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Book Part — Published Version

Changes in Total Factor Productivity

Suggested Citation: Prochniak, Mariusz (2016) : Changes in Total Factor Productivity, In: Weresa, Marzenna Anna (Ed.): Poland. Competitiveness Report 2016. The Role of Economic Policy and Institutions, SGH Warsaw School of Economics, Warsaw, pp. 141-148

This Version is available at:

<https://hdl.handle.net/10419/147258>

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POLAND

COMPETITIVENESS REPORT 2016

THE ROLE OF ECONOMIC POLICY AND INSTITUTIONS

Edited by
Marzenna Anna Weresa



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POLAND

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Changes in Total Factor Productivity

Mariusz Próchniak

This analysis of total factor productivity (TFP) will be conducted using the growth accounting framework. Growth accounting is an empirical exercise aimed at calculating how much economic growth is caused by changes in measurable factor inputs and in the level of technology.

The research methodology was presented in previous editions of this report (see, for example, Próchniak 2015). In the 2013 edition, we estimated total factor productivity in various sectors of the economy for Poland and selected other countries in Central-Eastern and Western Europe (10 sectors were examined according to the NACE-2 classification) (Próchniak, 2013). In the 2012 and 2014 editions, in addition to the basic model of growth accounting, we also estimated a model expanded to include human capital (Próchniak, 2012, 2014).

The analysis covers 11 CEE countries, referred to as the EU11 (Poland, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovakia, and Slovenia) during the 2006–2015 period. To assess changes in total factor productivity during that period, we also present the average TFP growth rates for the following subperiods: 2006–2007, 2008–2010, 2011–2014, and 2015.

In this round of research, we updated all the time series of the analyzed variables. All the steps of the analysis were recalculated. Moreover, some time series have new coverage. Thus, all the results are fully documented in the study and the analysis does not use information from previous editions of the report.

The following time series were collected for the purposes of our analysis: (a) the growth rate of GDP, (b) the growth rate of labor, and (c) the growth rate of physical capital. The data are derived from the following sources: the International Monetary Fund (IMF, 2016), the International Labor Organization (ILO, 2016), and the World Bank (World Bank, 2016). The economic growth rate is the real annual GDP growth rate, taken from the IMF database. The growth rate for labor is the change in total employment according to the ILO data (ILO, 2016). The amount of physical capital is calculated using the perpetual inventory method based on World Bank data (World Bank, 2016). This method requires a number of assumptions. We assumed a 5%

Table 9.1. Labor, physical capital, and TFP contribution to economic growth in 2006–2015

