100
6613	Building & monumental stone,worked,& artic.thereof	28	100
6618	Constructn.mater.of asbestos-cement & fibre-cement	28	100
661X	Lime,cement,and fabricated construction materials	28	100
6623	Refractory bricks & other refract.construct.mater.	28	100
6624	Non-refract.ceramic bricks,tiles,pipes & sim.prod.	28	100
662X	Clay construct.materials & refractory constr.mater	28	100
6631	Hand polishing stones,whetstones,oilstones,hones	28	100
6632	Natural or artificial abrasive powder or grain	28	100
6633	Manufactures of mineral materials,n.e.s.	28	100
6638	Manufactures of asbestos friction materials	28	100
663X	Mineral manufactures,n.e.s	28	100
665A	Glassware	28	100
6664	Tableware & other articles of porcelain or china	28	100
6665	Tableware & other articles of oth.kinds of pottery	28	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
6666	Statuettes & oth.ornaments,& articles of adornment	28	100
666X	Pottery	28	100
6672	Diamonds,unwork.cut/otherwise work.not mounted/set	9	100
6674	Synthetic/reconstructed precious/semi-prec.stones	28	100
667X	Pearls,precious& semi-prec.stones,unwork./worked	28	100
66XX	Non-metallic mineral manufactures,n.e.s.	28	100
6712	Pig iron,cast iron and spiegeleisen,in pigs,blocks	29	100
6713	Iron or steel powders,shot or sponge	29	100
6716	Ferro-alloys	29	100
671X	Pig iron,spiegeleisen,sponge iron,iron or steel	29	100
6724	Puddled bars and pilingsingots,blocks,lumps etc.	29	100
6725	Blooms,billets,slabs & sheet bars of iron or steel	29	100
672X	Ingots and other primary forms,of iron or steel	29	100
6731	Wire rod of iron or steel	29	100
6732	Bars & rods,of iron/steelhollow mining drill st.	29	100
6733	Angles,shapes & sections & sheet piling,of iron/st	29	100
673X	Iron and steel bars,rods,angles,shapes & sections	29	100
674A	Universals,plates and sheets,of iron or steel	29	100
6760	Rails and railway track construction material	29	100
6770	Iron/steel wire/wheth/not coated,but not insulated	29	100
6781	Tubes and pipes,of cast iron	29	100
6782	Seamless tubes and pipesblanks for tubes & pipes	29	100
6783	Other tubes and pipes,of iron or steel	29	100
6785	Tube & pipe fittings(joints,elbows)of iron/steel	31	100
678X	Tubes,pipes and fittings,of iron or steel	31	100
6793	Steel & iron forgings & stampings,in rough state	32	100
6794	Castings or iron or steel,in the rough state	32	100
679X	Iron & steel castings,forgings & stampingsrough	32	100
67XX	Iron and steel	29	100
6811	Silver,unwrought,unworked or semi-manufactured	30	100
6812	Platinum and other metals of the platinum group	30	100
681X	Silver,platinum & oth.metals of the platinum group	30	100
6821	Copper and copper alloys,refined or not,unwrought	30	100
6822	Copper and copper alloys,worked	30	100
682X	Copper	30	100
6831	Nickel & nickel alloys,unwrought (ingots,pigs,etc)	30	100
6832	Nickel and nickel alloys,worked	30	100
683X	Nickel	30	100
6841	Aluminium and aluminium alloys,unwrought	30	100
6842	Aluminium and aluminium alloys,worked	30	100
684X	Aluminium	30	100
6851	Lead and lead alloys,unwrought	30	100
6852	Lead and lead alloys,worked	30	100
685X	Lead	30	100
6861	Zinc and zinc alloys,unwrought	30	100
6863	Zinc and zinc alloys,worked	30	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
686X	Zinc	30	100
689A	Miscell.non-ferrous base metals employ.in metallgy	30	100
68XX	Non-ferrous metals	30	100
691A	Structures & parts of struc.iron,steel,aluminium	31	100
692A	Metal containers for storage and transport	31	100
6931	Stranded wire,cables,cordages and the like	31	100
6935	Gauze,cloth,grill of iron steel or copper	31	100
693X	Wire products and fencing grills	31	100
6940	Nails,screws,nuts,bolts etc.of iron,steel,copper	31	100
6951	Hand tools of a kind used in agriculture etc	31	100
6953	Other tools for use in the hand	31	100
6954	Interchangeable tools for hand & machine tools	31	100
695X	Tools for use in hand or in machines	31	100
6960	Cutlery	31	100
