14th Annual INFORUM Conference – Traunkirchen, 10th – 16th of September 2006

Econometric Model to predict the effect that various Water Resource Management Scenarios would have on South Africa's Economic Development

Conningarth Economists

Pretoria,
South Africa

Who is Conningarth?

- Company Profile
- Our involvement with INFORUM
- Clopper Almon's visit to South Africa
- Assistance from Ralph Doggett during Dr Mullins's visit to Nice, France

Background

Conningarth Economists was commissioned by the Water Research Commission (WRC) to develop an econometric model that considers the role of water as input to the South African economy.

The model will ultimately be used to evaluate the role of water in the South African economy and predict the likely effect of management and policy approaches on the efficient utilization of water resources.

Progress to date

Output 1: Literature Review (Completed June 2005)

Covering the local and international experience with regard to developing the proposed model, available data sources and relationships that could be incorporated into the proposed model

Output 2: Catered scenarios (Completed October 2005)

Report on the different scenarios that will be catered for in the developed model

Output 3: Selection of an econometric model (Completed March 2006)

Report on a selection of existing econometric models that may be used for the WRC purpose

Output 4: Interface with existing data sources (Completed May 2006)

Report on the interface with existing data sources that would provide input to the model and be sources of future data updates

The choice of Econometric Model

Based on the outcomes of Output 1 – 3, the following decision was made and elaborated on in Output 4:

The INFORUM Model was chosen as the preferred modeling structure for forecasting water demand and the simulation of different water management scenarios. The INFORUM Model was "tested" against a set of criteria, including its ability to track historical economic developments, as well as its usability for policy impact analysis. In this regard it received high marks.

The South African Interindustry Model (SAFRIM) was established

Content of this Presentation

- *Overview of SAFRIM*
- *Focus on the price model*

SAFRIM is developed in G7 and Interdyme - however, for the purpose of specifically the presentation of the price model, other software has been used as an interim step before attempting to incorporate it into SAFRIM.

Why choose the INFORUM Model to develop SAFRIM?

INFORUM Type Models have been around for a long time (almost four decades!) and they have an extremely good record. They have established themselves as very appropriate tools to apply in economic analyses, especially where sectoral detail is required.

Overview of SAFRIM

- *SAFRIM consists of three components:*

- **The real side**

$$q_t = [\, I - A \,]^{-1} \times f_t$$

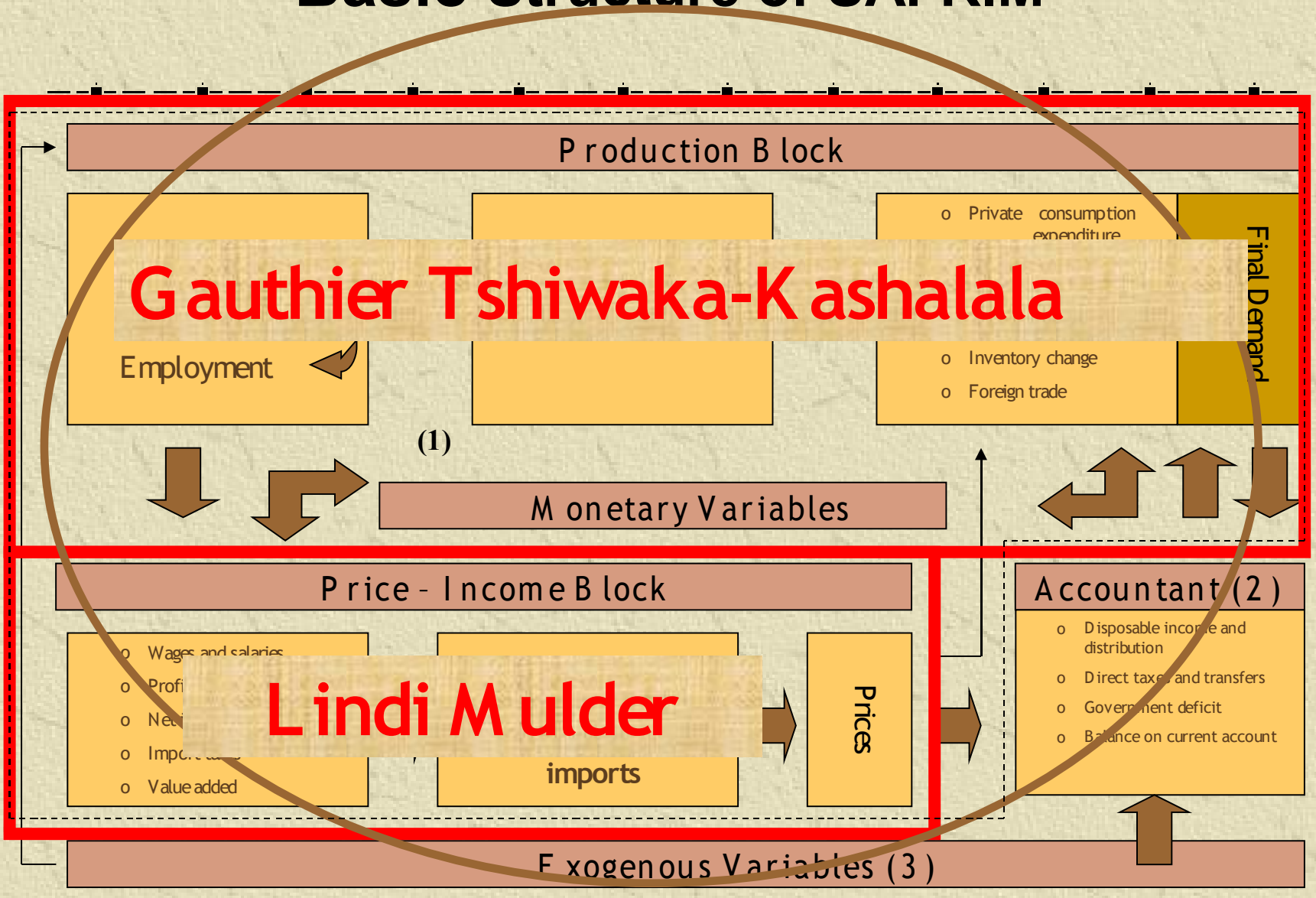
- **The price-income side**

$$p_t = v_t \times [\, I - A \,]^{-1}$$

- **The accountant**

Assures that the aggregations of individual components are calculated and is concerned with macroeconomic variables that are not industry-specific

