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Productivity of Slovenian Firms

Polona Domadenik, Bojan Ivanc and Denis Marinšek

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Abstract

We analyse productivity differences across non-financial Slovenian firms over the period 1994-2015. In particular, we investigate the impact of different factors (including size, ownership, investment activity and industry characteristics) on firms' total factor productivity (TFP), competitiveness and internationalisation. Large corporates appear to have the highest level of TFP, more than 50% above the average, and show stronger TFP growth. Exporting firms also show higher TFP growth than other firms, particularly after the recent crisis. Using a complete database of R&D subsidies over 1998-2015, the paper identifies R&D-intensive firms and investigates the impact of R&D investment on productivity and profitability. It is found that subsidies did not significantly increase firm-level productivity, once size, industry and year effects are taken into account. This could be because, during the recession (2009-2015), subsidies were granted to firms in difficulties.

JEL Classification: D22, D24, L25.

Keywords: productivity, state ownership, exporters, Slovenia.

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ABBREVIATIONS

TFP .....total factor productivity

SOE .....state-owned enterprises

AJPES .....Agency of the Republic of Slovenia for Public Legal Records and Related Services

AMECO .....macro-economic database of European Commission

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ANNEX I

1. INTRODUCTION

The analysis of productivity and efficiency has its roots in the literature on economic growth. Part of this literature attributes growth to productivity improvements, driven by advances in technology and the organisation of production, while others stress the importance of investments in human capital, knowledge, and fixed capital. In particular, the so-called "sources of growth analysis" (Hulten, 2001) tries to disentangle the growth contribution of capital formation and labour increases from that of technological factors. This provides the intellectual framework of the notion of 'total factor productivity' (TFP), which can be defined as the portion of output not explained by the amount of inputs (capital and labour) used in production. As such, its level is determined by the efficiency and intensity of utilising the inputs in the production process (Comin, 2009).

TFP plays an important role in analysing economic fluctuations and economic growth at the macroeconomic level, but also in analysing differences across industries and firms. Endogenous growth theory provides theoretical arguments for linking TFP growth to technology, R&D growth, market size and institutional environment (Acemoglu et al., 2006). However, as emphasised in recent work, also disembodied innovations such as managerial and organisational techniques, personnel, accounting and work practices are important factors that drive TFP differentials (Comin and Mulani, 2006).

Our paper analyses the evolution of TFP in Slovenian firms since the 1990's using an unbalanced panel[1] covering virtually all Slovenian firms with more than 8 employees. The aim of this study is to investigate the impact of different factors (such as size, type of ownership, investment activities and industry characteristics) on firm's productivity, competitiveness and internationalisation. Our results show that large firms had higher TFP (more than 50% above the average) and higher TFP growth than medium-sized or small ones. The TFP of exporters increased faster than that of other firms, particularly after the crisis. Based on a complete set of data on R&D subsidies over 1998-2015, we were able to identify R&D intensive firms and test the impact of R&D investment on productivity and profitability.

Over the last two decades, one of the most important challenges faced by Slovenia was to privatise state-owned firms and provide a sound business environment for new firms and foreign investment. Previous studies show that the privatisation process was relatively efficient for small and medium-sized firms (Prašnikar et al., 2016; Domadenik et al., 2015). Many of them eventually acquired the ownership stake of the other owners (the state and investment funds). For larger firms, the state remained a powerful owner through the indirect ownership of the (quasi-) sovereign funds. An important question that has remained unanswered in the literature is whether and to what extent the governance of privatised firms has contributed to productivity loss at microeconomic and macroeconomic levels. By identifying the firms that were privatised in the nineties and using detailed data on ownership structure, we attempt to quantify the impact of these factors on firms' productivity, while controlling for macroeconomic shocks and industry characteristics.

The study is structured as follows. In Chapter 2 we describe the data and present descriptive statistics. Chapter 3 presents evidence on zombie firms and compares our findings with recent OECD work, while empirical model and econometric issues are presented in Chapter 4. Chapter 5 outlines the main results and Chapter 6 concludes.

[1] 'Panel' data means that firms are observed at different periods in time. The panel is said 'unbalanced' because the number of observations is not the same for all firms.

2. DATA AND DESCRIPTIVE STATISTICS

The datasets used in the analysis were obtained from several sources: firms' annual financial statements, official sources for government subsidy allocation data and previous surveys for ownership structure (see, for example, Domadenik et al., 2015, for a description). The financial reports were acquired from the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES) and extend from 1994 until 2015. This allows us to study the TFP of virtually all Slovenian manufacturing and service firms with more than 8 employees, operating in different phases of the economic cycle, namely growth in the period 1995-2008, severe contraction during the period 2009-2013, and expansion since then.

Since accounting standards have changed in 2008, we had to make financial reports comparable over time as much as possible. Therefore, there are some limitations in the extent to which financial ratios could be calculated in a reliable way. For this reason, all financial ratios and operators used in this analysis were checked for consistency over the entire time period. We excluded all firms with average number of employees below 8 because of the low quality of data. We also excluded all firms operating in the financial sector due to the specific characteristics of their operations[2]. All continuous variables were winsorised[3] at 1st and 99th percentile. After the data were cleaned, we were left with 12,066 firms. The number of annual observations ranges from 4,926 in 1994 to 6,830 in 2008. Our estimations were based on 136,489 annual observations in an unbalanced panel dataset. Some descriptive statistics are shown in Tables 2.1 and 2.2.

Table 2.1: **Distribution of firms by industry**

Industry	Frequency	% of total observations
A – Agriculture	10	0.1
B - Mining and Quarrying	155	1.3
C – Manufacturing	3,563	29.5
D – Energy	56	0.5
E – Utilities	135	1.1
F – Construction	1,632	13.5
G – Trade	2,118	17.6
H – Transportation	654	5.4
I – Hotels	567	4.7
J – ICT	357	3.0
L - Real estate	698	5.8
M - Professional, Scientific and Tech. Act.	908	7.5
N – Adm. and Support service activities	610	5.1
O - Public adm. and defense, compulsory social security	15	0.1
P – Education	175	1.5
Q - Human health and social work activities	95	0.8
R - Arts, entertainment & recreation	75	0.6
S - Other service activates	243	2.0
Total	12,066	100.0

Source: AJPES.

[2] Their "conventional" value added is very low relative to sales, while the financial part of their income statements and balance sheets is considerably larger.

[3] Winsorisation is a commonly used technique for handling the problem of outliers, which can negatively affect the results obtained with any regression technique.

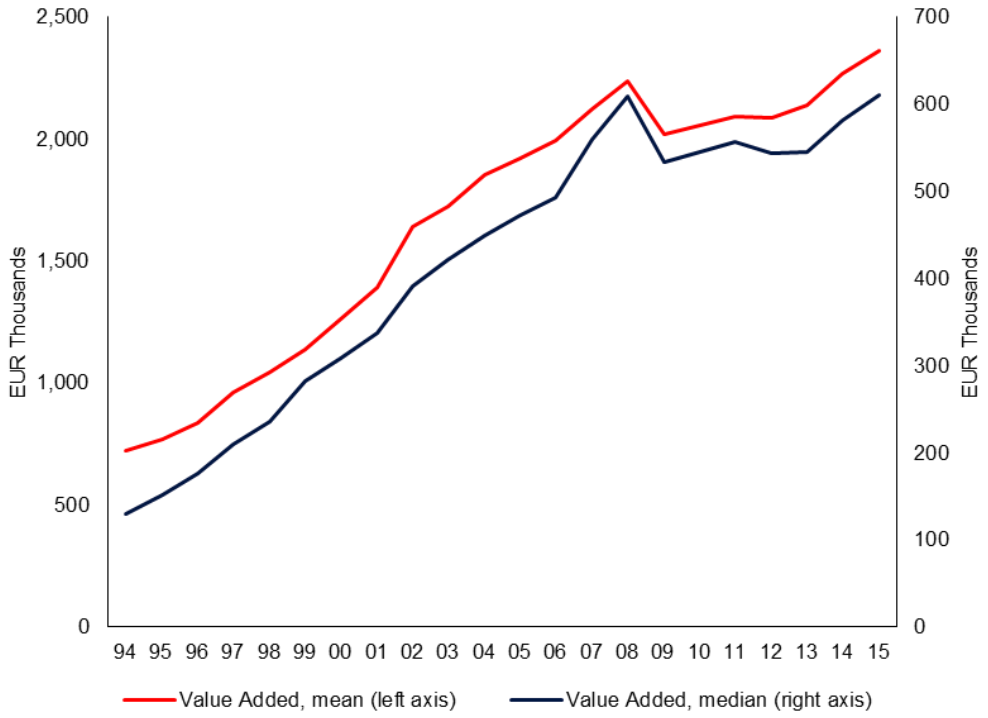
Table 2.2: **Firm-year observations by year**

Year	Frequency	Cumulative %
1994	4,926	3.6
1995	5,415	4.0
1996	5,549	4.1
1997	5,630	4.1
1998	5,741	4.2
1999	5,838	4.3
2000	5,970	4.4
2001	6,045	4.4
2002	6,075	4.5
2003	6,163	4.5
2004	6,323	4.6
2005	6,430	4.7
2006	6,515	4.8
2007	6,715	4.9
2008	6,830	5.0
2009	6,816	5.0
2010	6,819	5.0
2011	6,742	4.9
2012	6,643	4.9
2013	6,502	4.8
2014	6,444	4.7
2015	6,358	4.7
Total	136,489	100.0

Source: AJPES.