6973	Domestic-type,non-electric heating,cooking appar.	31	100
6974	Art.commonly used for dom.purposes,pot scourers	31	100
697X	Household equipment of base metal,n.e.s.	31	100
6991	Locksmiths wares,safes,strong rooms of base metal	31	100
6992	Chain and parts thereof,of iron or steel	31	100
6996	Miscellaneous articles of base metal	31	100
6997	Articles of iron or steel, n.e.s.	31	100
6998	Art.,nes.of copper,nickel,aluminium,lead,zinc,tin	31	100
6999	Semi-manufactures of tungsten,molybdenum etc.	31	100
699X	Manufactures of base metal,n.e.s.	31	100
69XX	Manufactures of metal,n.e.s.	31	100
6XXX	Manufactured goods classified chiefly by material	31	100
711A	Steam & other vapour generating boilers & parts	32	100
712A	Steam & other vapour power units,steam engines	32	100
7133	Int.combustion piston engines for marine propuls.	32	100
7139	Parts of int.comb.piston engines of 713.2-/713.8-	32	100
713X	Internal combustion piston engines & parts	32	100
714A	Engines & motors,non-electric	32	100
716A	Rotating electric plant and parts	38	100
7188	Engines & motors,n.e.s.such as water turbines etc.	32	100
718X	Other power generating machinery and parts	32	100
71XX	Power generating machinery and equipment	32	100
7211	Agricultural & horticul.mach. For soil preparat.	32	100
7212	Harvesting & treshing machinery and parts	32	100
7213	Dairy machinery and parts	32	100
7219	Agric.mach.& Appliances,n.e.s.and parts	32	100
721X	Agricultural machinery and parts	32	100
722A	Tractors fitted or not with power take-offs, etc.	32	100
723A	Civil engineering & contractors plant and parts	32	50
		40	50
7243	Sewing machines,furniture for sewing mach.& Parts	32	100
7247	Mach.for washing,cleaning,drying,bleaching text.	32	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
7248	Mach.for preparing,tanning or working hides	32	100
724X	Textile & leather machinery and parts	32	100
7251	Mach. For mak./finis. Cellul. Pulp,paper,paperbo.	32	100
7252	Paper & paperboard cutting mach.of all kinds	32	100
7259	Parts of the mach. Of 725--	32	100
725X	Paper & pulp mill mach.,mach for manuf.of paper	32	100
726A	Printing & bookbinding mach.and parts	32	100
727A	Food processing machines and parts	32	100
7281	Mach.tools for specialized particular industries	32	100
7283	Mach.for sorting,screening,separating,washing ores	32	100
7284	Mach.& Appliances for spezialized particular ind.	32	100
728X	Mach.& Equipment specialized for particular ind.	32	100
72XX	Machinery specialized for particular industries	32	100
7361	Metal cutting machine-tools	32	100
7369	Parts of the machine-tools of 736--	32	100
736X	Mach.tools for working metal or met.carb., Parts	32	100
7371	Converters,ladles,ingot moulds and casting mach.	32	100
737X	Metal working machinery and parts	32	100
73XX	Metalworking machinery	32	100
7413	Ind.& Lab.furnaces and ovens and parts	32	100
7414	Refrigerators & refr.equipment,ex.household,parts	32	100
7416	Mach.plant & sim.lab.equip.involv.a temp.change	32	100
741X	Heating & cooling equipment and parts	32	100
742A	Pumps for liquids,liq.elevators and parts	32	100
743A	Pumps & compressors,fans & blowers,centrifuges	32	100
7441	Work trucks,mechanically propelled,for short dist.	32	100
7442	Lifting,handling,loading mach.conveyors	32	100
744X	Mechanical handling equip.and parts	32	100
7451	Tools for working in the hand,pneumatic,parts	32	100
7452	Other non-electrical mach.amp parts	32	100
745X	Other non-electrical mach.tools,apparatus & parts	32	100
7491	Ball,roller or needle roller bearings	32	100
7492	Taps,cocks,valves etc.for pipes,tanks,vats etc	32	100
7493	Transmission shafts,cranks,bearing housings etc.	32	100
7499	Other non-electric parts & accessories of mach.	32	100
749X	Non-electric parts and accessories of machines	32	100
74XX	General industrial machinery & equipment,and parts	32	100
7511	Typewritterscheque-writting machines	32	50
		40	50
7512	Calculating machines,cash registers,ticket & sim.	39	100