Basic Structure of SAFRIM



Gauthier Tshiwaka-Kashalala

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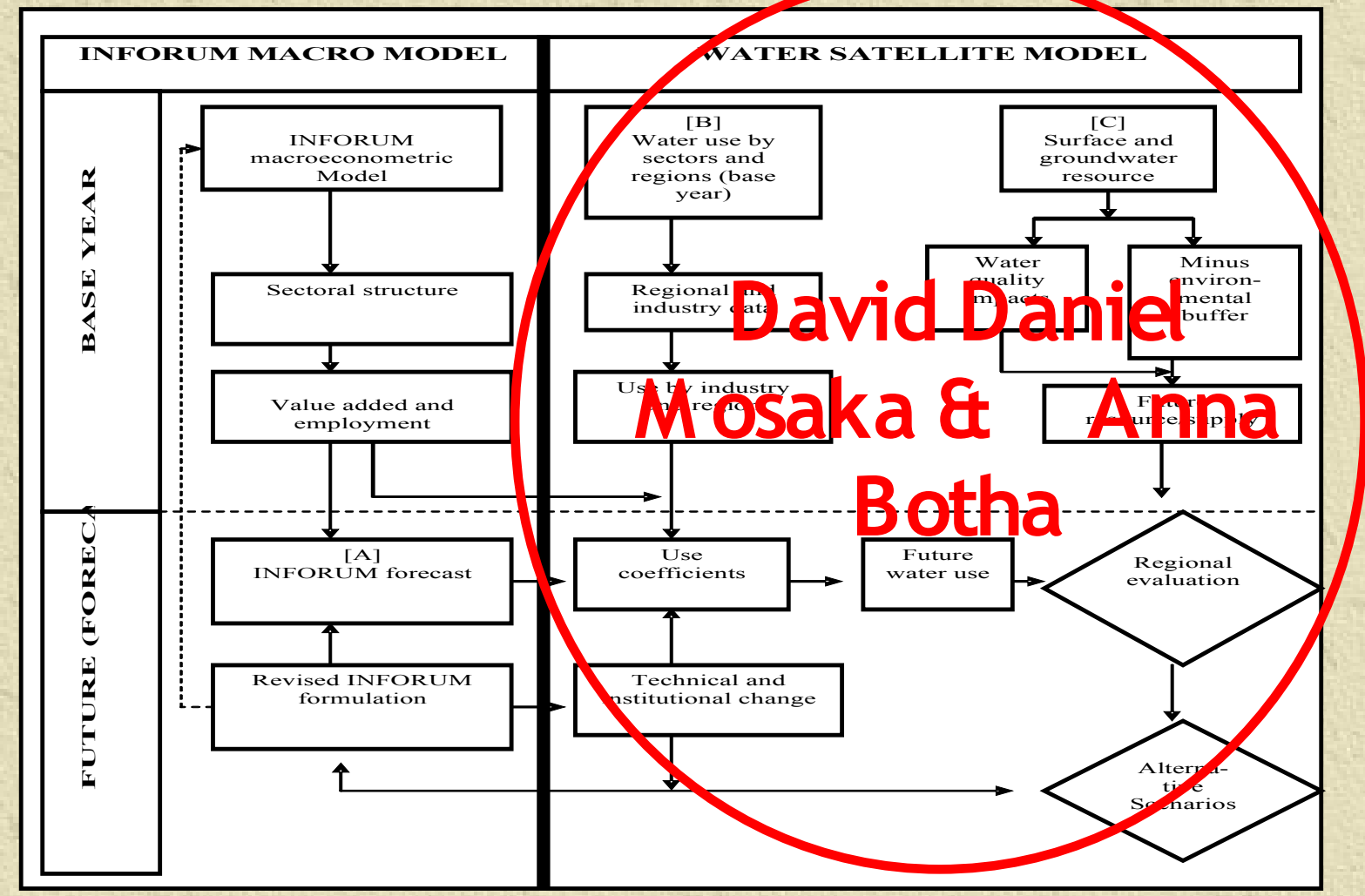
Structure of the INFORUM Model – with specific reference to the Water Impact Model

Diagram 1: Model Structure



Data requirements and sources

- *The model requires sectoral economic data from the demand and supply side of the economy*
- *The model requires "institutional" data which explains the distribution and re-distribution of income from its origin to various institutions such as households, the government, business enterprises, the rest of the world.*
- *International trade data*

South African Data Sources

- *Main suppliers of data*
  Statistics South Africa
  South African Reserve Bank
- *Based on information supplied by both institutions, a private company, QUANTEC RESEARCH (Pty), have produced a set of sectoral national accounting time series data from 1970 to 2005*
  - *46 industries*
  - *Private consumption expenditure (Durable, semi-durable and non-durable goods)*
  - *Government consumption expenditure*
  - *Investment goods*
  - *Change in inventories*
  - *Exports by destination*
  - *Imports by origin*

Data from QUANTEC Research

- An Input-Output Table exists on an annual basis from 1970 to 2005
- Each annum's table is depicted in nominal terms and constant 2000 prices
- Detailed information on the origin of imports and the destination of exports is available on a sectoral basis

Industries included in each I-O Table from 1970 to 2005

01: Agriculture, forestry & fishing
02: Coal mining
03: Gold and uranium ore mining
04: Other mining
05: Food
06: Beverages
07: Tobacco
08: Textiles
09: Wearing apparel
10: Leather & leather products
11: Footwear
12: Wood & wood products
13: Paper & paper products
14: Printing, publishing & recorded media
15: Coke & refined petroleum products
16: Basic chemicals
17: Other chemicals & man-made fibres
18: Rubber products
19: Plastic products
20: Glass & glass products
21: Non-metallic minerals
22: Basic iron & steel
23: Basic non-ferrous metals
24: Metal products excluding machinery
25: Machinery & equipment
26: Electrical machinery
27: Television, radio & communication equipment
28: Professional & scientific equipment
29: Motor vehicles, parts & accessories
30: Other transport equipment
31: Furniture
32: Other industries
33: Electricity, gas & steam
34: Water supply
35: Building construction
36: Civil engineering & other construction
37: Wholesale & retail trade
38: Catering & accommodation services
39: Transport & storage
40: Communication
41: Finance & insurance
42: Business services
43: Medical, dental & other health & veterinary services
44: Other community, social & personal services
45: Other