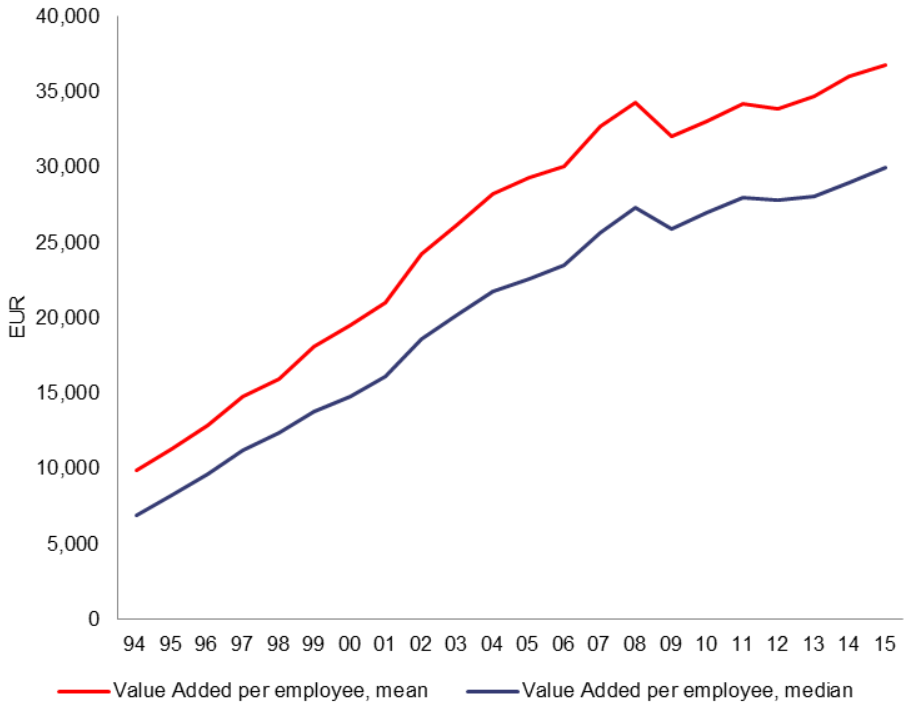
The majority of firms operated in manufacturing, followed by wholesale and retail trade, while the lowest number of firms operated in agriculture and public administration. Since value added is the an indicator of firms' productivity commonly used in the literature, we first investigate how it has changed over the period 1994-2015. In Graph 2.1, median and average values for value added for each year analysed is presented. We can see a strong growth during the period 1994 to 2008, a decline in 2009 due to the crisis and a recovery after 2012. The value added per employee experienced an even stronger growth (see the Graph 2.2). Over the period 1994-2008, its average and median value more than tripled. On average, Slovenian firms thus experienced a strong increase in productivity over the analysed period.

Graph 2.1: **Value added of sampled firms, mean and median values, 1994-2015**



Source: AJPES.

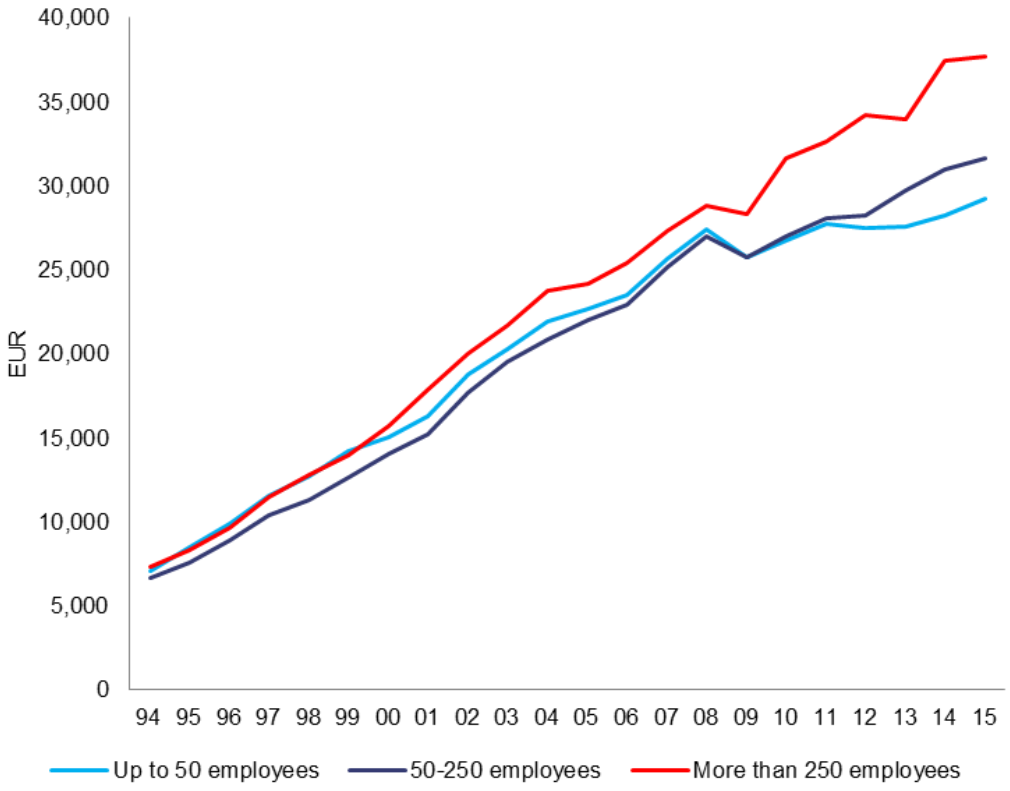
Graph 2.2: **Value added per employee in sampled firms, mean and median values, 1994-2015**



Source: AJPES.

We also considered if there were any differences in value added per employees across firm sizes. Graph 2.3 shows that value added per employee, expressed as median value, grew in all size categories, with large firms being the most productive. This is not surprising as larger firms benefit from economies of scale and may have access to better technology (automation, robots, IT) fostering an improvement in productivity, especially in manufacturing.

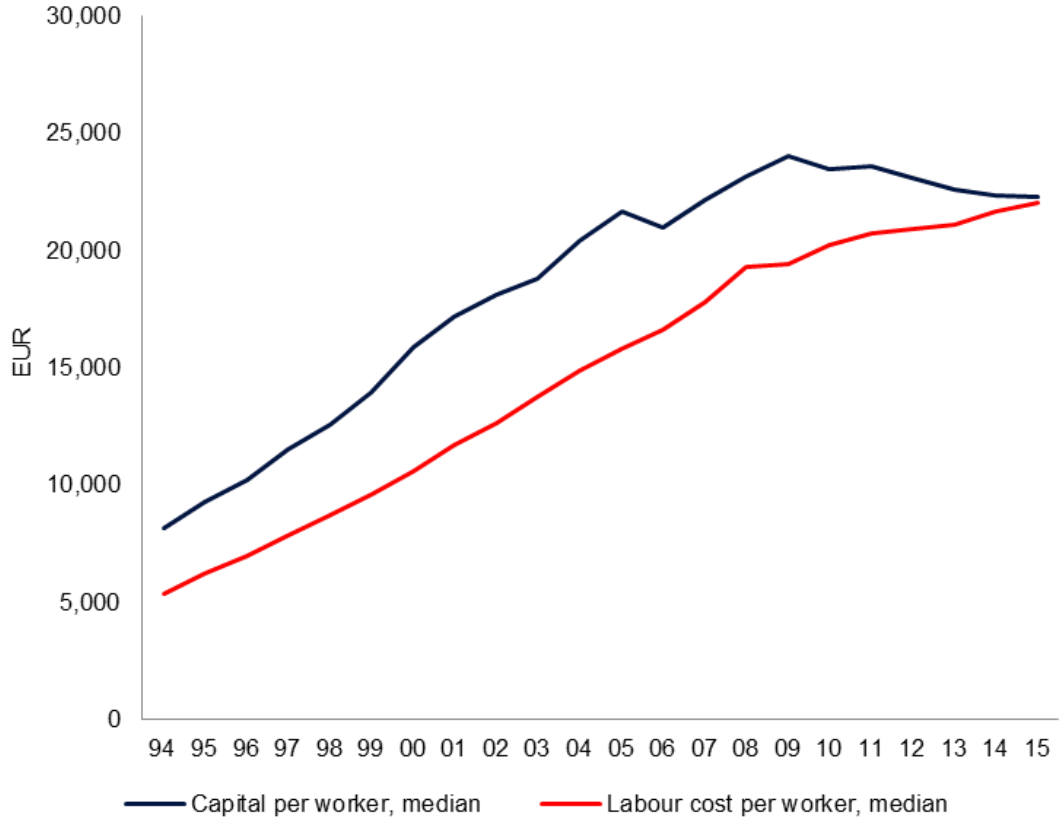
Graph 2.3: **Value added per employee in sampled firms, by firm size, median values, 1994-2015**



Source: AJPES.

Our statistical model for determining productivity is built on the production function, which uses labour and capital as explanatory variables. Due to the changes in accounting standards over the analysed period, we defined capital as *long-term* tangible and intangible assets, since only the long-term categories are fully comparable. Long-term tangible assets consist of land, buildings, machineries and tangible assets in the process of acquisition, while long-term intangible assets consist of long-term owners' rights, good-will, long-term deferred costs for R&D and other intangible assets. Capital per employee is measured as long-term tangible and intangible assets, divided by the average number of working hours. Graph 2.4 shows that there has been a constant increase in the cost of labour, while capital per worker started to decline after 2008 as a result of the financial crisis. When the crisis hit the financial sector, banks were not willing to renew their existing loans to companies. The latter had to repay their principal, which implied less cash flow for investment.

