Determinants of TFP growth in sectors of the Polish economy. A long-run and short-run 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: long-run and short-run perspective;
5) Database;
6) Empirical results;
7) Conclusions.

Main research questions:

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

2. What kind of channel of knowledge transfer from abroad are the most important for 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 on 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: phenomenon of transfer of knowledge among sectors.

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

The model:

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

The assumption of constant scale effects:

$$Y/_{L} = F\left(A, {}^{K}/_{L}\right) \qquad (2)$$

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

The model:

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

$$A = f(dom.knowl.;\ \ foreign\ knowl.) \qquad (5)$$

Domestic knowledge stock is represented by cumulative domestic R&D expenditures performed by business sector. The domestic knowledge transfer among industries via intermediate products flows also included.

Foreign knowledge stock is represented by cumulative R&D business expenditure transferred into the Polish economy (from the most developed countries) 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:

$$lnA_{it} = \alpha_0 + \alpha_1 lnS_{it}^{dom} + \alpha_2 lnS_{it}^{dom\_dyf} + \alpha_3 lnS_{it}^{imp} + \alpha_4 lnFDIS_{it} + \alpha_5 lnS_{it}^{dis} + \varepsilon_{it}$$

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

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

$S_{it}^{dom\_dyf}$ estimated as the column sum of matrix F:

$$F = \hat{s}(I - A^*)^{-1}\hat{x}$$

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

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

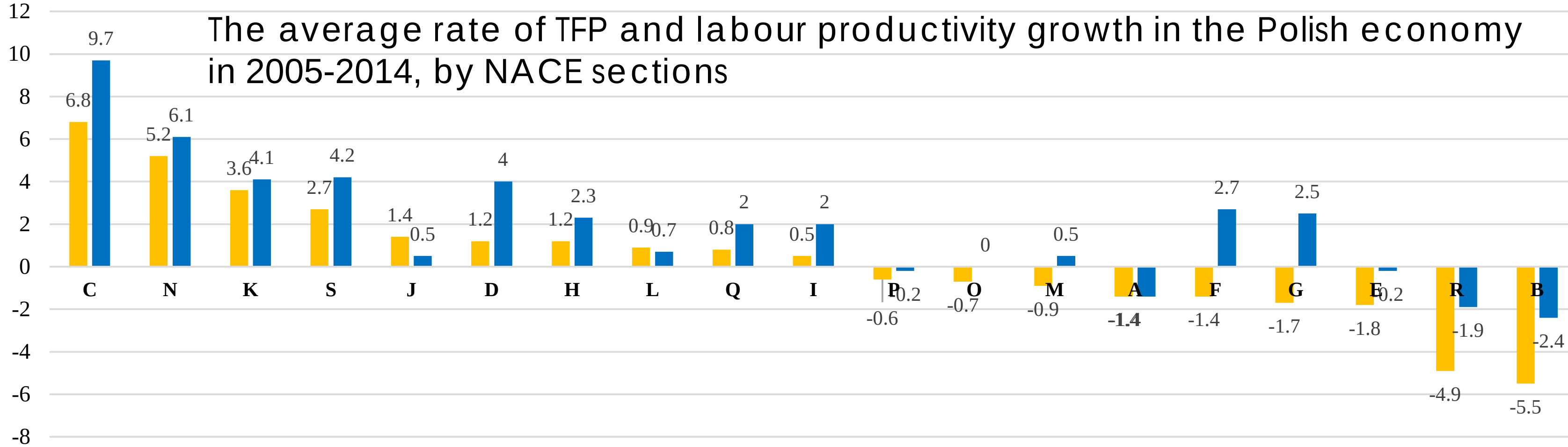
The data:

Main sources of the data:

1) Central Statistical Office of Poland;

2) OECD STAN Database:
   - R&D expenditures by industry;
   - STAN Bilateral trade database (imports);
   - OECD International Foreign Direct Investment.

Main conclusions about TFP changes in ihe Polsish economy



1) In the whole analysed period the highest rate of TFP (and labour productivity) growth was observed in manufacturing;
2) Among the manufacturing industries, the highest TFP growth rates were obtained in the high and medium-high technology branches (computers, electronic and optical equipment; electrical equipment; other transport equipment; machinery and equipment);
3) Traditional industries are characterized by relatively low TFP rate of growth;
4) Among the services, the highest rates of TFP growth were observed in administrative and support services and finance and insurance activities;
5) Surprisingly, in the case of KIBS the rate of TFP growth is low or even negative (information and communication –J; professional, scientific and technical activities – M).

Estimation methods

1) Parametrers of long-run relationships were estimated by using the FE (fixed effects) model for panel data. Random effect models were also tested.

Long-run relationship between TFP and knowledge capital factors is described by formula:

$$\ln A_{it} = \alpha_0 + \alpha_1 \ln S_{it}^{dom} + \alpha_2 \ln S_{it}^{dom\_dyf} + \alpha_3 \ln SF_{it}^{imp} + \alpha_4 \ln FDIS_{it} + \alpha_4 \ln SF_{it}^{dis} + \varepsilon_{it}$$

2) Dynamic version of the above model:

$$\Delta \ln A_{it} = \delta \ln A_{it-1} + \beta_1 \Delta \ln S_{it}^{dom} + \beta_2 \Delta \ln S_{it}^{dom\_dyf} + \beta_3 \Delta \ln SF_{it}^{imp} + \beta_4 \Delta \ln FDIS_{it} + \beta_4 \Delta \ln SF_{it}^{dis} + u_{it}$$

The parameters of this model were estimeted by using Arellano-Bond estimator (based on GMM method – first difference GMM estimator - FDGMM). Autoregressive parameter is equal to $\gamma = \delta + 1$.