The detail of value added included in each I-O Table from 1970 to 2005

- Compensation of employees
- Net operating surplus
- Consumption of fixed capital
- Other taxes on production
- Other subsidies on production
- Customs and excise duties
- VAT/GST
- Rest of indirect taxes on products
- Subsidies on products

Components of value added reflected in each I-O

The Price Model

$$P = P\,A_D + P_M\ A_M + unitva$$

where

P	=	Price of goods and services
A_D	=	Locally produced portion of domestic intermediate demand
P_M	=	Import price of goods and services
A_M	=	Imported portion of domestic intermediate demand
unitva	=	unit value added

The Price Model (Continued)

$$P = P A_D + P_M A_M + unitva$$

$$P - PA_D = P_M A_M + unitva$$

$$P [I - A_D] = P_M A_M + unitva$$

$$P = \{ P_M A_M + unitva \} [I - A_D]^{-1}$$

Step 1: Calculate Leontief Inverse

The $[I - A_D]^{-1}$ matrix will be calculated for each year, from 1970 to 2005. The results of the current price model have been based on only the 2000 inverse.

(1) x (2) =

1.05	0.01	0.36
0.03	1.03	0.02
0.13	0.04	1.14

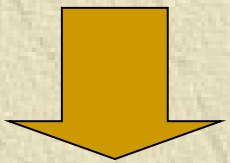
$= M = A_D$

Then calculate $[I - A_D]^{-1}$

Step 2: Calculate Unit Value Added

$$P_D = \{ P_M A_M + unitva \}[I - A_D]^{-1}$$

Unitva = Value added / Production



Value added =

+ Remuneration of employees (REM)

+ Gross operating surplus (GOS)

+ Net indirect tax

Step 2: Calculate Unit Value Added – The Regression Analyses

Remuneration of employees (REM)

$$REM = f(CPI, caplab)$$

Net operating surplus

Gross operating surplus (GOS)

GOS

f (1) Profits and (2) Interest payments *st)*

where

CPI = Consumption of fixed capital

caplab = *Capital stock / Employment ratio*

PPI = *Production price index*

Interest = *Capital market interest rate*

Unique equation for each sector

Step 2: Calculate Unit Value Added – Results of the Regression Analyses

Dependent Variable: SECTOR_S_W_34 (Salaries & wages in the water sector)

Method: Least Squares

Sample: 1970 2005

Included observations: 36

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant (Intercept)	*0.015*	*0.020*	*0.770*	*0.447*
CPI	*0.001*	*0.000*	*10.822*	*-*
CAPLAB	*-0.034*	*0.038*	*-0.906*	*0.371*

R-squared	***0.9457***
Adjusted R-squared	***0.9424***

Step 2: Calculate Unit Value Added – Results of the Regression Analyses

Dependent Variable: SECTOR_GOS_34 (Gross Operating Surplus in the water sector)