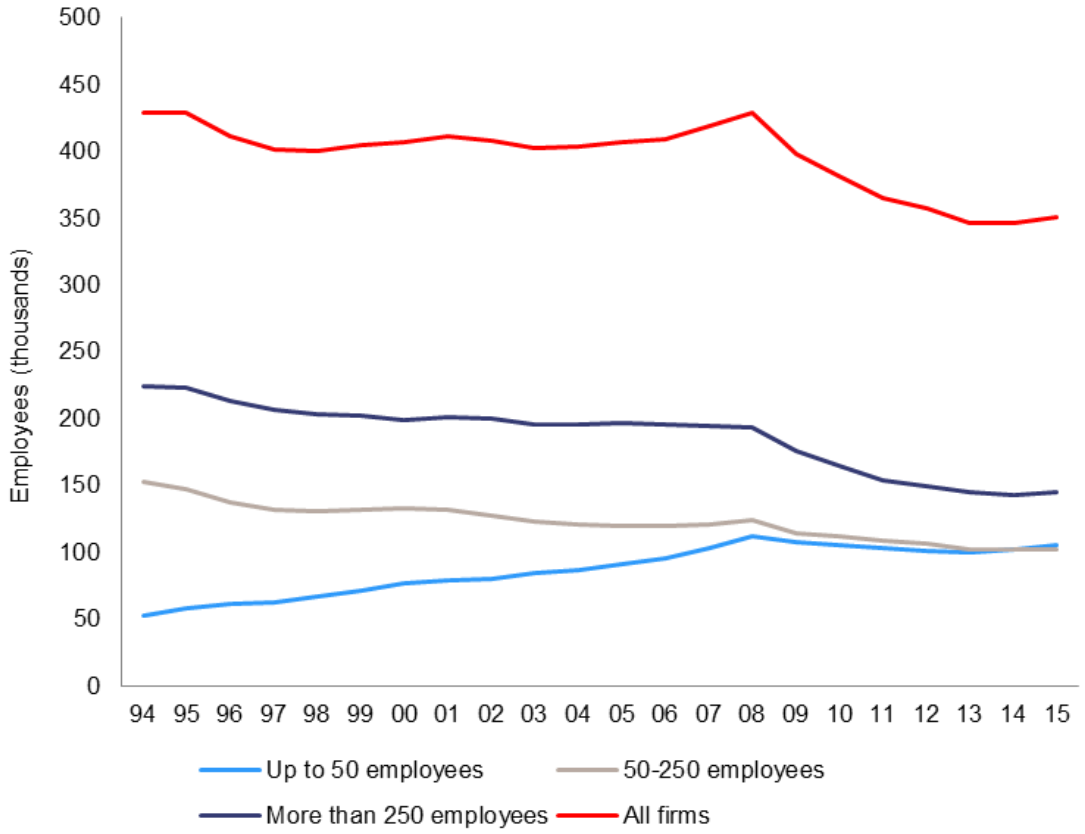
Graph 2.4: **Labour cost and capital per employee of sampled firms, median values, 1994-2015**



Source: AJPES.

Graph 2.5 shows that small firms have increased their relative prominence over time. The number of employees in small firms doubled (from 53,000 to 105,000), while it decreased by one third in medium and large firms. Overall, the number of employees in an average firm fell by 18%. Contraction in the number of jobs was most significant in the period 2008-2013, when it fell by 48,000 in large firms, followed by 21,000 in medium-sized firms and 12,700 in small firms. Since 2009 only small firms increased the number of employees (+5,600).

Graph 2.5: **Total number of employees in sampled firms, by firm size, 1994-2015**

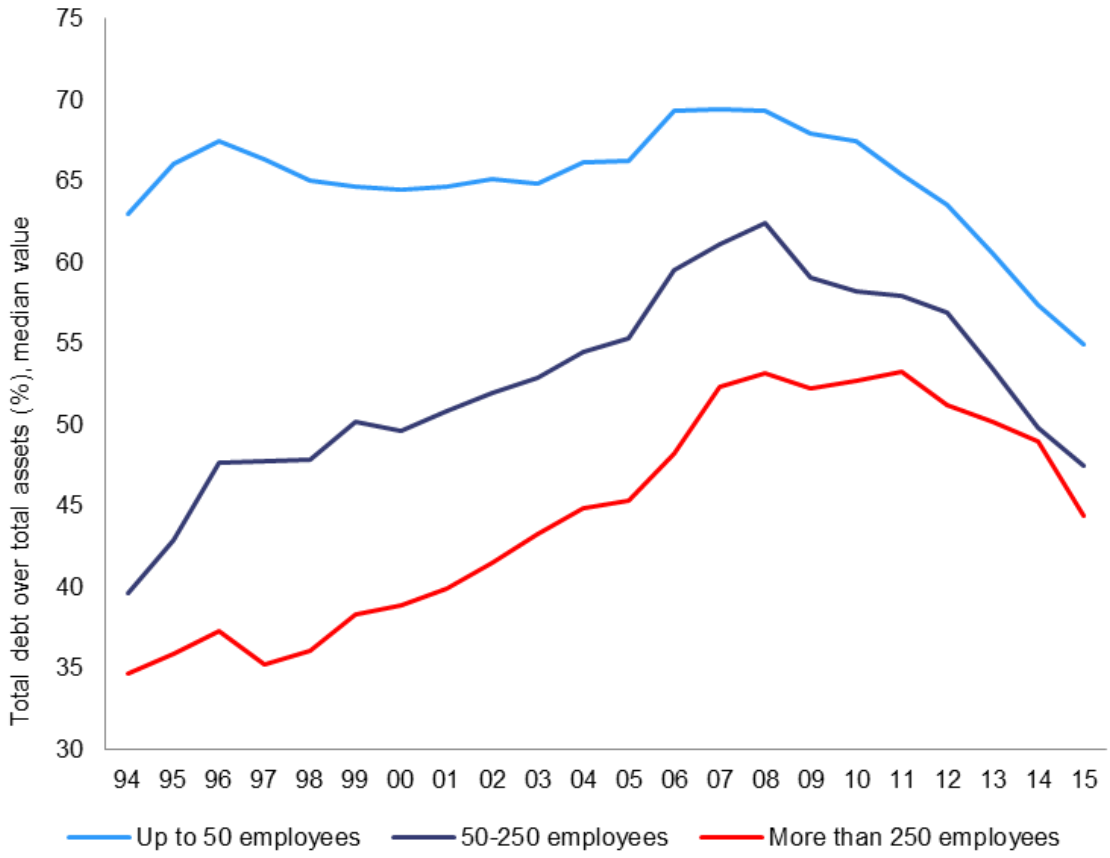


Source: AJPES.

Notes: The graph displays the total number of employees working in sampled firms, by firm size: employees in firms with up to 50 employees, with between 50 and 250 employees and with more than 250 employees.

We were also interested in Slovenian corporate indebtedness. Since we only have data on financial indebtedness from 2006, we use total indebtedness. The latter includes also business obligations to suppliers (accounts payables), as a share of total asset (indebtedness ratio). With the onset of the crisis, the total debt-to-assets ratio of Slovenian firms started to decrease dramatically. This was due to decreasing stock of debt (as defined above) while decreasing assets had a counter effect on the ratio (write-offs, revaluations, working capital optimisation). No significant recapitalisation occurred at the firm level, since the primary market (IPO, SPO) is virtually non-existent in Slovenia. Regarding firm size, we observe that large firms reported the highest share of own capital as a source of financing.

Graph 2.6: **Debt as a share of total assets, by firm size, median values, 1994-2015**



Source: AJPES.

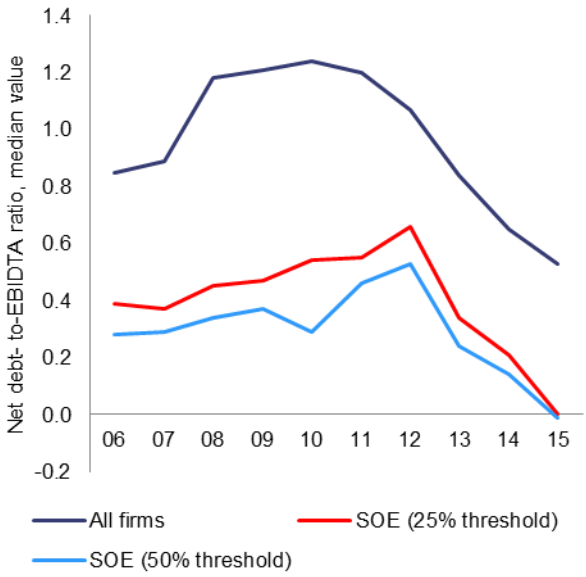
Notes: The graphs displays the median of the distribution of the total debt-to-total assets ratio for three sub-samples: firms with up to 50 employees, with between 50 and 250 employees and with more than 250 employees.

Comparing net debt-to-earnings[4] median ratios, Graph 2.7 reveals that state-owned enterprises (SOEs) were on average less indebted than other firms. This is mainly due to industry and size effects, as a disproportionately higher numbers of SOEs are in sectors of utilities that operate on a full cost recovery principle. Graph 2.8 shows, however, that among large firms, SOEs have less favourable ratios after the year 2008.[5] Small companies are less indebted but their parent company may have higher indebtedness.

[4] Earnings are before interest, taxes, depreciation and amortisation (EBITDA).

[5] The list of corporates is the same as the analysis carried out for the Slovenia Country Report 2015 (European Commission, 2015) However, the results are not directly comparable, since in the latter the net debt-to-EBITDA ratio was calculated on an aggregate weighted basis. In this study, it is calculated as a median, thereby giving equal weight to all companies included. Especially large SOEs (above 250 employees) attributed much more to the total indebtedness of SOEs, whereas small and medium-sized SOEs had lower indebtedness. Therefore the median value of indebtedness is smaller when compared with calculations based on weights.

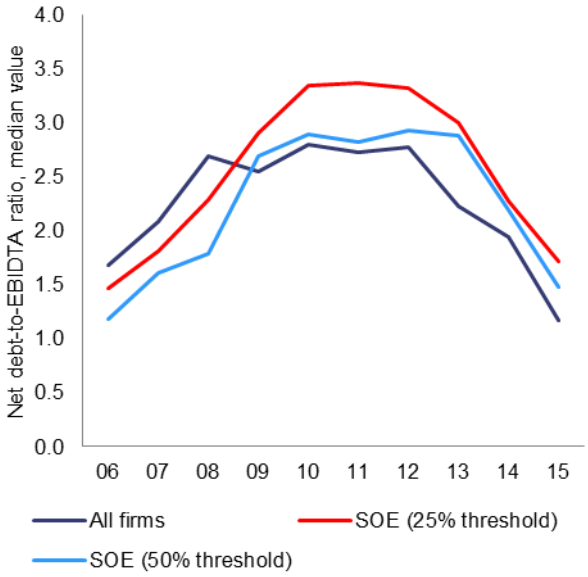
Graph 2.7: **Net debt-to-EBITDA ratio, all firms, 2006-2016**



Source: AJPES.

