Labour productivity in the Polish economy. A sectoral perspective

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Structure of the presentation

1) Main research questions;

2) Labour productivity and total factor productivity (TFP);

3) A short review of contemporary studies on TFP growth – macroeconomic and sectoral perspectives;

4) Model of TFP growth for Poland;

5) Database;

6) Empirical results;

7) Conclusions and goals for future research.

Main research questions:

1. To what extent changes in labor productivity in the Polish economy and its various sectors result from the changes in total factor productivity and capital -to- labour ratio?

2. What factors associated with broadly understood knowledge resources stimulate TFP growth of the Polish economy and its sectors?

3. What kind of channel of knowledge transfer from abroad are of utmost importance in the growth of TFP in the Polish economy and its sectors?

Labour productivity and total factor productivity (TFP)

1. In the neoclassical approach, labour productivity is a function of capital-to-labour ratio and technical progress (mostly represented by the changes in TFP).

2. In the endogenous growth theory technical progress results from the accumulation of knowledge (Romer, 1986, 1990, Aghion, Howitt, 1992) or from the stock of human capital (Lucas, 1988).

The main factors of TFP growth – contemporary empirical studies

1) The first empirical studies into TFP growth and factors determining it – the 1980s (research for the US economy, Griliches 1980, 1982, Griliches, Lichtenberg, 1984).

2) Main factors of TFP growth in these studies: domestic knowledge stock, possibility of externalities (transfers of knowledge among enterprises or industries).

The main factors of TFP growth – contemporary empirical studies

3) Coe&Helpman (1995) – macroeconomic panel study for developed countries. The main sources of TFP growth: domestic and foreign knowledge stock. The main channel of knowledge transfer from abroad: imports.

4) Coe&Helpman&Hoffmaister (1997) – macroeconomic panel study for developing countries. The main sources of productivity growth: foreign knowledge stock transferred by imports of capital goods.

The main factors of TFP growth – contemporary empirical studies

5) The dynamic development of research on the issues of TFP growth at the macroeconomic level after 1997 (Engelbrecht, 1997; Xu Wang, 1999; Rham, Zheng, 2002; Lee, 2006; Seck, 2012, Ang Madsen, 2013).

6) Possible channels of technology transfer from abroad: import (key factor), export (learning – by – exporting), FDI, ITC technologies, patent and licences flow, disembodied knowledge transfer.

The main factors of TFP growth – contemporary empirical studies

- In the research on the industry level: the phenomenon of transfer of knowledge among sectors.

- Significance of the absorbtive capabilities as a factor stimulating knowledge transfer. These capabilities are strongly associated with human capital stock.

The model:

The neoclassical approach: aggregate production function:

$$Y = F(A, K, L) \qquad\qquad (1)$$

The assumption about constant economies of scale:

$$Y/L = f(A, K/L) \qquad\qquad (2)$$

$$A = f(technology) \qquad\qquad (3)$$

The model:

$$A = TFP = \frac{Y}{K^{\alpha}L^{(1-\alpha)}} \tag{4}$$

$$A = f(dom. knowl.; \ foreign \ knowl.) \tag{5}$$

Domestic knowledge stock is represented by cumulative domestic R&D expenditures performed by business sector.

Foreign knowledge stock is represented by cumulative R&D business expenditure transferred into the Polish economy by imports and FDI.

The transfer of knowledge from abroad is taken into account in its disembodied form .

The model:

The final form of the model is as follows:

$$lnA_{it} = \alpha_0 + \alpha_1 lnS_{it}^{dom} + \alpha_2 lnS_{it}^{imp} + \alpha_3 lnFDIS_{it} + \alpha_4 lnS_{it}^{dis} + \varepsilon_{it}$$

$$S_{it}^{dom} = (1-\rho)S_{it-1}^{dom} + RD_{it}^{dom}$$

$$S_{it=0} = \frac{RD_{it=0}}{\rho+\delta}$$

$$S_{it}^{imp} = \sum_{j=1}^{9} \frac{m_{it}^{j}}{Y_{it}^{j}} S_{it}^{j(dom)}$$

$$S_{it}^{dis} = \frac{1}{9}\sum_{j=1}^{9} S_{it}^{j(dom)}$$

The data:

Main sources of the data:

1) The Polish Central Statistical Office;

2) OECD STAN Database:

     - R&D expenditures by industry;

     - STAN Bilateral trade database (imports);

     - OECD International Foreign Direct Investment.

Labour productivity and TFP rate of growth (NACE 2 Code)

	High rate of TFP growth (at least 3% p.a)	Low rate of TFP growth (below 3% p.a.)
High rate of labour productivity growth (at least 3% p.a)	C11, C13, C14, C15, C17, C18, C21, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, D, N	C10, C12, C16, C19, C22, F, G
Low rate of labour productivity growth (below 3% p.a.)	-	A, B, C20, E, H, I, J, K, L, M, O, P, R, S

a) In the majority of the manufacturing divisions a high rate of growth of LB was accompanied with the high rate of TFP growth (particulary in the high-tech and medium high-tech manufacturing industries).

b) In most branches of service sector and in agriculture, mining, water supply and chemical industry the changes in both variables are similar but the rate of growth was lower than in first group;

Estimation results (whole economy, 42 branches, 2005-2013)