Method: Least Squares

Sample: 1970 2005

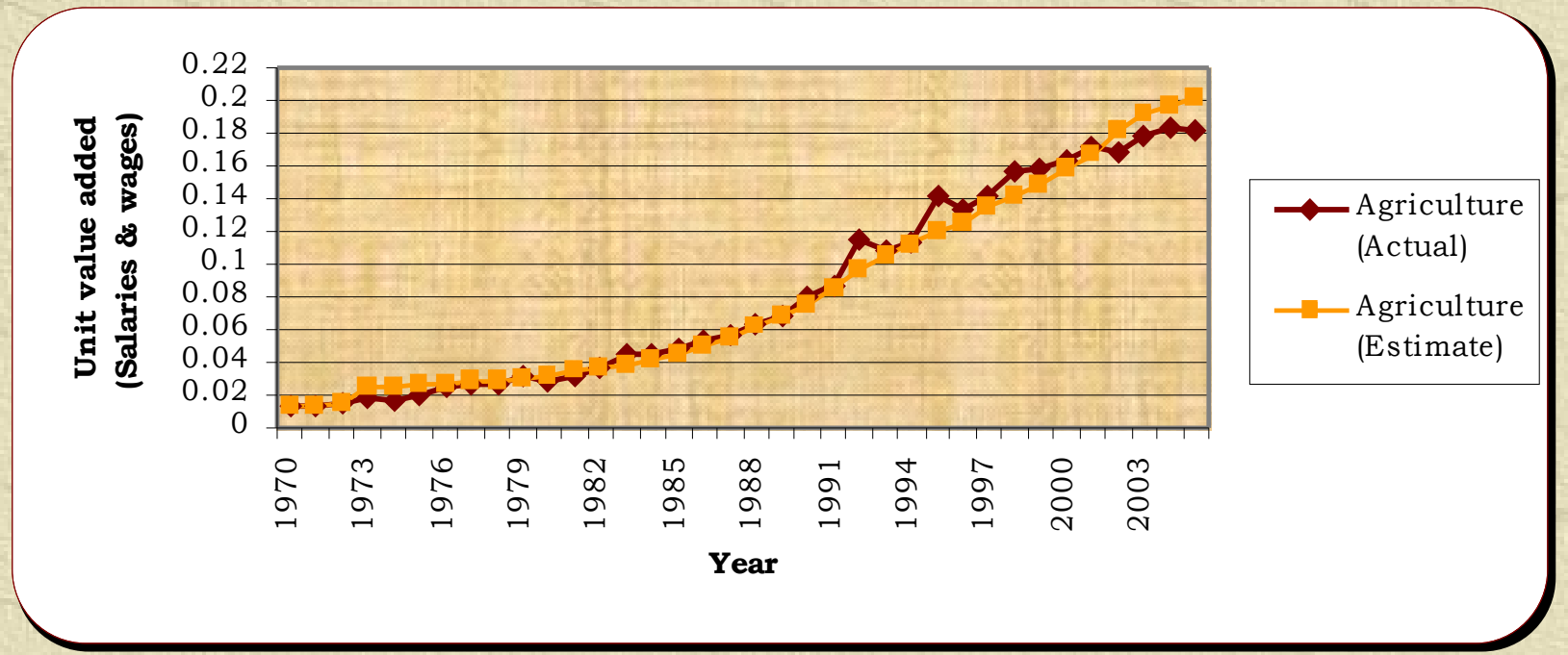
Included observations: 36

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
Constant (Intercept)	*-0.065*	*0.026*	*-2.460*	*0.020*
PPI	*0.002*	*0.000*	*11.280*	*-*
CAPLAB	*0.093*	*0.068*	*1.356*	*0.185*
INTEREST	*0.000*	*0.001*	*0.240*	*0.812*

R-squared	***0.9814***
Adjusted R-squared	***0.9797***

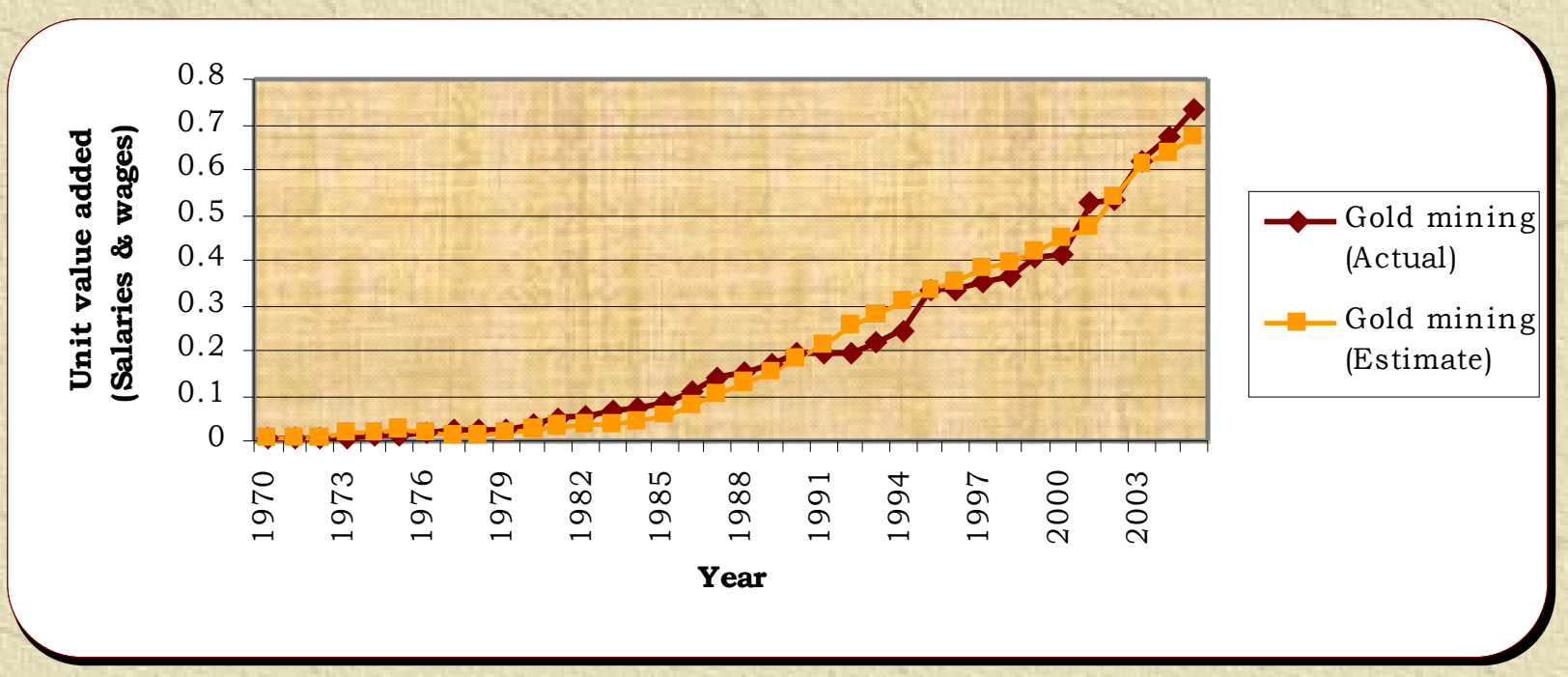
Step 2: Calculate Unit Value Added – Results of the Regression Analyses

Graph 1: Actual & estimated unit value added in terms of salaries and wages in the agriculture sector



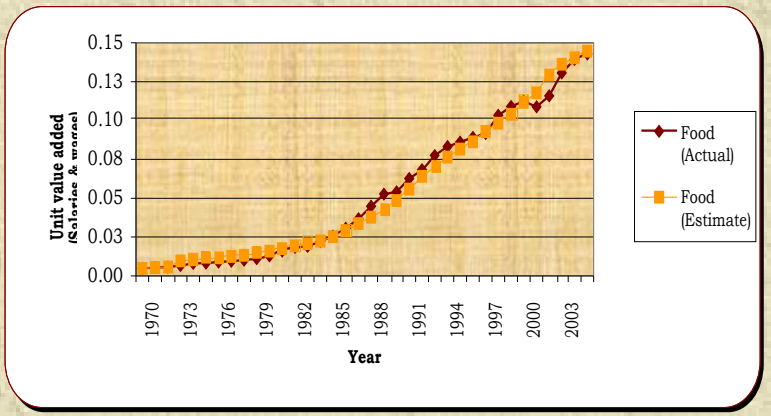
Step 2: Calculate Unit Value Added – Results of the Regression Analyses