Note: EBITDA=earnings before interest, taxes, depreciation and amortisation. See Section 2 for the definition of SOEs and the relative thresholds.

Graph 2.8: **Net debt-to-EBITDA ratio, big firms, 2006-2016**



Source: AJPES.

Note: EBITDA=earnings before interest, taxes, depreciation and amortisation. See Section 2 for the definition of SOEs and the relative thresholds.

In Table 2.3, we present descriptive statistics for selected variables. We find that the average value added of yearly observations of Slovenian firms over the entire period analysed was EUR 1.7 million, while the average value added per employee was EUR 26,100. Capital, defined as long-term tangible and intangible assets, amounted to EUR 1.2 million, on average. Capital per employee was on average EUR 41,000 and cost per employee EUR 16,500. Data shows that an average firm had 64 employees, average investments represented 7.1% of total assets, while the majority of firm's subsidies, received from government, represented a very small share in total assets. The average total indebtedness of a firm was 62.4% of total assets.

We devoted specific effort to identify the effect of different ownership structures on firm performances, looking in particular at foreign ownership, state ownership and privatisation.

Firstly, based on the evidence on foreign direct investment, we identified firms with foreign ownership among all firms with more than 8 employees. In total there were 9,987 firm observations (450 firms per year on average) and they represented 7.32% of our sample.

Table 2.3: **Summary statistics for selected variables**

Variable	Mean	Stand dev.	1st%ile	Q1	Median	Q3	99th%ile	Mean 25% SOE	Mean 50% SOE
VA (in millions)	1.7	8.9	-0.5	0.2	0.4	1.1	22.3	10.6	8.9

VA per employee (in th.)	26.1	39.4	1.0	11.6	19.3	30.9	131.7	34.8	34.9
Capital (in millions)	1.2	1.8	0.0	0.0	0.3	1.3	6.3	41.8	3.7
Capital per emp. (in th.)	41.0	145.2	0	4.9	16.1	39.6	395.2	65.4	66.1
Cost per empl. (in th.)	16.5	10.7	2.4	9.4	14.7	20.8	52.0	21.7	21.8
Labour (number)	63.8	242.6	1.0	10.0	18.0	44.4	777.9	298	250
Investments / TA (in %)	7.1	252.8	-6.0	0.8	4.2	11.2	58.7	6.2	6.3
Subsidies / TA (in %)	0.36	13.9	0	0	0	0	7.42	0.52	0.45
Total indeb. / TA (in %)	62.4	35.3	4.2	38.6	62.0	81.7	233.7	45.2	45.8

Source: AJPES.

Note: TA=Total Assets, VA=Value Added

Secondly, based on Ivanc (2013), we identified state-ownership. In particular, we defined SOEs as those with a level of direct or indirect state ownership above 50% (see Table 2.4). The cut-off date was the year 2013, as in Ivanc (2013). Using this definition, SOEs employed 16% of all employees, accounted for 21.2% of total value added and 12.5% of capital. Their share of investments stood at 11.6%, slightly lower than the share of capital. SOEs reported negative earnings before interest, taxes, depreciation and amortisation (EBITDA) in 12% of all observations. Net debt-to-EBITDA was negatively reported for 53% of all observations. This was mainly due to an overrepresentation of utilities in the population of SOEs, which operate on a full cost recovery principle and who are not indebted in general. Overall, SOEs were found to be dominant in Energy, Utilities, Transportation and Arts & entertainment (above 50% of value added) and made up an important share (above 25%) in Hotels, ICT and Professional & Scientific Activities. Defining SOEs as those with a level of direct or indirect ownership above 25%, increased the importance of SOEs especially in 4 sectors: Retail, Manufacturing, Transportation and Hotels (see Table 2.5).

Table 2.4: **Importance of SOEs in different industries, 50% ownership threshold**

Sector, Nace Rev.2	**Employees**	**Value added**	**Capital**	**Investment**	**Tangible capital**
	(% of total)	(% of total)	(% of total)	(% of total)	(% of total)
A – Agriculture	0	0	0	0	0
B - Mining and Quarrying	0	0	0	0	0
C – Manufacturing	9.5	9.6	6.3	5.9	6.2
D – Energy	87.6	94.2	76.8	79.9	77.6
E – Utilities	79.3	75.8	77.6	77.1	77.7
F – Construction	3.1	4.9	3.2	2.8	2.9
G – Trade	3.3	4.2	3.6	2.8	3.6
H – Transportation	52.9	60.4	17.2	13.8	17.1
I – Hotels	24.2	28.6	19.8	19.1	19.9
J – ICT	32.7	37.5	11.4	11.3	12.1
L - Real estate	2.4	5.2	9.1	7.9	9.0
M - Professional, Scientific and Tech. Act.	38.5	28.5	6.6	5.9	6.7

N – Adm. and Support service activities	6.3	5.3	9.2	7.5	9.3
O - Public adm. and defense.	0.0	0.0	0.0	0.0	0.0
P – Education	0.0	0.0	0.0	0.0	0.0
Q - Human health and social work activities	5.8	6.5	12.2	7.7	12.0
R - Arts, entertainment & recreation	73.3	79.8	44.3	44.8	45.2
S - Other service activates	8.8	12.1	15.8	11.3	15.5
Total	16.0	21.2	12.5	11.6	12.5

Source: AJPES.

Table 2.5: **Importance of SOEs in different industries, 25% ownership threshold**

Sector, Nace Rev.2	**Employees**	**Value added**	**Capital**	**Investment**	**Tangible capital**
	(% of total)	(% of total)	(% of total)	(% of total)	(% of total)
A – Agriculture	0	0	0	0	0
B - Mining and Quarrying	0	0	0	0	0
C – Manufacturing	18.4	23.6	9.3	8.8	9.3
D – Energy	88.0	94.5	79.7	81.6	80.7
E – Utilities	83.9	81.6	83.6	82.6	83.6
F – Construction	5.3	6.9	5.8	5.1	5.6
G – Trade	16.6	18.8	5.0	3.9	5.0
H – Transportation	60.8	68.1	23.6	18.3	23.4
I – Hotels	28.7	34.9	21.9	21.7	22.0
J – ICT	33.1	37.5	11.9	11.8	12.4
L - Real estate	2.5	5.4	9.1	8.0	9.1
M - Professional, Scientific and Tech. Act.	39.3	30.0	8.7	7.9	8.9
N – Adm. and Support service activities	6.8	6.2	13.6	9.5	13.7
O - Public adm. and defense, compulsory social security	0.0	0.0	0.0	0.0	0.0
P – Education	0.6	3.0	4.8	2.7	4.8
Q - Human health and social work activities	6.5	7.5	14.8	8.7	14.6
R - Arts, entertainment & recreation	73.3	79.8	44.3	44.8	45.2
S - Other service activates	8.8	12.1	15.8	11.3	15.5
Total	23.0	30.6	15.1	14.0	15.2

Source: AJPES.

Thirdly, we identified the firms that underwent privatisation in the early 1990s. In particular, we identified 19,124 observations related to previous socially owned firms (representing 14% of the complete sample of 136,489 observations). In Section 5.2.3, we used a smaller dataset, based on previous surveys of Slovenian firms, in order to provide more detailed analysis on how different owners affect productivity differentials. Notably, we sorted privatised firms in six different groups according to their prevailing owner in year 2008. The majority of privatised firms (67.5% or 12,901 firms) were owned by other domestic private firms, around 7% (1,332 observations) were state-owned, 5% (971 firms) were foreign-owned, 2.4% (452 firms) belonged to a group of diversified ownership. Internal owners had the control over 4.4% of firms (employee owned firms), while management-buy-out (MBO) took place in 4.6% of firms. In some 9% of all privatised firms, block holders (especially the successors of privatisation funds, state funds and employees) dominated the governance. Since large and medium-sized firms are overrepresented in this sample, the outcomes are not directly comparable with but complement the analysis carried out in the other sections.

Finally, data on government subsidy allocation programs were obtained from the Ministry of Finance and extend from 1998 until 2015. State aid initially declined, from 2.53% of GDP in 1998 to only 0.87% of GDP in 2008, due to restrictive EU competition policy. Following the economic crisis, subsidies increased again to 1.9% of GDP in 2009, 2.9% of GDP in 2012 and 1.46% of GDP in 2015. During the observed period, 31,529 firms with more than 5 employees in 1998 received subsidies for a total amount of more than EUR 2,460 million, excluding those for agriculture and fishing. The subsidies were divided in four groups. The first group are employment subsidies and account for two thirds of total subsidies. The average amount was EUR 40,914 per firm (constant prices). The second group are revenue-enhancing subsidies, including subsidies for research and development, export subsidies and other subsidies. The average amount of these subsidies was EUR 58,198. The third group of subsidies was given mostly to firms in difficulties, either related to the restructuring during the 1990s or to the economic downturn in 2008-2012. Although this group represented only a small fraction of the total number of subsidies allocated since 1998 (3.8%), the average subsidy was large (EUR 425,315), implying that this group seized 21% of total subsidies. The fourth group are subsidies for purposes not included in the first three groups (7% of total sample). The average subsidy in this group amounted to EUR 366,070. Such high average was mostly driven by the high subsidies to the Slovene railway firm during the period. Firms that received any subsidies (in at least one year) represented 47% of all firms. The average subsidy amounted to EUR 137,135, representing on average 0.36% of total assets. Therefore dividing subsidies in different groups would not make sense in regression analysis.

3. ZOMBIE FIRMS

Recent studies stress the importance of financially weak or "zombie" firms on aggregate labour productivity growth. McGowan et al. (2017) applied the framework used in the study on Japanese firms by Caballero et al. (2008) to a broader sample of OECD countries. They show that industries with higher share of capital tied in zombie firms are associated with lower investment and employment growth. Moreover, market congestion generated by zombie firms also increases productivity dispersions and barriers to entry, limiting capital reallocation and post-entry growth of start-up firms.