751X	Office machines	32	50
		40	50
752A	Automatic data processing machines & units thereof	39	100
7591	Parts of and accessories suitable for 751.1-,751.8	39	100
759X	Parts of and accessories suitable for 751--or 752-	39	100
75XX	Office machines & automatic data processing equip.	39	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
761A	Television receivers	39	100
762A	Radio-broadcast receivers	39	100
7641	Elect.line telephonic & telegraphic apparatus	39	100
7642	Microphones,loudspeakers,amplifiers	39	100
7649	Parts of apparatus of division 76---	39	100
764X	Telecommunications equipment and parts	39	100
76XX	Telecommunications & sound recording apparatus	39	100
771A	Electric power machinery and parts thereof	38	100
772A	Elect.app.such as switches,relays,fuses,plugs etc.	38	100
7731	Insulated,elect.wire,cable,bars,strip and the like	38	100
7732	Electric insulating equipment	38	100
773X	Equipment for distributing electricity	38	100
7742	App.based on the use of x-rays or of radiations	32	50
		40	50
774X	Electric apparatus for medical purposes,(radiolog)	32	50
		40	50
7751	Household type laundry equipment	38	100
7752	Refrig hh,fd frz,e/o	38	100
7754	Shavers & hair clippers with motor and parts	31	100
7757	Elec.-mech.,domestic appliances and parts	38	100
7758	Electro-thermic appliances,n.e.s.	38	100
775X	Household type,elect.& Non-electrical equipment	38	100
776A	Thermionic,cold & photo-cathode valves,tubes,parts	39	100
7781	Batteries and accumulators and parts	38	100
7782	Elect.filament lamps and discharge lamps	38	100
7783	Electr.equip.for internal combustion engines,parts	38	100
7784	Tools for working in the hand with elect.motor	32	100
7788	Other elect.machinery and equipment	38	100
778X	Electrical machinery and apparatus,n.e.s.	38	100
77XX	Electrical machinery,apparatus & appliances n.e.s.	38	100
7810	Passenger motor cars,for transport of pass.& Goods	34	100
7821	Motor vehicles for transport of goods/materials	34	100
7822	Special purpose motor lorries and vans	34	100
782X	Motor vehicles for transport of goods/materials	34	100
7831	Public-service type passenger motor vehicles etc.	34	100
783X	Road motor vehicles,n.e.s.	34	100
7849	Other parts & accessories of motor vehicles	34	100
784X	Parts & accessories of 722--,781--,782--,783--	34	100
7852	Cyles,not motorized	32	33
		37	33
		40	34
785X	Motorcycles,motor scooters,invalid carriages	37	100
786A	Trailers & other vehicles,not motorized	33	50
		37	50
78XX	Road vehicles (incl. Air cushion vehicles	37	100
791A	Railway vehicles & associated equipment	33	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
792A	Aircraft & associated equipment and parts	36	70
		41	30
793A	Ships,boats and floating structures	35	80
		26	10
		17	10
79XX	Other transport equipment	37	100
7XXX	Machinery and transport equipment	32	100
8121	Boilers & radiators for central heating	32	100
8122	Sinks,wash basins,bidets,water closet pans,etc	32	100
8124	Lighting fixtures and fittings and parts	38	100
812X	Sanitary,plumbing,heating,lighting fixtures	32	100
821A	Furniture and parts thereof	18	100
8310	Travel goods,handbags,brief-cases,purses,sheaths	16	100
8421	Overcoats and other coats, men,s	15	100
8422	Suits,men's,of textile fabrics	15	100
8423	Trousers,breeches etc.of textile fabrics	15	100
8429	Other outer garments of textile fabrics	15	100
842X	Outer garments,men's,of textile fabrics	15	100
8431	Coats and jackets of textile fabrics	15	100
8432	Suits & costumes,women's,of textile fabrics	15	100
8433	Dresses,women's,of textile fabrics	15	100
8434	Skirts,women's,of textile fabrics	15	100
843X	Outer garments,women's,of textile fabrics	15	100
8441	Shirts,men's,of textile fabrics	15	100
8442	Under garments,excl.shirts,of textile fabrics	15	100
844X	Under garments of textile fabrics	15	100
8451	Jerseys,pull-overs,twinsets,cardigans,knitted	14	100
8452	Dresses,skirts,suits etc,knitted or crocheted	14	100