		2006			2007			2008			2009			2010		
		growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)
Bulgaria	L	4.6	2.3	36	4.5	2.3	33	3.2	1.6	28	-3.4	-1.7	34	-6.1	-3.1	-467
	K	5.3	2.7	41	6.1	3.0	44	6.8	3.4	59	8.5	4.2	-85	5.2	2.6	399
	TFP	1.5	1.5	23	1.6	1.6	23	0.7	0.7	13	-7.5	-7.5	150	1.1	1.1	168
	GDP	6.5	6.5	100	6.9	6.9	100	5.8	5.8	100	-5.0	-5.0	100	0.7	0.7	100
Croatia	L	0.8	0.4	8	1.6	0.8	16	1.1	0.5	26	-1.6	-0.8	11	-3.9	-1.9	114
	K	4.2	2.1	44	4.7	2.4	46	4.9	2.5	120	5.3	2.7	-36	3.4	1.7	-100
	TFP	2.3	2.3	48	2.0	2.0	38	-1.0	-1.0	-47	-9.3	-9.3	126	-1.5	-1.5	86
	GDP	4.8	4.8	100	5.2	5.2	100	2.1	2.1	100	-7.4	-7.4	100	-1.7	-1.7	100
Czech Rep.	L	1.1	0.5	8	1.9	1.0	17	1.2	0.6	21	-1.5	-0.8	16	-0.6	-0.3	-14
	K	4.3	2.1	31	4.4	2.2	40	5.2	2.6	97	5.0	2.5	-51	3.5	1.8	77
	TFP	4.2	4.2	61	2.4	2.4	43	-0.5	-0.5	-18	-6.6	-6.6	135	0.8	0.8	37
	GDP	6.9	6.9	100	5.5	5.5	100	2.7	2.7	100	-4.8	-4.8	100	2.3	2.3	100
Estonia	L	5.3	2.7	26	1.3	0.7	9	-0.1	-0.1	1	-9.1	-4.6	31	-4.4	-2.2	-90
	K	7.2	3.6	35	9.0	4.5	58	9.2	4.6	-85	6.3	3.1	-21	1.7	0.9	35
	TFP	4.0	4.0	39	2.6	2.6	33	-9.9	-9.9	184	-13.3	-13.3	90	3.8	3.8	155
	GDP	10.3	10.3	100	7.7	7.7	100	-5.4	-5.4	100	-14.7	-14.7	100	2.5	2.5	100
Hungary	L	0.3	0.2	4	-0.2	-0.1	-15	-1.0	-0.5	-60	-2.3	-1.1	17	-0.2	-0.1	-13
	K	3.4	1.7	43	3.2	1.6	315	3.3	1.6	187	3.1	1.6	-24	2.2	1.1	141
	TFP	2.1	2.1	52	-1.0	-1.0	-200	-0.2	-0.2	-28	-7.0	-7.0	106	-0.2	-0.2	-28
	GDP	4.0	4.0	100	0.5	0.5	100	0.9	0.9	100	-6.6	-6.6	100	0.8	0.8	100
Latvia	L	5.0	2.5	21	2.1	1.1	11	-0.6	-0.3	10	-13.7	-6.8	48	-6.3	-3.1	109