McGowan et al. (2017) claimed that in Slovenia there was a relatively small share of zombie firms in the observed period. Their analysis included firms with at least 20 employees and at least 10 years of operating history. A firm is defined to be a zombie if during the most recent 3-year period its interest coverage ratio did not exceed one. The interest coverage ratio is defined as earnings before interest and taxes (EBIT) over interest. Results are reported for 2007, 2010 and 2013. In practice, a firm would be reported in 2007 analysis, only if it had been active at least since 1998. It would be classified as zombie if over the period 2005-2007, in each specific year, the firm had an interest coverage ratio lower or equal to one. McGowan et al. (2017) report that the share of such firms in Slovenia was around 2% in 2007, around 1% in 2010 and around 3% in 2013. In 2013, the share of capital stock in zombie firms accounted for 5% of total capital, the lowest share among the 13 analysed OECD countries.

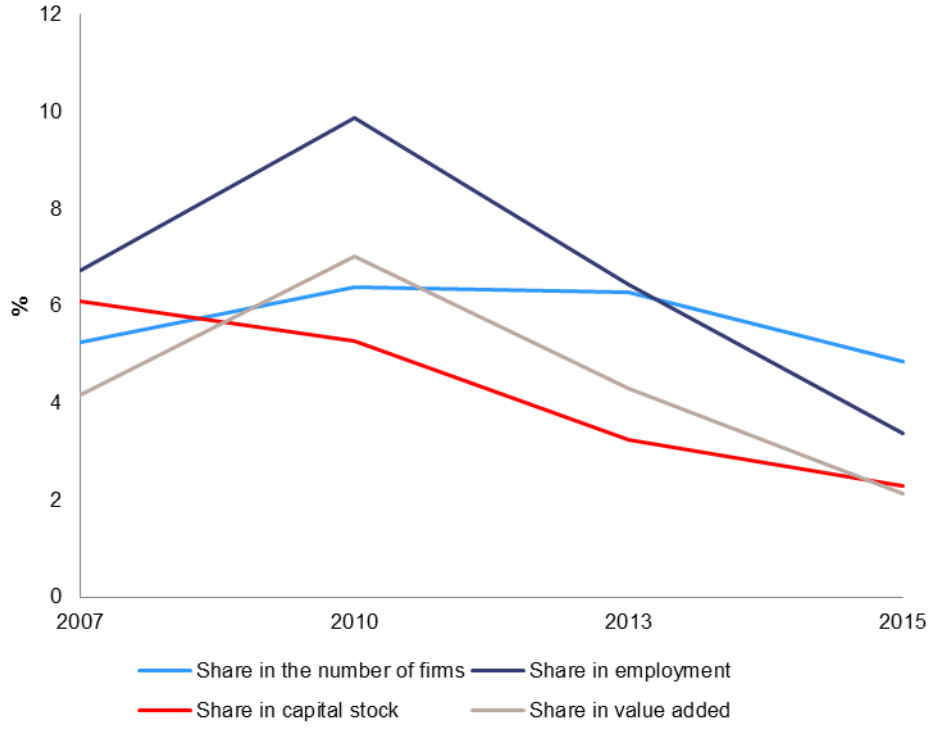
We replicate the analysis by McGowan et al. (2017) on our complete database of Slovenian firms extending to 2015. Interestingly, we obtained different results, although applying the same methodology. Our results are shown in Table 3.1 and Graph 3.1. Data show that Slovenia had around 2,000 firms with at least 20 employees and 10 years of operating history.

Table 3.1: **Zombie firms in Slovenia, 2007-2015**

Year	All firms	Zombie firms	Share in empl.	Share in capital stock	Share in value added
		(number and %)	(%)	(%)	(%)
2007	2,019	106 (5.2)	6.7	6.1	4.2
2010	2,005	128 (6.4)	9.9	5.3	7.0
2013	1,926	121 (6.3)	6.4	3.2	4.3
2015	1,938	94 (4.8)	3.4	2.3	2.1

Note: Firms with at least 20 employees and at least 10 years of operations are used in the analysis. Zombie firm is a firm with interest coverage ratio lower or equal to 1 during the 3 most recent years.

Graph 3.1: **Shares of zombie firms in Slovenia, 2007-2015**



Source: AJPES.

Our results indicate that Slovenia had a higher share of zombie firms than observed in McGowan et al. (2017). We discover that the highest share of such firms was in 2010, when they amounted to 6.4% of total sample of firms (vs. 1% detected by McGowan et al. (2017)). These firms accounted for 9.9% of all employees and 5.3% of total capital. While our share of capital stock is in line with McGowan et al. (2017), the share of employees is much higher. In year 2013, the share of zombie firms was very close to 2010 level, but it fell by 1.5 p.p. in year 2015. Firms having financial problems in 2013-2015 represented only 3.2% of total employment, merely 2.3% of capital stock and created only 2.1% of added value.

We further investigated the characteristics of zombie firms over 2008-2015 by omitting the requirement that firms had been operating for at least 10 years while keeping the 20 employees threshold. As before, a firm was defined as zombie if, during the previous 3 years, its interest coverage ratios did not exceed one. We then divided firms based on their size and sector. Results are shown in Table 3.2.

Table 3.2: **Shares of zombie firms, by firm size and by industry, 2008-2015**

Year	All firms	Zombie firms	Share in empl.	Share in VA
		(number and %)	(%)	(%)
2008	**2774**	**244 (8.8)**	**9.3**	**5.4**
Small	1446	88 (6.0)	6.4	3.6
Medium	1079	125 (11.6)	11.1	6.1
Large	249	31 (12.5)	8.7	5.4
Manufacturing	1174	127 (10.8)	11.7	6.7
Services	1322	112 (8.4)	6.8	4.2
2009	**2760**	**284 (10.3)**	**11.4**	**7.1**

Small	1458	117 (8.0)	8.4	5.0
Medium	1058	136 (12.8)	12.7	6.9
Large	244	31 (12.7)	10.7	7.8
Manufacturing	1164	137 (11.8)	12.9	8.9
Services	1310	141 (10.8)	9.6	5.6
2010	**2740**	**370 (13.5)**	**17.8**	**12.1**
Small	1457	159 (10.9)	11.2	6.9
Medium	1051	166 (15.8)	16.7	10.4
Large	232	45 (19.4)	20.4	14.4
Manufacturing	1148	162 (14.1)	16.7	10.6
Services	1305	195 (14.9)	20.8	14.6
2011	**2639**	**402 (15.2)**	**18.6**	**11.2**
Small	1414	177 (12.5)	13.3	8.0
Medium	1004	181 (18.0)	18.4	11.6
Large	221	44 (19.9)	20.3	11.7
Manufacturing	1120	179 (15.9)	16.7	8.7
Services	1259	198 (15.7)	21.9	14.0
2012	**2599**	**372 (14.3)**	**18.0**	**10.3**
Small	1409	170 (12.1)	12.4	7.4
Medium	976	160 (16.4)	16.9	11.2
Large	214	42 (19.6)	20.2	10.5
Manufacturing	1119	156 (13.9)	15.1	8.0
Services	1232	181 (14.7)	21.9	12.9
2013	**2536**	**320 (12.6)**	**17.2**	**9.0**
Small	1367	132 (9.7)	9.9	6.0
Medium	955	148 (15.5)	16.2	9.8
Large	214	40 (18.7)	19.8	9.4
Manufacturing	1116	140 (12.5)	14.2	7.2
Services	1185	153 (12.9)	21.8	11.2
2014	**2502**	**258 (10.3)**	**10.4**	**5.8**
Small	1353	114 (8.4)	8.3	4.4
Medium	945	119 (12.6)	12.9	12.6
Large	204	25 (12.3)	9.3	5.3
Manufacturing	1102	109 (9.9)	10.3	5.2
Services	1170	128 (10.9)	10.6	6.6
2015	**2471**	**222 (9.0)**	**9.6**	**4.9**
Small	1347	98 (7.3)	7.1	3.0
Medium	923	99 (10.7)	10.3	5.0
Large	201	25 (12.4)	9.8	5.3
Manufacturing	1086	94 (8.6)	9.1	4.3
Services	1161	109 (9.4)	10.4	5.7

Note: Firms with at least 20 employees are used in the analysis. Zombie firm is a firm with interest coverage ratio lower or equal to 1 during the 3 most recent years.

Source: Firms financial reports.

The main finding is that without the precondition of 10-year operating history, the share of zombie firms is considerably higher, reaching a peak in 2011 with over 15%. Before and after the crisis, these shares were 8.8% in 2008 and 9% in 2015. Results also reveal that the highest share of zombie firms was among large firms (more than 250 employees). Before the crisis, there were relatively more zombie firms in the manufacturing sector while after the crisis there were more zombie firms in the service sector.

SOEs represented an important share of zombie firms. In 2007, almost 20% of zombie firms were controlled by the state. During the crisis, the share of SOEs among zombie firms significantly decreased mostly due to the increase in the number of privately-owned zombie firms (Table 3.3).

Table 3.3: **Share of SOEs in zombie firms, 2007-2015**

	All Zombies	25% SOE Zombies	25% SOE as a share of total	50% SOE Zombies	50% SOE as a share of total
2007	106	21	19.8%	20	18.8%
2010	128	24	18.8%	22	17.2%
2013	121	23	19.0%	20	16.5%
2015	94	14	14.9%	10	10.6%

Note: in the sample of 12,066 firms, 391 firms are 25% SOE (3.2%) and 326 firms are 50% SOE (2.7%).

Although the sample is small, it is interesting that, among large firms, the share of SOEs (25% threshold) in all zombie firms increased from 20% to 33% over 2007-2015 although the number of large zombie firms decreased by half (Table 3.4).