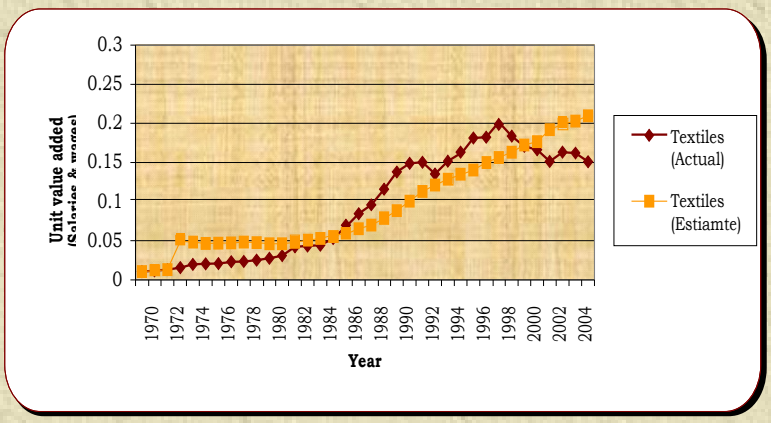
Graph 2: Actual & estimated unit value added in terms of salaries and wages in the gold mining sector

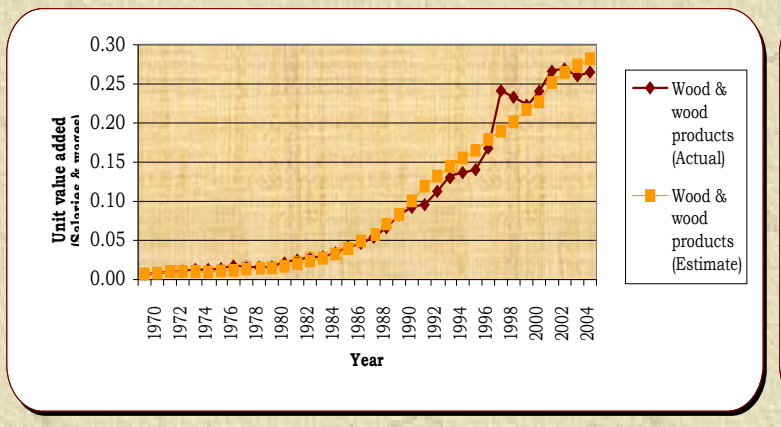


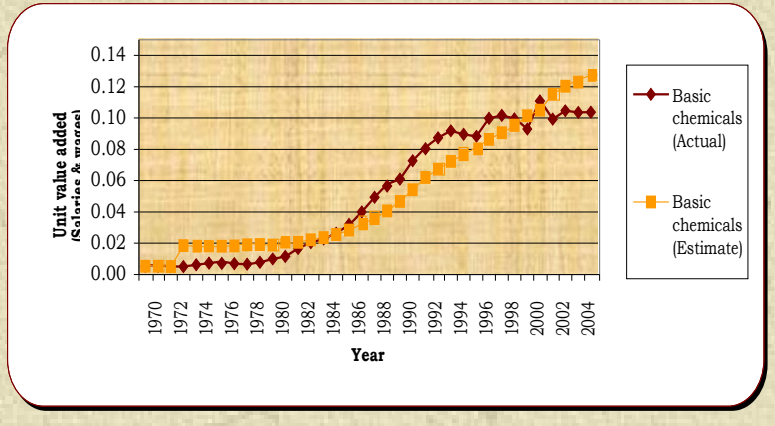
Step 2: Calculate Unit Value Added – Results of the Regression Analyses

Graph 3 -7: Actual & estimated unit value added in terms of salaries and wages in various manufacturing sectors









Step 2: Calculate Unit Value Added – Results of the Regression Analyses

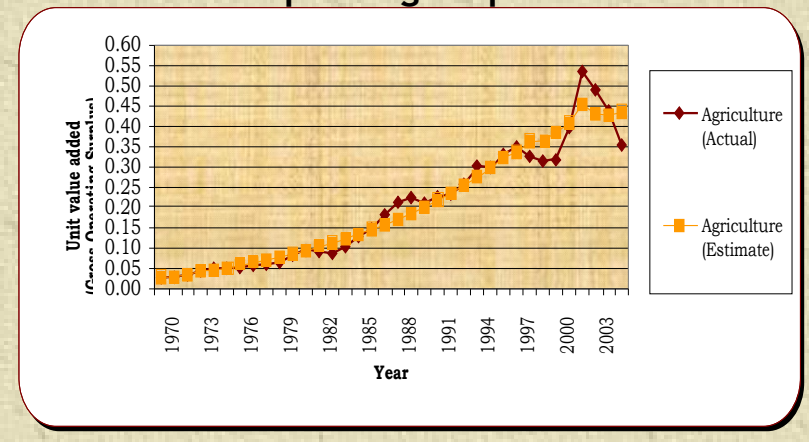
Dependent Variable: SECTOR_S_W_42 (Salaries & wages in the business services sector)
Method: Least Squares
Sample: 1970 2005
Included observations: 36

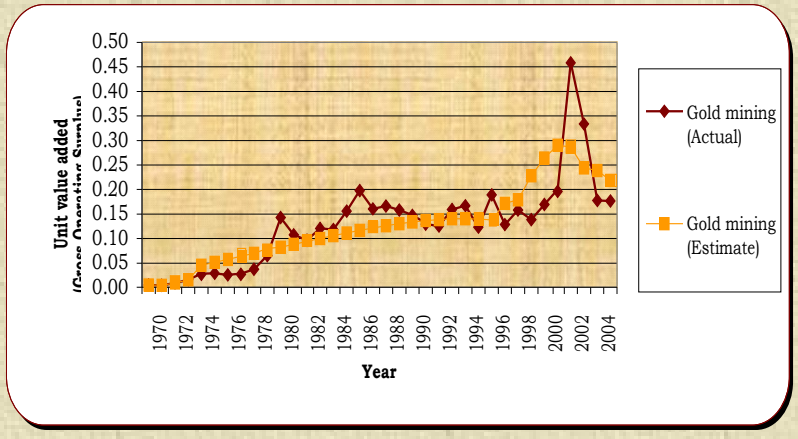
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	*0.01*	*0.01*	*1.72*	*0.09*
CPI	*0.00*	*0.00*	*47.98*	*0.00*
CAPLAB	*-0.02*	*0.01*	*-2.02*	*0.05*