Estimation results (whole economy, 42 branches, 2005-2014)

Variables	Long-run relation model FE (last version)	Short-run relation Model FDGMM (last version)
constant	1.29*** (50.42)[a)]	-
$\ln(TFP_{it-1})$	-	-0.369*** (28.44)
$\ln(S_{it}^{kraj})$	0.019*** (4.58)	0.022*** (2.91)
$\ln(S_{it}^{dyf\_kraj})$	0.041*** (5.54)	0.058*** (3.44)
$\ln(SF_{it}^{imp})$	0.0312*** (5.18)	0.037** (2.45)
$\ln(FDIS_{it})$	0.013* (1.73)	0.0147** (2.05)
$\ln(SF^{disemb})$	0.072*** (6.26)	0.032** (1.98)
Number of observations	420	336
Adjusted R^2	0.996	-
Durbin-Watsona statistics	1.02	-
Hausman test (*p-value*)	<0.01	-
Arellano-Bond'a AR(1) statistics, (*p-value*)	-	-1.723 (<0.05)
Arellano-Bond'a AR(2) statistics (*p-value*)	-	-0.107 (>0.1)

Source: own calculations
* statistically significant at 10%, ** - statistically significant at 5%,
*** - statistically significant at1%

Estimation results (industry, 27 branches, 2005-2014)

Variables	Long-run relation model FE (last version)	Short-run relation Model FDGMM (last version)
constant	0.49*** (2.83)[a)]	-
$\ln(TFP_{it-1})$	-	-0.379*** (15.35)
$\ln(S_{it}^{kraj})$	0.073*** (6.48)	0.140*** (4.62)
$\ln(S_{it}^{dyf\_kraj})$		0.114*** (4.15)
$\ln(SF_{it}^{imp})$	0.089*** (3.42)	
$\ln(FDIS_{it})$	0.042* (1.75)	0.049** (4.25)
$\ln(SF^{disemb})$		0.142** (3.70)
Number of observations	270	216
Adjusted R^2	0.974	-
Durbin-Watsona statistics	1.25	-
Hausman test (*p-value*)	<0.01	-
Arellano-Bond'a AR(1) statistics, (*p-value*)	-	-0.62 (<0.05)
Arellano-Bond'a AR(2) statistics (*p-value*)	-	-1.507 (>0.1)

Source: own calculations

* statistically significant at 10%, ** - statistically significant at 5%,

*** - statistically significant at1%

Estimation results (manufacturing, 24 branches, 2005-2014)

Zmienne	**Manufacturing**		**High- and medium high-tech branches**		**Low- and medium low-tech branches**	
	FE model (last version)	FDGMM model	FE model (last version)	FDGMM model	FE model (last version)	FDGMM model
constant	0.197 (1.26)	-	-2.026*** (-5.23)	-	0.734*** (3.73)	-
$\ln(TFP_{it-1})$	-	-0.512*** (7.91)	-	-0.449*** (35.03)	-	-0.855*** (6.82)
$\ln(S_{it}^{kraj})$	0.062*** (8.38)	0.044*** (2.61)	0.083*** (2.76)	-	0.068*** (6.88)	0.069*** (5.67)
$\ln(S_{it}^{dyf\_kraj})$	-	-	0.213*** (6.86)	-	-	-
$\ln(SF_{it}^{imp})$	0.038** (2.24)	0.107* (1.85)	0.293*** (5.159)	0.176*** (5.05)	-	-
$\ln(FDIS_{it})$	0.156*** (5.69)	0.140*** (8.68)	0.095** (2.01)	-	0.082** (2.51)	0.132*** (11.89)
$\ln(SF^{disemb})$	-	0.113** (2.01)	-	-	-	-
Number of observations	240	192	90	72	150	120
Adjusted R^2	0.978	-	0.923	-	0.983	-
Durbin-Watson statistic	1.34	-	1.14	-	1.38	-
Hausman test (*p-value*)	<0.05	-	<0.05	-	<0.05	-
Arellano-Bond'a AR(1), (*p-value*)	-	-0.947 (<0,01)	-	-0.486 (<0.05)	-	-0.512 (<0.05)
Statystyka Arellano-Bond'a AR(2) (*p-value*)	-	-0.111 (>0,1)		0,066 (>0.1)		0.102 (>0.1)

Estimation results (services, 13 branches, 2005-2014)

Variables	Long-run relation model FE (last version)	Short-run relation Model FDGMM (last version)
constant	2.09*** (43.02)[a)]	-
$\ln(TFP_{it-1})$	-	-0.259*** (16.3)
$\ln(S_{it}^{kraj})$	0.006* (1.79)	
$\ln(S_{it}^{dyf\_kraj})$		
$\ln(SF_{it}^{imp})$		
$\ln(FDIS_{it})$	0.023*** (3.33)	0.028* (1.72)
$\ln(SF^{disemb})$	0.071*** (5.30)	0.073** (6.61)
Number of observations	130	104
Adjusted R^2	0.989	-
Durbin-Watsona statistics	1.23	-
Hausman test (*p-value*)	<0.01	-
Arellano-Bond'a AR(1) statistics, (*p-value*)	-	-0.236 (<0.1))
Arellano-Bond'a AR(2) statistics (*p-value*)	-	0.046 (>0.1)

Source: own calculations
* statistically significant at 10%, ** - statistically significant at 5%,
*** - statistically significant at1%

Main conclusions:

1. For the majority of sectors in the Polish economy, the labour productivity is determined by TFP. This relationship is particularly strong in the case of certain branches of the manufacturing industry, especially 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. 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 its disembodied form.

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. Once the economy is disaggregated into various areas of economic activity, particular factors have different influence on TFP growth.

THANK YOU FOR ATTENTION