8459	Other outer garments & clothing,knitted	14	100
845X	Outer garments and other articles,knitted	14	100
8461	Under garments,knitted or crocheted of wool	14	100
8465	Corsets,brassieres,suspendres and the like	14	100
846X	Under garments,knitted or crocheted	14	100
8471	Clothing accessories of textile fabrics	14	100
8472	Clothing accessories,knitted or crochetem,n.e.s.	14	100
847X	Clothing accessories of textile fabrics	14	100
8481	Art.of apparel & clothing accessories,of leather	16	100
8482	Art.of apparel & clothing accessories,of plastic	27	100
8483	Fur clothing,articles made of furskins	16	100
8484	Headgear and fittings thereof,n.e.s.	15	100
848X	Art.of apparel & clothing accessories,no textile	15	100
84XX	Articles of apparel and clothing accessories	15	100
8510	Footwear	16	60
		26	10
		27	30
8710	Optical instruments and apparatus	40	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
8720	Medical instruments and appliances	32	100
8741	Surveying,hydrographic,compasses etc.	32	100
8745	Measuring,controlling & scientific instruments	40	100
8748	Electrical measuring,checking,analysing instrum.	40	100
8749	Parts,n.e.s.accessories for 873--,8743-,87454,8748	40	100
874X	Measuring,checking,analysing instruments	40	100
87XX	Professional,scientific & controling instruments	40	100
8811	Photographic,cameras,parts & accessories	32	33
		37	33
		40	34
8813	Photographic & cinematographic apparatus n.e.s.	32	50
		40	50
881X	Photographic apparatus and equipment,n.e.s.	32	50
		40	50
8822	Photographic film,plates,paper	23	100
882X	Photographic & cinematographic supplies	23	100
8830	Cinematograph film,exposed-developed,neg.or pos.	23	100
8841	Lenses,prisms,mirrors,other optical elements	40	100
8842	Spectacles and spectacle frames	28	100
884X	Optical goods,n.e.s.	40	100
8851	Watches,watch movements and cases	32	33
		37	33
		40	34
8852	Clocks,clock movements and parts	32	33
		37	33
		40	34
885X	Watches and clocks	32	33
		37	33
		40	34
88XX	Photographic apparatus,optical goods,watches	32	100
8921	Books,pamphlets,maps and globes,printed	20	100
8922	Newspapers journals,periodicals	20	100
8925	Maps, greeting cards music, printed	20	100
8928	Printed matter,n.e.s.	20	100
892X	Printed matter	20	100
8931	Art.for the conveyance or packing of goods	18	20
		19	80
8939	Miscellaneous art.of materials of div.58	18	20
		19	80
893X	Articles of materials described in division 58	18	20
		19	80
8942	Children s toys,indoor games,etc.	21	100
8946	Non-military arms and ammunition therefor	21	100
8947	Other sporting goods and fairground amusements	21	100
894X	Baby carriages,toys,games and sporting goods	21	100
895A	Office and stationery supplies,n.e.s.	21	100

Table B.1 – Concordance between the SITC and MuDan Sectors (cont.)

SITC Code	SITC Title	MuDan Sector#	% of SITC to the MuDan Sector
8960	Works of art,collectors pieces & antiques	21	100
897A	Jewellery,goldsmiths and other art. Of precious m.	21	100
8981	Pianos and other string musical instuments	21	100
8982	Other musical instruments of 898.1-	21	100
8983	Gramophone records and sim.sound recordings	21	100
898X	Musical instruments,parts and accessories	21	100
8991	Art.& Manuf.of carving or moulding materials	21	100
8996	Orthopaedic appliances,surgical belts and the like	32	100
8997	Basketwork,wickerwork etc. Of plaiting materials	21	100
8998	Small-wares and toilet art.,feather dusters etc.	21	100
8999	Manufactured goods,n.e.s.	41	100
899X	Other miscellaneous manufactured articles	41	100
89XX	Miscellaneous manufactured articles,n.e.s.	41	100
8XXX	Miscellaneous manufactured articles	41	100
9310	Special transactions & commod.,not class.to kind	41	100
9410	Animals,live,n.e.s.,incl. Zoo-animals	3	100
9510	Armoured fighting vehicles,arms of war & ammunit.	41	100
9710	Gold,non-monetary	41	100
9999	Non-identified products	41	100
9XXX	Commodities & trans. Not classified elsewhere	41	100

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