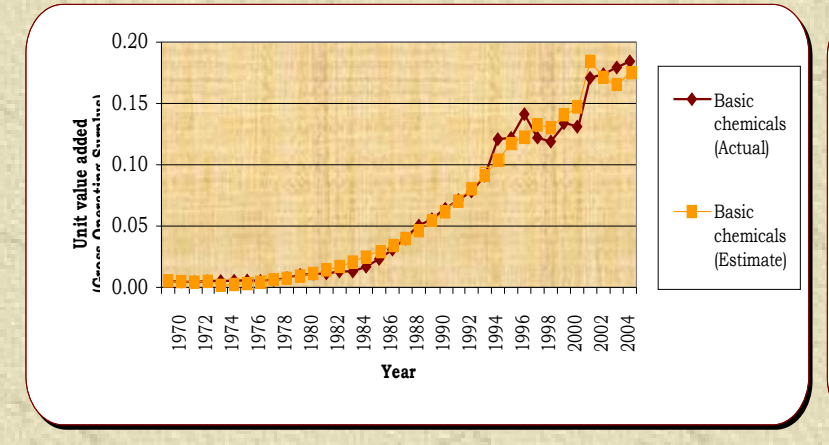
R-squared	***0.9973***
Adjusted R-squared	***0.9971***

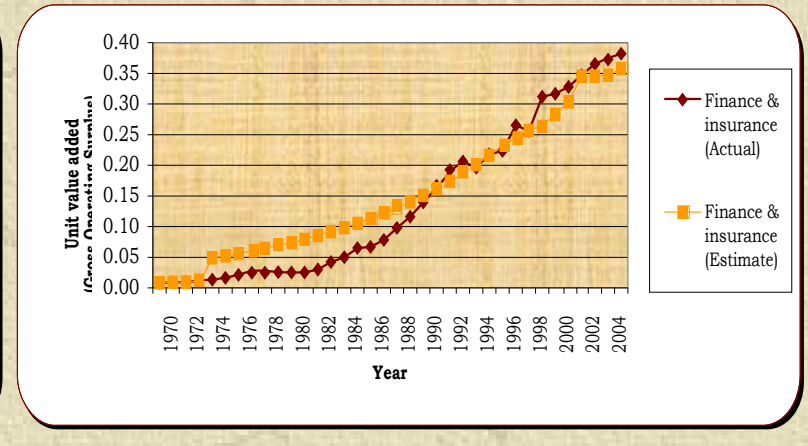
Step 2: Calculate Unit Value Added – Results of the Regression Analyses

Graphs 9 -12: Actual & estimated unit value added in terms of Gross Operating Surplus









Step 3: Calculate the Price of Imports

Due to the availability of I-O Tables from 1970 to 2005 in nominal and constant prices, it is possible to establish import price time series for each of the 46 sectors.

Import prices

$$IMP = f(worldprice, exchange\ rate)$$

where

IMP	=	*Import price index*
worldprice	=	*World consumer price index*
exchange rate	=	*Nominal effective exchange rate of the rand*