	K	7.7	3.8	33	8.5	4.3	44	10.3	5.1	-162	7.6	3.8	-27	2.8	1.4	-49
	TFP	5.3	5.3	46	4.5	4.5	46	-8.0	-8.0	252	-11.1	-11.1	79	-1.1	-1.1	40
	GDP	11.6	11.6	100	9.8	9.8	100	-3.2	-3.2	100	-14.2	-14.2	100	-2.9	-2.9	100
Lithuania	L	0.8	0.4	5	1.6	0.8	7	-2.1	-1.1	-40	-8.1	-4.1	27	-5.5	-2.8	-170
	K	4.9	2.5	33	6.3	3.1	28	8.0	4.0	152	6.6	3.3	-22	1.6	0.8	50
	TFP	4.5	4.5	61	7.1	7.1	64	-0.3	-0.3	-12	-14.0	-14.0	95	3.6	3.6	220
	GDP	7.4	7.4	100	11.1	11.1	100	2.6	2.6	100	-14.8	-14.8	100	1.6	1.6	100
Poland	L	4.2	2.1	34	5.1	2.5	35	4.3	2.2	55	0.4	0.2	8	0.0	0.0	0
	K	1.7	0.9	14	2.5	1.2	17	3.7	1.9	47	4.1	2.1	78	3.6	1.8	48
	TFP	3.2	3.2	52	3.4	3.4	47	-0.1	-0.1	-2	0.4	0.4	15	1.9	1.9	52
	GDP	6.2	6.2	100	7.2	7.2	100	3.9	3.9	100	2.6	2.6	100	3.7	3.7	100
Romania	L	1.2	0.6	7	0.0	0.0	0	-1.0	-0.5	-6	-2.8	-1.4	20	-1.1	-0.6	69
	K	4.5	2.2	28	6.0	3.0	43	10.6	5.3	62	11.5	5.8	-82	4.4	2.2	-275
	TFP	5.2	5.2	65	3.9	3.9	57	3.7	3.7	43	-11.4	-11.4	162	-2.4	-2.4	306
	GDP	8.1	8.1	100	6.9	6.9	100	8.5	8.5	100	-7.1	-7.1	100	-0.8	-0.8	100
Slovakia	L	3.2	1.6	19	2.6	1.3	12	3.3	1.7	31	-3.1	-1.6	29	-2.2	-1.1	-23
	K	4.6	2.3	28	5.0	2.5	24	5.4	2.7	50	5.0	2.5	-48	2.8	1.4	29
	TFP	4.3	4.3	52	6.9	6.9	64	1.1	1.1	20	-6.3	-6.3	118	4.5	4.5	94
	GDP	8.3	8.3	100	10.7	10.7	100	5.4	5.4	100	-5.3	-5.3	100	4.8	4.8	100
Slovenia	L	1.3	0.7	12	2.8	1.4	20	0.6	0.3	9	-1.1	-0.6	7	-1.3	-0.7	-53
	K	3.8	1.9	34	4.4	2.2	31	5.0	2.5	76	5.2	2.6	-34	2.6	1.3	104
	TFP	3.1	3.1	54	3.4	3.4	49	0.5	0.5	15	-9.8	-9.8	126	0.6	0.6	48
	GDP	5.7	5.7	100	6.9	6.9	100	3.3	3.3	100	-7.8	-7.8	100	1.2	1.2	100