Variable	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
const.	1.192***	1.33***	1.31***	1.18***	1.33***
	(14.89)	(36.65)	(17.44)	(13.86)	(15.74)
$\ln(S^{dom})$	0.032***	0.039***	0.024***	0.039***	0.043***
	(5.94)	(8.28)	(4.36)	(7.07)	(7.08)
$\ln(FDIS)$	0.026**		0.037***	0.022	0.033**
	(2.02)		(2.94)	(1.65)	(2.42)
$\ln(SF^{imp})$	0.069***	0.078***		0.095***	
	(5.20)	(5.99)		(7.69)	
$\ln(SF^{dis})$	0.069***	0.068***	0.094***		
	(5.02)	(4.76)	(6.96)		
Number of observations	378	378	378	378	378
Cross section fixed (dummy variables)	yes	yes	Yes	yes	yes
Adjusted R^2	0.997	0,997	0.998	0,996	0.995
Hausman test (p-value)	<0.01	<0.01	<0.01	<0.01	<0.01

Estimation results (industry and construction, 28 branches, 2005-2013)

Variable	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
const.	0.39**	0.69***	0.89***	0.78***	1.06***
	(2.15)	(5.99)	(5.91)	(7.47)	(14.30)
$\ln(S^{dom})$	0.058***	0.069***	0.094***	0.080***	0.102***
	(4.75)	(6.18)	(10.39)	(8.95)	(10.24)
$\ln(FDIS)$	0.058**		0.056**		
	(2.24)		(2.30)		
$\ln(SF^{imp})$	0.110***	0.114***		0.123***	
	(4.65)	(4.59)		(4.78)	
$\ln(SF^{dis})$	0.049*	0.060**			0.064**
	(1.77)	(2.07)			(2.18)
Number of observations	252	252	252	252	252
Cross section fixed (dummy variables)	yes	Yes	Yes	yes	Yes
Adjusted R^2	0.975	0,974	0.979	0,974	0.974
Hausman test (*p-value*)	<0.01	<0.01	<0.01	<0.01	<0.01

Estimation results (services, 13 branches, 2005-2013)

Variable	Variant 1	Variant 2	Variant 3
const.	2.54***	2.22***	2.03***
	(22.36)	(44.08)	(23.94)
$\ln(S^{dom})$	0.005	0.01**	
	(0.92)	(2.35)	
$\ln(FDIS)$	0.026**		0.065***
	(2.12)		(5.14)
$\ln(SF^{dis})$	0.067***	0.07***	0.031***
	(5.18)	(5.37)	(3.00)
Number of observations	117	117	117
Cross section fixed (dummy variables)	yes	Yes	Yes
Adjusted R^2	0.998	0.998	0.998
Hausman test (*p-value*)	<0.01	<0.01	<0.01

Estimation results (manufacturing, 24 branches, 2005-2013)

Variable	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5
const.	-0.086 (-0,38)	-0.11 (-0.52)	0.171 (0.90)	0.606*** (4.07)	0.96*** (9.50)
$\ln(S^{dom})$	0.079*** (5.97)	0.079*** (6.94)	0.102*** (10.09)	0.113*** (10.04)	0.133*** (16.25)
$\ln(FDIS)$	0.154*** (5.08)	0.154*** (5.13)	0.158*** (5.01)		
$\ln(SF^{imp})$	0.07** (2.65)	0.075*** (2.75)		0.110*** (3.53)	
$\ln(SF^{dis})$	0.0006 (0.01)				0.042 (1.45)
Number of observations	216	216	216	216	216
Cross section fixed (dummy variables)	yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.976	0.975	0.977	0.973	0.98
Hausman test (p-value)	<0.01	<0.01	<0.01	<0.01	<0.01

Estimation results in manufacturing (high-tech and medium high-tech vs. low-tech and medium low-tech sectors)

Variable	High-tech and medium high-tech manufacturing sectors			Medium-low and low manufacturing sectors		
	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5	Variant 6
const.	-2.85*** (-2.28)	-2.95*** (-8.24)	-2.89*** (-8.02)	0.895*** (4.31)	0.847*** (4.36)	0.741*** (3.99)
$\ln(S^{dom})$	0.21*** (5.46)	0.204*** (5.56)	0.234*** (8.09)	0.092*** (5.91)	0.093*** (7.46)	0.087*** (8.76)
$\ln(FDIS)$	0.105 (1.43)	0.110 (1.53)		0.051 (1.53)	0.063** (2.03)	0.065** (2.12)
$\ln(SF^{imp})$	0.428*** (6.196)	0.422*** (6.01)	0.494*** (9.19)	0.003 (0.09)		
$\ln(SF^{dis})$	-0.029 (-0.36)			-0.035 (-1.07)	-0.04 (-1.43)	
Number of observations	81	81	81	135	135	135
Cross section fixed (dummy variables)	yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.940	0.937	0.936	0.981	0.984	0.981
Hausman test (*p-value*)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Main conclusions:

1. In the majority of sectors in the Polish economy labour productivity is determined by TFP. This relationship is particularly clear in the branches of the manufacturing industry, especially in the high and medium-high tech industries.

2. TFP in various sectors of the Polish economy depends on the stock of both domestic and foreign knowledge. From among all possible channels of foreign knowledge transfers, only imports and FDI were analysed. It was also assumed that knowledge may diffuse between countries through disembodied forms.

3. At the level of the entire economy, both the stock of domestic knowledge and the transfer of knowledge from abroad are significant drivers of TFP growth. After the economy was disaggregated into various areas of economic activity, particular factors turned out to have different influence on TFP growth.

Future directions:

1. Future research on factors stimulating TFP growth in the Polish economy should also take into account other carriers of domestic (inter-industry knowledge diffusion), and foreign knowledge (i.e. imports of intermediate and capital goods).

2. In this search for determinants of TFP in Poland, the stock of human capital was omitted, mainly because of problems with estimating its amount at the sectoral level. From studies carried out for different countries it follows that the appropriate stock of human capital improves absorptive abilities of an economy and makes the stock of domestic and foreign knowledge more important for TFP growth.

THANK YOU FOR ATTENTION