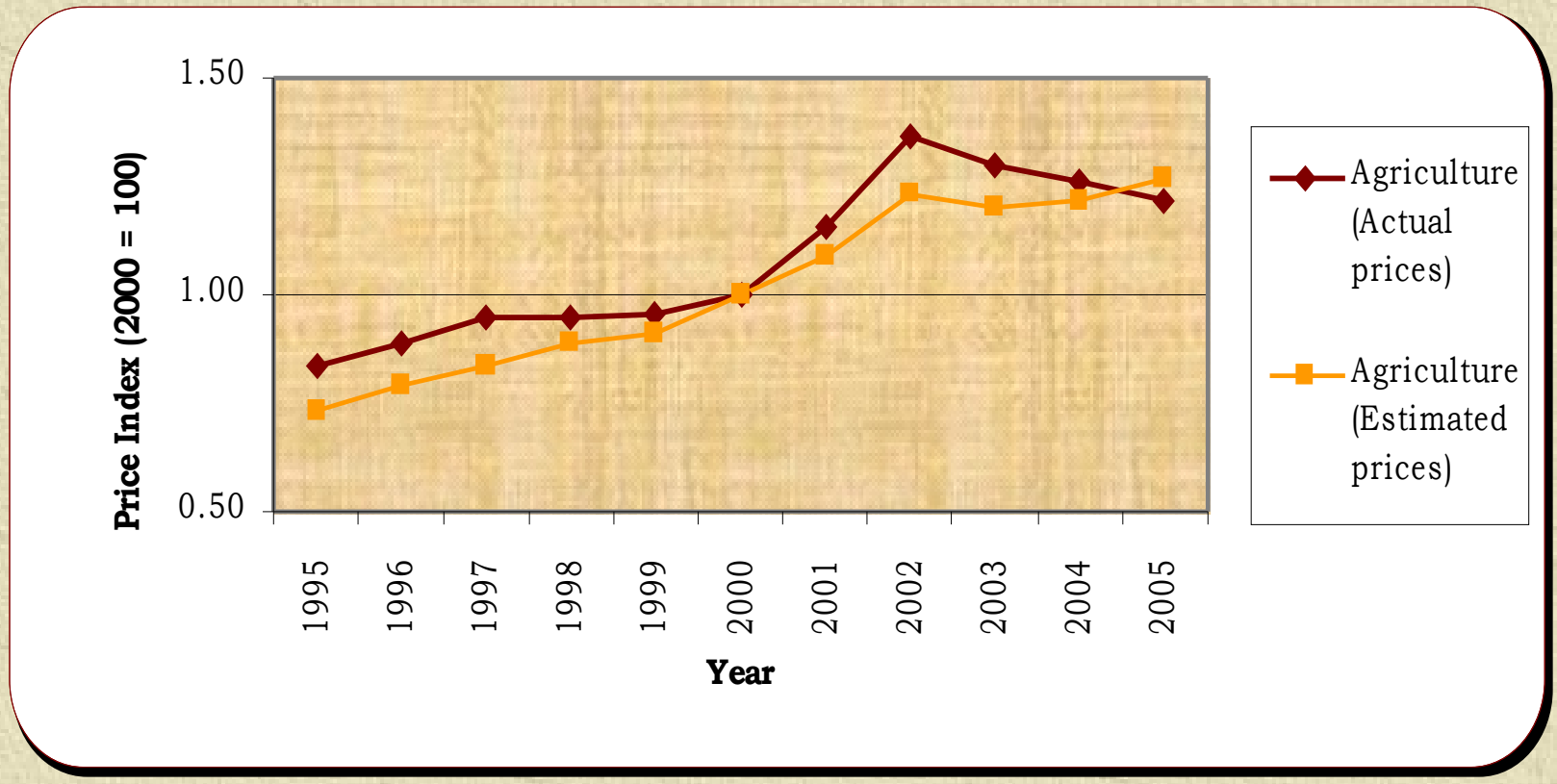
Results of the Price Model

$$P = \{ P_M A_M + unitva \}[I - A_D]^{-1}$$

P can also be determined using the annual I-O Tables from 1970 to 2005, by simply dividing nominal production per annum by real production per annum, for each sector.