		2011			2012			2013			2014			2015		
		growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)	growth (%)	contr. (% points)	contr. (%)
Bulgaria	L	-3.6	-1.8	-90	-0.9	-0.5	-95	0.0	0.0	-1	1.4	0.7	41	1.0	0.5	29
	K	3.0	1.5	76	2.4	1.2	247	2.4	1.2	112	2.2	1.1	65	2.3	1.2	68
	TFP	2.3	2.3	114	-0.3	-0.3	-52	-0.1	-0.1	-10	-0.1	-0.1	-7	0.0	0.0	3
	GDP	2.0	2.0	100	0.5	0.5	100	1.1	1.1	100	1.7	1.7	100	1.7	1.7	100
Croatia	L	-3.6	-1.8	649	-3.3	-1.6	75	-2.7	-1.3	125	2.8	1.4	-388	0.9	0.5	56
	K	1.9	0.9	-337	1.6	0.8	-36	1.3	0.6	-60	1.3	0.6	-177	1.0	0.5	60
	TFP	0.6	0.6	-212	-1.3	-1.3	61	-0.4	-0.4	35	-2.4	-2.4	665	-0.1	-0.1	-16
	GDP	-0.3	-0.3	100	-2.2	-2.2	100	-1.1	-1.1	100	-0.4	-0.4	100	0.8	0.8	100
Czech Rep.	L	0.5	0.3	13	0.4	0.2	-20	1.0	0.5	-93	0.9	0.4	22	0.8	0.4	10
	K	3.4	1.7	85	3.2	1.6	-176	2.7	1.3	-253	2.3	1.1	57	2.2	1.1	29
	TFP	0.0	0.0	2	-2.7	-2.7	296	-2.4	-2.4	446	0.4	0.4	21	2.4	2.4	61
	GDP	2.0	2.0	100	-0.9	-0.9	100	-0.5	-0.5	100	2.0	2.0	100	3.9	3.9	100
Estonia	L	6.3	3.1	41	1.3	0.6	12	1.4	0.7	44	0.6	0.3	10	1.2	0.6	29
	K	1.4	0.7	9	3.5	1.8	34	3.8	1.9	121	3.7	1.9	64	3.2	1.6	80
	TFP	3.7	3.7	49	2.8	2.8	54	-1.0	-1.0	-64	0.7	0.7	25	-0.2	-0.2	-9
	GDP	7.6	7.6	100	5.2	5.2	100	1.6	1.6	100	2.9	2.9	100	2.0	2.0	100
Hungary	L	0.7	0.3	19	1.5	0.8	-52	1.5	0.8	50	5.6	2.8	78	0.6	0.3	10
	K	1.4	0.7	39	1.2	0.6	-41	0.9	0.4	29	1.2	0.6	17	1.9	0.9	31
	TFP	0.8	0.8	42	-2.9	-2.9	193	0.3	0.3	21	0.2	0.2	5	1.8	1.8	59
	GDP	1.8	1.8	100	-1.5	-1.5	100	1.5	1.5	100	3.6	3.6	100	3.0	3.0	100
Latvia	L	2.3	1.1	23	2.1	1.1	22	2.2	1.1	26	0.2	0.1	5	0.1	0.1	3
	K	1.1	0.5	11	2.5	1.2	26	3.3	1.7	39	2.6	1.3	55	2.4	1.2	56
	TFP	3.3	3.3	67	2.5	2.5	53	1.5	1.5	34	1.0	1.0	40	0.9	0.9	41
	GDP	5.0	5.0	100	4.8	4.8	100	4.2	4.2	100	2.4	2.4	100	2.2	2.2	100
Lithuania	L	2.8	1.4	23	1.3	0.6	17	0.2	0.1	4	1.5	0.8	26	-0.1	-0.1	-4
	K	1.6	0.8	13	2.8	1.4	37	2.5	1.2	38	2.9	1.5	49	3.1	1.5	88
	TFP	3.9	3.9	64	1.8	1.8	46	1.9	1.9	58	0.7	0.7	25	0.3	0.3	16
	GDP	6.1	6.1	100	3.8	3.8	100	3.3	3.3	100	3.0	3.0	100	1.8	1.8	100
Poland	L	0.4	0.2	4	0.1	0.1	4	0.0	0.0	0	2.1	1.1	31	1.6	0.8	22
	K	3.3	1.6	34	3.7	1.8	105	3.2	1.6	94	2.9	1.4	42	3.4	1.7	49
	TFP	3.0	3.0	62	-0.2	-0.2	-9	0.1	0.1	6	0.9	0.9	27	1.0	1.0	29
	GDP	4.8	4.8	100	1.8	1.8	100	1.7	1.7	100	3.4	3.4	100	3.5	3.5	100
Romania	L	-2.2	-1.1	-102	0.5	0.2	36	-1.0	-0.5	-15	1.7	0.9	30	-1.1	-0.5	-16
	K	3.8	1.9	179	3.7	1.9	289	3.4	1.7	50	2.7	1.3	48	1.9	1.0	29
	TFP	0.2	0.2	23	-1.4	-1.4	-225	2.2	2.2	65	0.6	0.6	22	2.9	2.9	87
	GDP	1.1	1.1	100	0.6	0.6	100	3.4	3.4	100	2.8	2.8	100	3.4	3.4	100
Slovakia	L	1.0	0.5	19	0.4	0.2	12	0.1	0.0	3	1.4	0.7	29	2.1	1.0	33
	K	3.1	1.6	57	3.9	1.9	120	2.7	1.4	96	2.4	1.2	51	2.5	1.3	40
	TFP	0.6	0.6	23	-0.5	-0.5	-32	0.0	0.0	0	0.5	0.5	20	0.9	0.9	27
	GDP	2.7	2.7	100	1.6	1.6	100	1.4	1.4	100	2.4	2.4	100	3.2	3.2	100
Slovenia	L	-2.9	-1.4	-223	-1.2	-0.6	22	-2.0	-1.0	94	0.7	0.4	12	-0.2	-0.1	-4
	K	1.4	0.7	108	1.0	0.5	-18	0.4	0.2	-20	0.5	0.2	8	0.6	0.3	14
	TFP	1.4	1.4	215	-2.6	-2.6	96	-0.3	-0.3	26	2.4	2.4	80	2.1	2.1	91
	GDP	0.6	0.6	100	-2.7	-2.7	100	-1.1	-1.1	100	3.0	3.0	100	2.3	2.3	100