Table 3.4: **Share of SOEs in large zombie firms, 2007-2015**

	All Zombies	25% SOE Zombies	25% SOE as a share of total	50% SOE Zombies	50 % SOE as a share of total
2007	19	4	21.1%	3	15.8%
2010	23	7	30.4%	6	26.1%
2013	17	6	35.3%	5	29.4%
2015	9	3	33.3%	1	11.1%

4. EMPIRICAL MODEL AND ECONOMETRIC ISSUES

Our empirical model builds on studies of Acemoglu (2009) and Jones (1998) and assumes that the production function of an individual firm may be approximated by a Cobb-Douglas form in a standard way as:

$$Y_{it} = A_t K_{it}^{\alpha K} L_{it}^{\alpha L}, \quad (1)$$

where Y_{it} represents the output of firm i in period t, K_t and L_t are capital and labour inputs, respectively, and At is the Hicks-neutral efficiency level of firm i in period t.

While Y_{it}, K_{it} and L_{it} are observable (usually in terms of value rather than in quantities), A_{it} is unobservable and is usually inferred as a residual. The acceleration of productivity growth in the USA in the mid-1990s has generated the "new economy" view and a source-of-growth model started to stress the potential importance of intangible investments and their capitalisation over time.

In order to make the methods of measuring capital and labour more symmetric and capture the quality of the workforce, we use the wage bill as a measure of labour (L_{it}). As argued for instance by Fox and Smeets (2011), the wage bill reflects the marginal product of labour better than the number of employees.

Expressing equation (1) in logs yields

$$y_{it} = \alpha_0 + \alpha_K k_{it} + \alpha_L l_{it} + \xi_{it} + u_{it}, \quad (1a)$$

where lower case letters correspond to the natural logarithms of the variables in equation (1), while $lnA_{it} = \alpha_0 + \xi_{it} + u_{it}$ and represents the ratio of output to use of input, so called total factor productivity (TFP). While α_0 measures the mean efficiency level across all firms over time, ξ_{it} and u_{it} capture producer-specific deviations from the mean – ξ_{it} refers to factors such as managerial ability, investment activity and export orientation that are observed by firm i and are likely to affect its choices of inputs. Finally, u_{it} is an i.i.d. component that captures factors that are unobserved by the firms. These factors affect output but not the choice of inputs. The term also represents a measurement error in output or errors due to functional form discrepancies.

To obtain our measure of TFP, we first have to estimate the production function. However, the direct estimation of the production function faces well-known econometric problems. A key issue is the correlation between unobservable productivity shocks and input levels. Profit-maximising firms respond to positive productivity shocks by expanding output, which requires additional inputs. Negative shocks lead firms to contract output, decreasing their input usage. Olley and Pakes (1996) developed an estimator that uses investment as a proxy for these unobservable shocks. Levinsohn and Petrin (2003), on the other hand, introduced an estimator that uses intermediate inputs as proxies, arguing that intermediates may respond more smoothly to productivity shocks. Since the productivity shocks will affect both the firm's input choices and the decision to shut down, consistent estimation of the production function parameters requires addressing problems of simultaneity and selection. Therefore, we use the multistep estimation algorithm of Levinsohn and Petrin (2003), which accounts for both problems, allowing for unbiased and unconstrained estimation of the production function coefficients. Their estimation algorithm differs from previous approach by Olley-Pakes in two important aspects. First, by using intermediate inputs to proxy for unobserved productivity, it means that intermediated inputs are expressed as a function of capital and productivity, i.e. $m_{it} = m_t (k_{it}, \omega_{it})$. Provided the monotonicity condition is met and material inputs are

strictly increasing in ω_{it}, this function can be inverted, allowing us to express unobserved productivity as a function of observables, i.e. $\omega_{it}=s_t(k_{it}, m_{it})$ where $st(.)=m_{t-1}$.

Replacing this in production equation (1a)

$$y_{it} = \alpha_0 + \alpha_K k_{it} + \alpha_L l_{it} + \alpha_M m_{it} + \omega_{it} + u_{it}, \quad (2)$$

we obtain

$$y_{it} = \alpha_0 + \alpha_K k_{it} + \alpha_L l_{it} + \alpha_M m_{it} + s_t(k_{it}, m_{it}) + u_{it}, \quad (3)$$

A final identification restriction follows Olley and Pakes (1996) assuming that productivity if governed by a first-order Markov process

$$\omega_{it} = E[\omega_{it}|\omega_{i,t-1}] + \xi_{it} \quad (4)$$

where ξ_t is an innovation to productivity that is uncorrelated with k_t, but not necessarily with l_t. The production function is now given as

$$y_{it} = \alpha_L l_{it} + \varphi_{it}(k_{it}, m_{it}) + u_{it}, \quad (5)$$

where

$$\varphi_{it}(k_{it}, m_{it}) = \alpha_0 + \alpha_K k_{it} + \alpha_M m_{it} + s_t(k_{it}, m_{it}) \quad (6)$$

Estimation of α_L is obtained using OLS with a third-order polynomial approximation in k_t and m_t in place of $\varphi_{it}(k_{it}, m_{it})$. The second stage identifies the coefficients α_K and α_M. It begins by computing the estimated value for φ_{it} and continues with a prediction for s_t for all periods t using for any candidate values α^*_K and α^*_M. Based on Levinsohn – Petrin procedure we calculate TFP as the residual from the production function and compare residuals between different types of firms and over time. Section 5.1 analyses the average TFP for different types of firms in the period under study.

The alternative stream of literature suggests the use of dynamic panel data methods, which allows for more sophisticated error structure in (1). Differencing the equation (1a) in two consecutive periods, the growth form is obtained:

$$\Delta y_{it} = \alpha_K \Delta k_{it} + \alpha_L \Delta l_{it} + \Delta lnA_{it} \quad (7)$$

Furthermore, we assume that the change in firm-specific efficiency levels (ΔlnA_{it}) is a function of past productivity and allow for a gradual convergence in efficiency levels between firms. Klette (1996) shows that productivity differences between firms are persistent and requires specification that allows for gradual convergence. Therefore the change in firm-specific efficiency levels can be specified as:

$$\Delta lnA_{it} = \theta y_{it-1} - \upsilon_{it} \quad (8)$$

Firms that are behind the most productive peers are more likely to be able to record stronger growth. We expect θ to be on the interval between -1 and 0 with 0 when no gradual convergence happened and -1 in the case of complete adjustment. To allow unobserved firm-level heterogeneity in efficiency growth and

macroeconomic shocks, the error term in equation includes firm fixed-effects and year specific-effect in addition to serially uncorrelated measurement errors ξit.

$$\upsilon_{it} = \alpha_i + \xi_{it} + u_t \quad (9)$$

In the steady state the proportional change in capital stock can be approximated by the proportional change in fixed capital investments (Jones, 2002). Combining equations (7), (8) and (9) and bringing the lagged output term to the right hand side, the dynamic model equation is obtained:

$$y_{it} = (1+\theta)y_{it-1} + \alpha_K \Delta k_{it} + \alpha_L \Delta l_{it} + \alpha_i + \xi_{it} + u_t \quad (10)$$

The specification (9) allows for firm fixed-effects and performance differences between firms as is acknowledged to be important in empirical studies (Blundell and Bond, 2000). Dynamic GMM panel data models (e.g., Arellano and Bond, 1991, and Blundell and Bond, 2000), similar to the specification (10), are among the most popular approaches to tackle the problem of endogeneity by exploiting instruments based on lagged input decisions. We use the Blundell-Bond approach as an alternative to an OLS estimation (which we also present in appendix) and specify our model (10) as a dynamic augmented production function in which different firm-specific factors – contained in the α_i term in equation (10) above – may affect TFP. The key explanatory variables with which we augment equation (10) are dummies for prevalent foreign (FOREIGN_OWN) and state ownership (STATE_OWN), history of the firm (de-novo versus privatised firm) and R&D activity. In order to test the impact of subsidies and past investment on productivity growth we include the amount of subsidies received per euro of asset and the lagged investment deviation from mean industry investment. In addition, we control for industry and regional differences and macroeconomic shocks by including 1-digit industry (INDUSTRY), regional (REGION) and year (YEAR) dummies, respectively. Firm size is included to control for productivity differences between small and large firms.

The empirical model is specified as follows:

$$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + \alpha_2 k_{it} + \alpha_3 k_{it-1} + \alpha_4 l_{it} + \alpha_5 l_{it-1} + \alpha_6 * \text{INVESTMENT\_DIFF}_{it-1} + \alpha_7 * \text{R\&DActivity}_i + \alpha_8 * \text{SUBSIDIES}_{it-1} + \alpha_9 * \text{PRIVATISED\_FIRMS}_i + \alpha_{10} * \text{FOREIGN\_OWN}_i + \alpha_{11} * \text{STATE\_OWN}_i + \alpha_{12}' * \text{SIZEi} + \alpha_{13}' * \text{YEAR}_t + \alpha_{14}' * \text{INDUSTRY}_i + \alpha_{15}' * \text{REGION}_i + \xi_{it}, \quad (11)$$

Our static version is specified as:

$$y_{it} = \alpha_0 + \alpha_1 k_{it} + \alpha_2 l_{it} + \alpha_3 * \text{INVESTMENT\_DIFF}_{it-1} + \alpha_4 * \text{R\&DActivity}_i + \alpha_5 * \text{SUBSIDIES}_{it-1} + \alpha_6 * \text{PRIVATISED\_FIRMS}_i + \alpha_7 * \text{FOREIGN\_OWN}_i + \alpha_8 * \text{STATE\_OWN}_i + \alpha_9' * \text{SIZEi} + \alpha_{10}' * \text{YEAR}_t + \alpha_{11}' * \text{INDUSTRY}_i + \alpha_{12}' * \text{REGION}_i + \xi_{it}, \quad (11a)$$

Based on the dynamic model (11), we were able to disentangle the short and long term effects of capital and labour on value added.