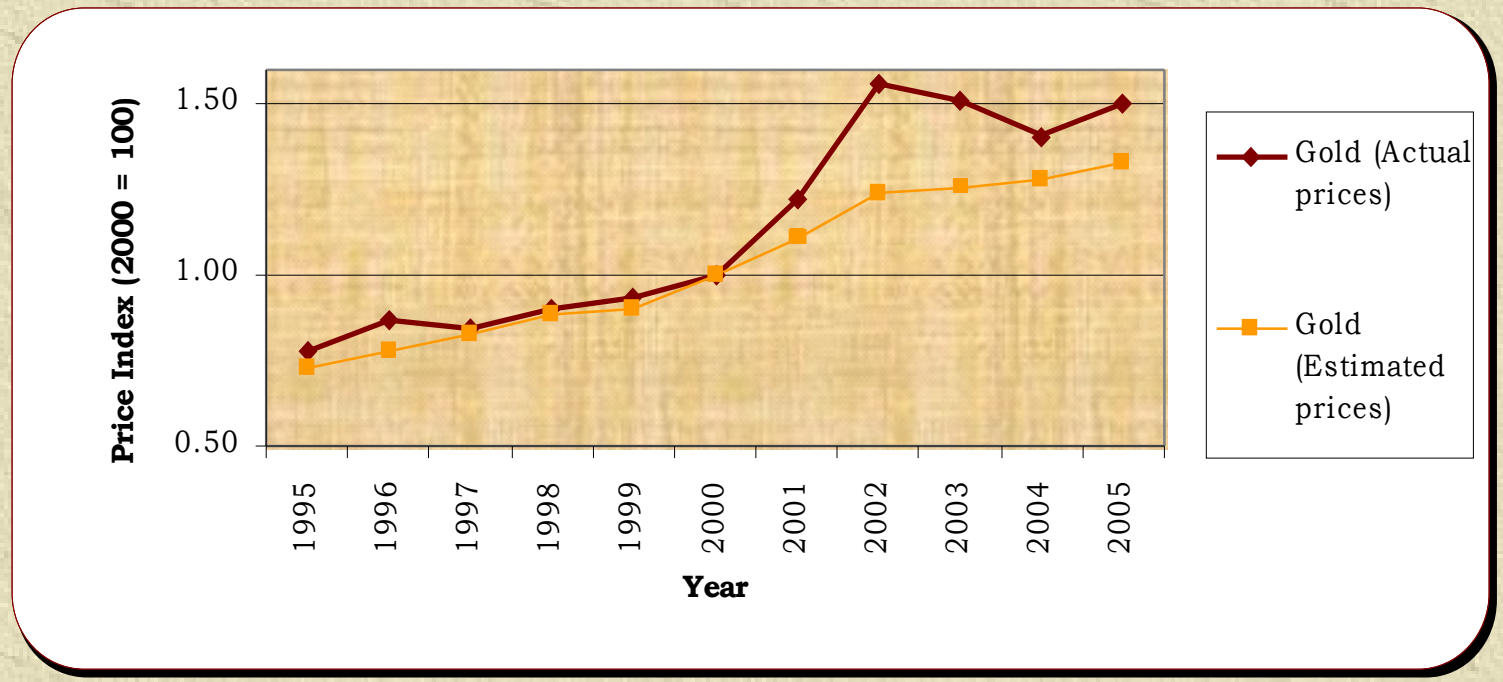
Results of Price Model

Graph 13: Actual & estimated price of agriculture products



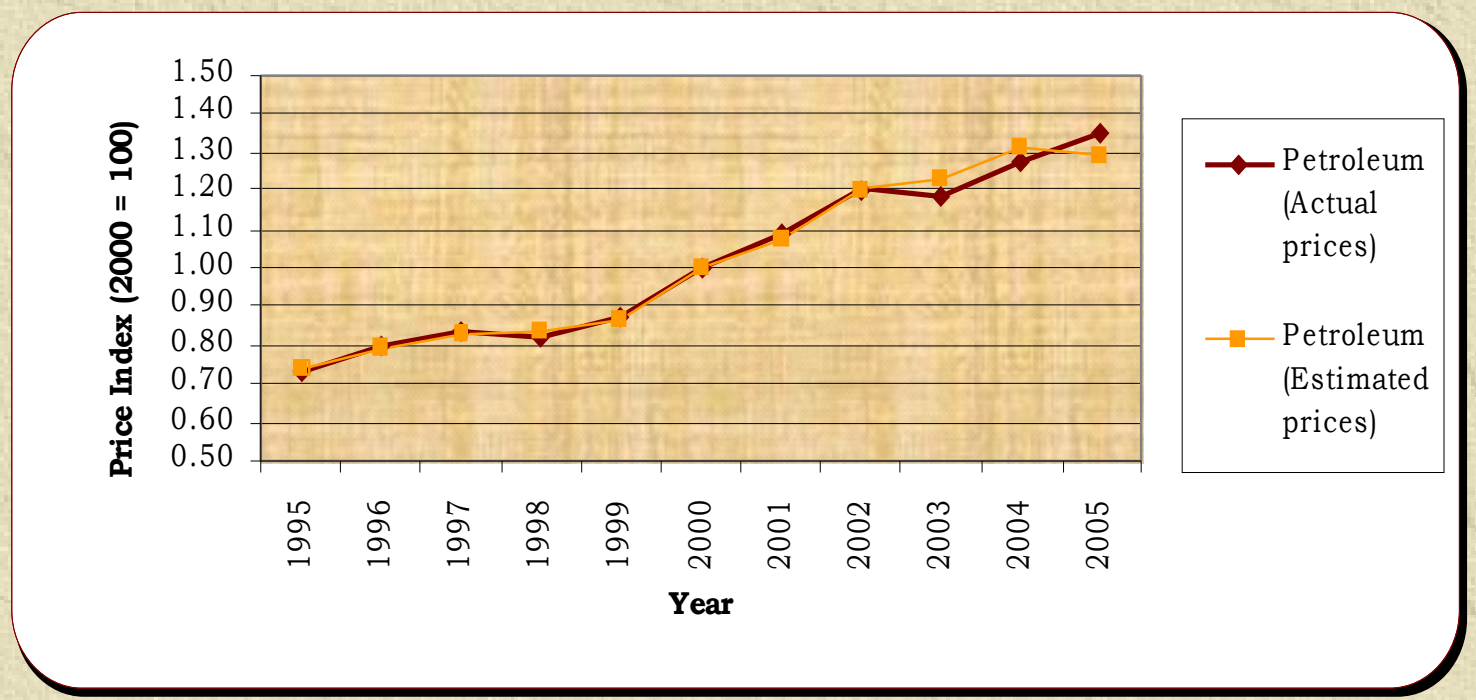
More results of Price Model

Graph 14: Actual & estimated price of gold



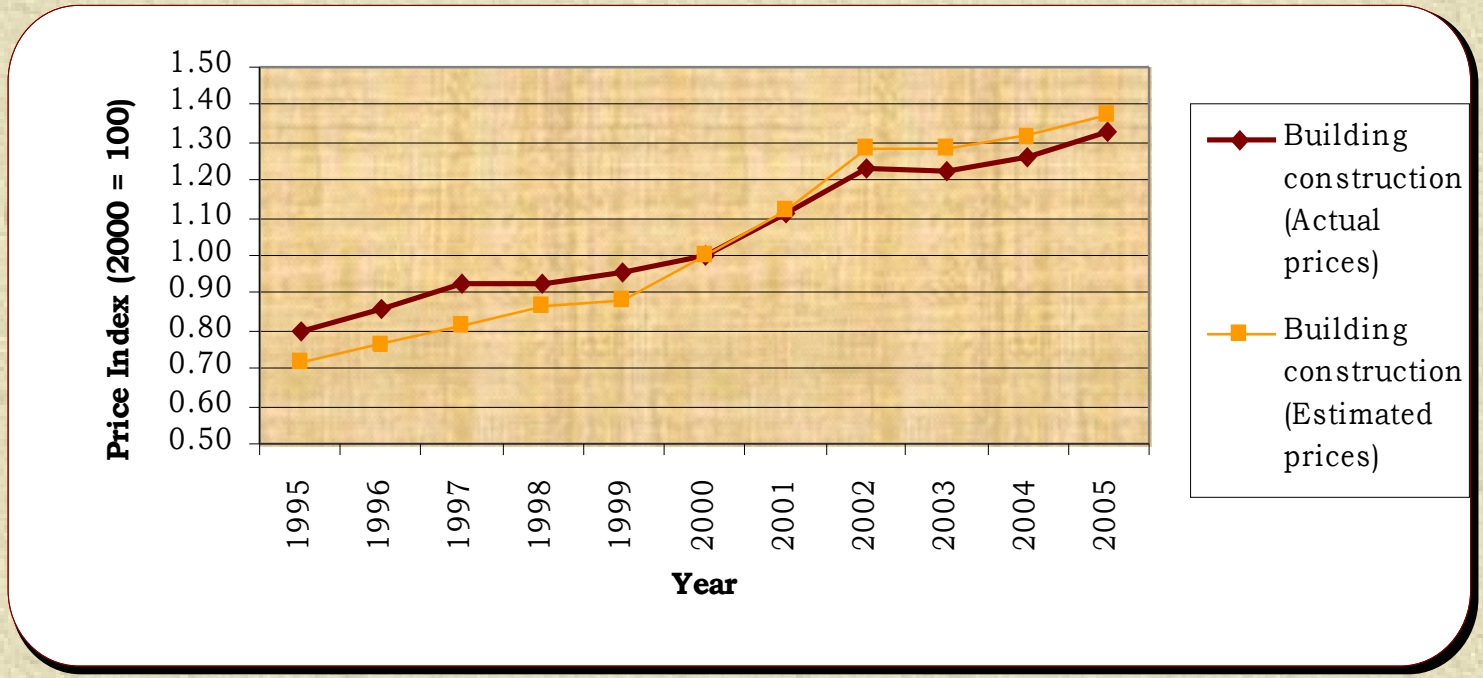
More results of Price Model

Graph 15: Actual & estimated price of petroleum



More results of Price Model

Graph 16: Actual & estimated price of building construction



Questions?

- **Is it advisable to calculate $[I – A]^{-1}$ for each year from 1975 to 2005?**
- **Any suggestions on regressing salaries and wages, and Gross Operating Surplus (GOS)?**
- **In terms of GOS, it is advisable to have separate equations for Net Operating Surplus (NOS) and Consumption of Fixed Capital (Depreciation). Should NOS also be separated into Profits and Interest Payments? If yes, any suggestions on the specifications of such equations?**
- **Import Prices – any suggestions on specification?**

Thank