Source: Author's calculations.

depreciation rate and an initial capital/output ratio of 3. In the perpetual inventory method, the initial year should be earlier than the first year for which TFP is calculated. In our analysis the perpetual inventory method starts in 2000; this is the year for which we assume a capital/output ratio of 3. Investments are measured by gross fixed capital formation. The labor and physical capital shares in income are one-half each.

Table 9.1 shows the detailed breakdown of economic growth. Tables 9.2 and 9.3 sum up the data given in Table 9.1.

Over the entire period, the highest TFP growth rate was recorded in Poland, Slovakia, and Lithuania. In 2006–2015, total factor productivity grew at an average rate of 1.4% per annum in Poland, 1.2% in Slovakia, and 1.0% in Lithuania. In the remaining EU11 countries, the growth of productivity was much slower, not exceeding 0.3%, and in many countries it was negative. Romania and Slovenia recorded TFP growth rates of 0.3% and 0.1% per annum respectively in the years 2006–2015, while the remaining countries noted a fall in TFP per annum on average: –0.1% in Bulgaria and Latvia, –0.2% in the Czech Republic, –0.6% in Hungary, –0.7% in Estonia, and –1.1% in Croatia.

In interpreting the results for TFP changes, it is necessary to point out that the part of TFP which is due to increased labor productivity should be partly considered as a human capital contribution to economic growth. Because of the difficulties in calculating the stock of human capital for the group of countries studied, TFP in our approach also includes the impact of human capital on economic growth.

Poland's superior performance in terms of changes in total factor productivity compared with the other EU11 economies can undoubtedly be treated as a success. In studies conducted several years ago, the Baltic states had the best TFP growth rates. Prior to the global crisis, they showed very rapid economic growth, which was hard to explain by changes in labor and physical capital, and consequently it was attributed to TFP. The position of Poland in these analyses was moderate – not as good as that of the Baltic states, but neither was it trailing the group. The extension of the time horizon significantly changed the outcomes for individual countries in favor of Poland, while worsening the position of the Baltic states. This is visible when the results for the individual subperiods are discussed.

In previous rounds of this research, published in earlier editions of this report and covering a longer time horizon before the crisis (e.g. Próchniak, 2012), the rates of TFP growth were higher on average. The global crisis had a negative impact on the TFP growth rates calculated using the residual method and as a result, many countries recorded negative TFP growth rates in the entire period from 2006 to 2015. There is a visible lowering of the TFP growth rates in the wake of the global crisis when the results for the individual subperiods are discussed.

Table 9.2. TFP growth rates (%)

Country	The whole 2006–2015 period			2006–2007	2008–2010	2011–2014	2015
	Mean	Minimum	Maximum	Mean	Mean	Mean	
Bulgaria	-0.1	-7.5	2.3	1.5	-1.9	0.4	0.0
Croatia	-1.1	-9.3	2.3	2.1	-3.9	-0.9	-0.1
Czech Republic	-0.2	-6.6	4.2	3.3	-2.1	-1.1	2.4
Estonia	-0.7	-13.3	4.0	3.3	-6.5	1.6	-0.2
Hungary	-0.6	-7.0	2.1	0.5	-2.5	-0.4	1.8
Latvia	-0.1	-11.1	5.3	4.9	-6.8	2.1	0.9
Lithuania	1.0	-14.0	7.1	5.8	-3.6	2.1	0.3
Poland	1.4	-0.2	3.4	3.3	0.7	1.0	1.0
Romania	0.3	-11.4	5.2	4.6	-3.4	0.4	2.9
Slovakia	1.2	-6.3	6.9	5.6	-0.2	0.2	0.9
Slovenia	0.1	-9.8	3.4	3.2	-2.9	0.2	2.1

Source: Author's calculations.

Table 9.3. TFP contribution to economic growth (%)

Country	The whole 2006–2015 period		
	Mean	Minimum	Maximum
Bulgaria	43	-52	168
Croatia	78	-212	665
Czech Republic	108	-18	446
Estonia	56	-64	184
Hungary	22	-200	193
Latvia	70	34	252
Lithuania	64	-12	220
Poland	28	-9	62
Romania	60	-225	306
Slovakia	39	-32	118
Slovenia	80	15	215

Source: Author's calculations.

The highest variance of TFP growth rates in the analyzed period was noted in the Baltic states and Romania. The strong differences in how productivity grew in these countries resulted to a large extent from high fluctuations in GDP growth rates. The Baltic states recorded rapid economic growth in the first few years of their EU membership, at times exceeding 10% per annum. These countries were also hardest hit by