5. RESULTS OF THE EMPIRICAL ANALYSIS

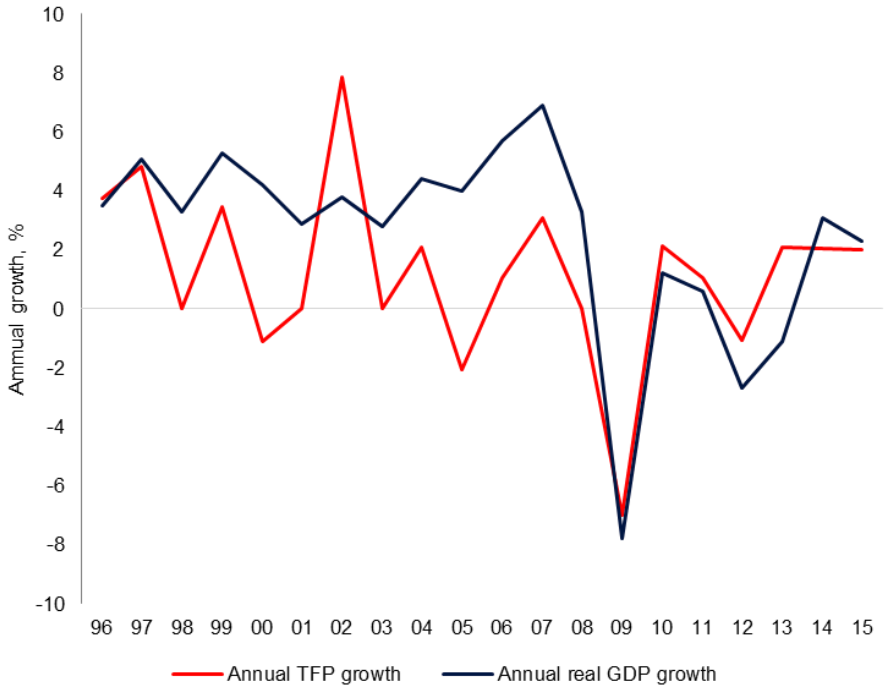
5.1. EXPLAINING THE PRODUCTIVITY OF SLOVENIAN FIRMS: RESULTS FROM USING THE LEVINSOHN-PETRIN METHODOLOGY

In this section we report the results of the model estimating total factor productivity as a residual (as specified in Section 2) applying the Levinsohn – Petrin methodology. We report the average productivity for different groups of firms.

5.1.1. TFP follows GDP

Graph 5.1 shows that TFP increased in 17 of the last 21 years. In the first period (1995-2008), Slovenia's GDP increased on average by 4.2% per year and TFP by 1.8% per year. Afterwards, Slovenia experienced a double-dip recession, with one of the largest GDP drop in the EU in 2009 (-7.8) and a second drop of GDP in 2012 (-2.7%). The severe recession followed the period of abundant cheap short-term money, borrowed from EA-19 banks, which fuelled the construction boom, real estate bubble and MBOs. In the recession period (2009-2013), TFP on average fell by 0.5% annually, 4-times less than the GDP (-2%). After that, it began to increase by some 2% per year, almost doubling the average rate over the whole period (1.2%). This was mostly due to the reduction of idle capacity as well as to cost optimisation measures taken at firm level.

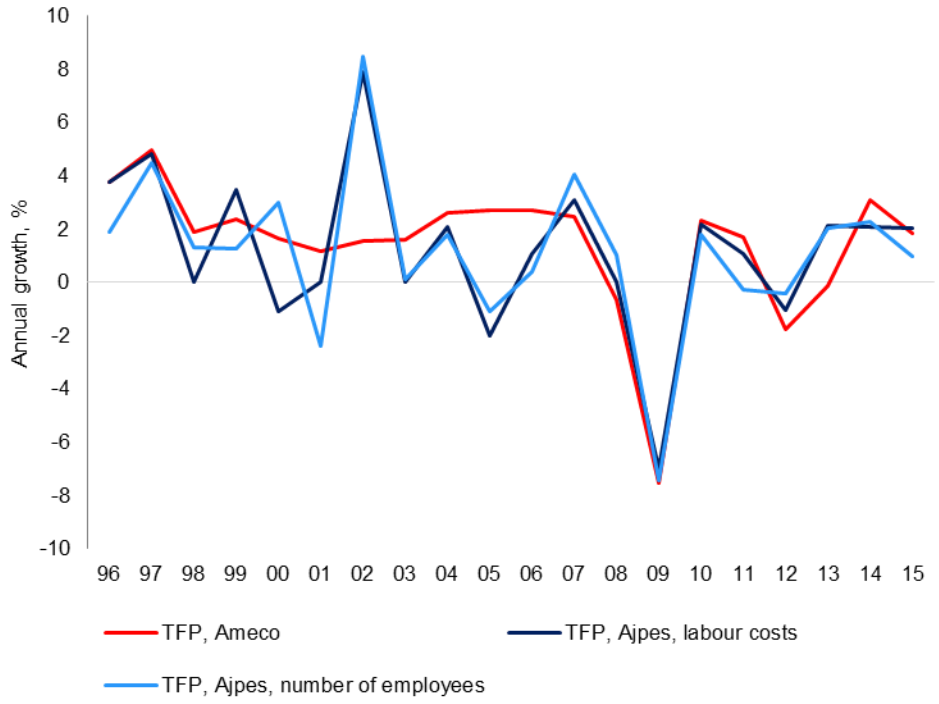
Graph 5.1: **TFP vs. real GDP growth, 1996-2015**



Source: AJPES and Statistical office of Slovenia.

We compare TFP yearly growth rate calculated by applying Levinsohn-Petrin methodology at the firm-level to the ones calculated using the macro-level AMECO database[6]. In AMECO, TFP is calculated for the total economy, based on macro accounts for the following parameters: total employment, wage and salary earners, compensation of employees, GDP and net capital stock. Our estimations of TFP are based on individual financial accounts provided by AJPES and as such are more appropriate to estimate the TFP of individual firms. Graph 5.2 shows that the difference in annual TFP growth between the two approaches (macro-Ameco vs micro-Ajpes) is somehow pronounced before 2007 but relatively small after 2008. We report TFP estimates using both the number of employees and the labour costs as a measure of labour input, which are broadly aligned

Graph 5.2: **TFP annual growth, comparing AMECO and AJPES data, 1996-2105**



Sources: Firms financial reports, Statistical Office of Slovenia, European Commission (AMECO).

Notes: TFP growth from the European Commission database AMECO is compared with our estimates based on firm-level data. Our estimate uses as labour input either the number of employees or the labour costs.

Table 5.1 presents growth in total factor productivity in different industries. During the whole period 1994-2015, TFP increased by 28% on average. Energy (+67%) and Transportation (+47%) were the leading sectors, whereas Construction (+20%) and Retail (+14%) were clear laggards. In agriculture, though a less important industry, TFP dropped by 15% over the same period. In terms of level, average TFP in 2015 was higher in the Energy sector (55% above average), followed by Transportation (10% above) and ICT (6% above). Education (71%) and Agriculture (78%) were stragglers. We decompose the whole period of 1994-2015 into 3 sub-periods: pre-crisis (1994-2008), crisis (2009-2013) and post-crisis (2014-2015). In the first period, TFP rose on average by 2%, in the second it fell by 1% and in third it rose

[6] AMECO is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs. It is available online at: http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm

again by 2% annually. In terms of industries, Energy was the top growth sector (4%) in the first period (followed by Professional, Scient. and techn. activ., and Arts, entertain and recreat.).

Table 5.1: **TFP growth in the pre-crisis, crisis and post-crisis periods, by industry**

	2008/ 1994	1994-2008 avg.	2013/ 2008	2008-2013 avg.	2015/ 2013	2013-2015 avg.
A – Agriculture	7.0	n.a.[7]	n.a.	n.a.	n.a.	n.a.
B - Mining and Quarrying	35.4	n.a.	n.a.	n.a.	n.a.	n.a.
C – Manufacturing	25.0	9.2	-4.0	9.6	5.2	9.9
D – Energy	61.6	13.4	1.9	16.0	1.2	16.2
E – Utilities	27.6	8.7	3.1	9.8	-4.0	9.8
F – Construction	28.9	8.8	-9.2	8.9	2.2	9.1
G – Trade	16.7	9.8	-7.6	9.8	6.2	10.0
H – Transportation	37.2	9.8	-0.9	10.4	8.5	11.0
I – Hotels	19.1	8.1	-1.2	8.0	5.0	8.1
J – ICT	29.3	9.6	-1.9	10.3	2.9	10.5
L - Real estate	25.6	8.7	0.0	9.3	5.1	10.3
M - Professional, Scientific and Tech. Act.	41.7	8.8	-2.0	10.0	2.0	10.1
N – Adm. and Support service activities	33.3	8.4	2.1	9.5	5.1	10.1
O - Public adm. and defense, compulsory social security	50.9	7.4	n.a.	n.a.	n.a.	n.a.
P – Education	28.1	6.8	-2.7	7.2	0.0	7.1
Q - Human health and social work activities	28.4	9.0	1.1	9.6	1.0	9.7
R - Arts, entertainment & recreation	48.1	9.9	-5.1	11.3	1.8	11.5
S - Other service activates	23.5	7.6	-6.0	7.9	3.8	8.0
Total	26.6	9.1	-3.0	9.6	4.1	9.9