the implications of the global crisis because, in 2009, they noted a double-digit fall in GDP. As a result, TFP changes in the Baltics were the most differentiated among EU11 countries. The difference between the highest and the lowest TFP growth rates was slightly above 21 percentage points in Lithuania (ranging from -14.0% to 7.0%) and 16–17 p.p. in the two other Baltic states and Romania. In the remaining CEE countries except Poland, the spread between the TFP growth rates ranged from 13 p.p. in Slovenia and Slovakia to 9 p.p. in Hungary. Poland, which exhibited regular growth in output throughout the 2006–2015 period and was the only EU country to avoid recession, recorded the smallest variations in TFP, at 3.6 percentage points. This last result is another reason to positively assess Poland's achievements in terms of total factor productivity. Apart from the fact that Poland recorded the fastest growth of productivity in the last 10 years, it was the most stable of the whole group of Central and Eastern European countries. In Poland, the slowest growth of TFP in the examined period was recorded in 2012 (-0.2%), while the fastest growth appeared in 2007 (3.4%).

Based on the data in Table 9.2, it is worth analyzing the dynamics of total factor productivity in the individual subperiods. Before the global crisis, in 2006–2007, all the CEE countries recorded a positive growth rate of TFP. It was the highest in Lithuania (5.8%), Slovakia (5.6%), Latvia (4.9%) and Romania (4.6%), which was due to very rapid GDP growth in these countries before the crisis. The growth rate of TFP in Poland at that time was moderate at 3.3% on average (the same as in Estonia and the Czech Republic and similar to Slovenia's). The other three CEE countries, Croatia, Bulgaria and Hungary, showed slower dynamics in terms of total factor productivity in 2006–2007, at 2.1% , 1.5% , and 0.5% respectively.

The crisis brought significant changes in the dynamics of total factor productivity. In 2008–2010, all the CEE countries except Poland recorded negative TFP growth. The Baltics, which recorded the highest pre-crisis TFP growth rates, performed the worst in terms of productivity growth during the crisis, with negative growth rates at -6.8% in Latvia, -6.5% in Estonia, and -3.6% in Lithuania. Poor results in 2008–2010 were also recorded in Croatia (-3.9%), Romania (-3.4%), Slovenia (-2.9%), and Hungary (-2.5%). Poland was the only country with positive TFP growth, at 0.7% in 2008–2010.

In 2011–2014, the CEE countries improved their position compared with the 2008–2010 period in terms of TFP dynamics. The Baltic states again recorded positive TFP growth rates. They stood at 2.1% in Latvia and Lithuania, and 1.6% in Estonia. Poland maintained positive TFP growth at 1.0% per annum, slightly better than in previous years. Bulgaria, Romania, Slovakia, and Slovenia also noted positive TFP growth rates, but very close to zero (not exceeding 0.5%). Hungary, Croatia, and the Czech Republic displayed negative TFP growth rates in this period, ranging from -0.4% to -1.1% a year.

In 2015, the CEE countries posted varied outcomes in terms of TFP dynamics. Some of them improved their performance in relation to 2011–2014, while others worsened their positions. The TFP growth rate in Poland in 2015 was 1.0%, identical to the average for the 2011–2014 period. Seven other CEE countries also recorded positive TFP growth: Romania (2.9%), the Czech Republic (2.4%), Slovenia (2.1%), Hungary (1.8%), Latvia and Slovakia (0.9%), and Lithuania (0.3%). In three CEE countries, the TFP growth rate was either equal to zero or negative in 2015: Bulgaria (0.0%), Croatia (−0.1%) and Estonia (−0.2%).

As regards TFP contributions to economic growth, the figures for the studied period are strongly distorted by the fact that positive TFP growth during a recession means a negative contribution to economic growth. On the other hand, in the case of a strong economic slowdown with GDP growth close to 0%, a change of a few percent in total factor productivity translates into a several thousand percent TFP contribution to economic growth. Nevertheless, it is possible to determine some trends and regularities on the basis of the aggregated results for the whole period.

As indicated by the data presented in Table 9.3, TFP contributions to economic growth in most countries (except the Czech Republic, Poland, and Hungary) ranged between 40% and 80% in 2006–2015. This confirms the important role of TFP in the economic growth of the studied countries after their EU entry. In Poland, the TFP contribution to economic growth was 28% on average in 2006–2015.

Summing up, our overall results for the analyzed period show that changes in productivity played an important role in Poland's economic growth and helped improve the relative competitive position of the Polish economy with regard to other Central and Eastern European countries.

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