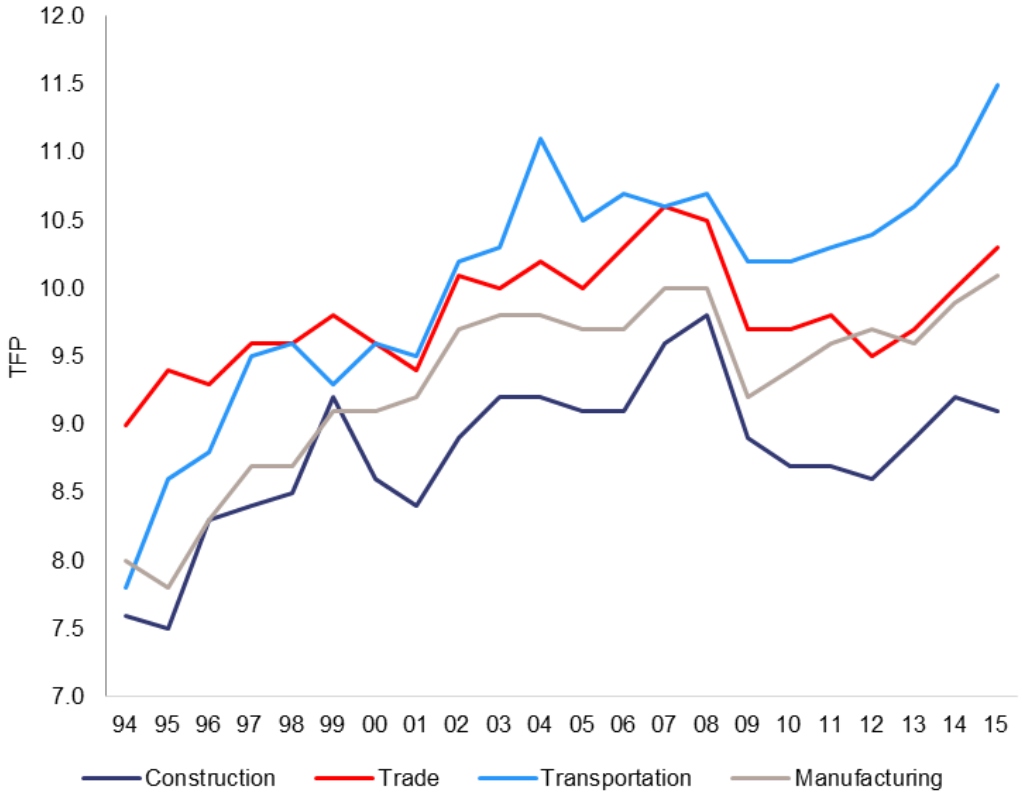
Source: AJPES.

In the crisis period, Construction and Retail sectors underperformed (TFP fell by 2% annually). This was due to the large drop in construction works and retail sales as companies reduced investments and household reduced spending. Utilities were the only sector where TFP increased (by 1% annually). In the post-crisis period, export oriented industries (Transportation, Manufacturing) and sectors with low performance in crisis period (Retail, Real Estate, Administrative and Support Services) experienced the highest rebound in TFP.

[7] Not available or statistically not representative due to small data set.

Graph 5.3 shows interesting movements in TFP in the four most important industries: Manufacturing, Transportation, Trade and Construction. The biggest drop during the recession was in Construction, while Transportation recorded the highest growth after the crisis and over the whole period.

Graph 5.3: **Firms' average TFP, by industry, 1994-2015**

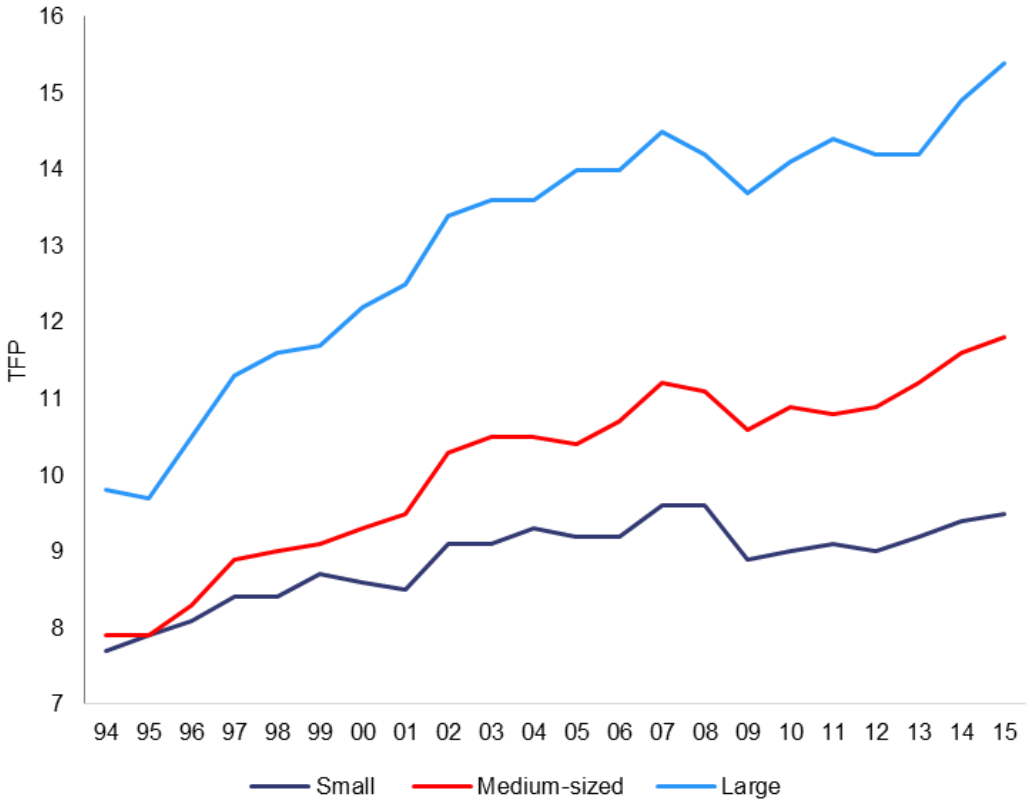


Source: AJPES and own calculations.

5.1.2. The large firms are clear winners

In 2015, large and medium-sized firms' TFP was 52% and 17% above average, respectively, while small firms' TFP was 6% below average. In terms of growth, large corporates experienced the highest rise in TFP (+57%) over the whole period, followed by medium-sized firms (+49%) whereas small firms increased their TFP by only 23% (see Graph 5.4). This was because outperformers were big or medium-sized firms in the non-tradable sectors (Energy), while small firms suffered from the decline in domestic consumption and the cost-cutting undertaken by larger firms. This ranking does not change when looking at the different sub-periods. Before the crisis, the TFP of large corporates increased by 3% annually vs. 2% for small and medium-sized companies. In the crisis period, TFP increased by 8.5% annually in large firms, 6.3% in medium-sized firms and decreased by 1% in small firms. Also after the crisis, large firms (4%) outperformed medium-sized ones (3%) and small ones (2%). This was due to the high rebound in exports and the sluggish growth of domestic consumption.

Graph 5.4: **Firms' average TFP, by firm size, 1994-2015**

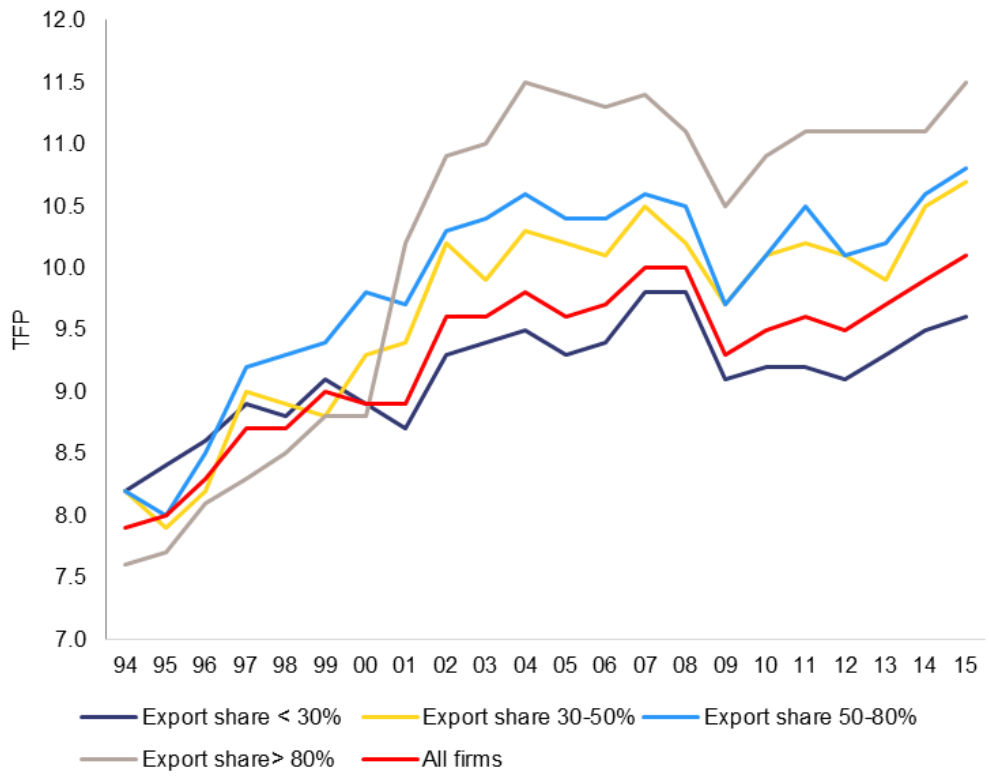


Source: AJPES and own calculations.

5.1.3. Exporting firms show higher TFP

As illustrated in Graph 5.5, exporters experienced far stronger TFP growth than other firms over the whole period. In firms with a share of export in total sales above 80%, TFP increased by 51%. In those with an export share between 30 and 50% and between 50 and 80%, TFP increased by 30% and 32%, respectively. The strong performance of exporters is also attributed to their average larger size, better corporate governance, higher R&D and stronger presence in global value chains (B2B automobile, pharmaceutical, machinery). In firms with an export share in sales below 30%, TFP grew only by 17%. During the crisis, TFP of these modest-to-non-exporters (export share in sales below 30%) fell by 2%, while that of exporters rose by 3 to 5%, depending on the share of export in sales. The smaller size of the modest-to-non-exporters, their lower ranking in value chain and focus on domestic market made the difference. Firms carrying out R&D experienced strong TFP growth (+41%), as did privatised ones. In the crisis period, R&D active firms were the only ones that retained their TFP at the pre-crisis level.

Graph 5.5: **Firms' average TFP, by export orientation, 1994-2015**



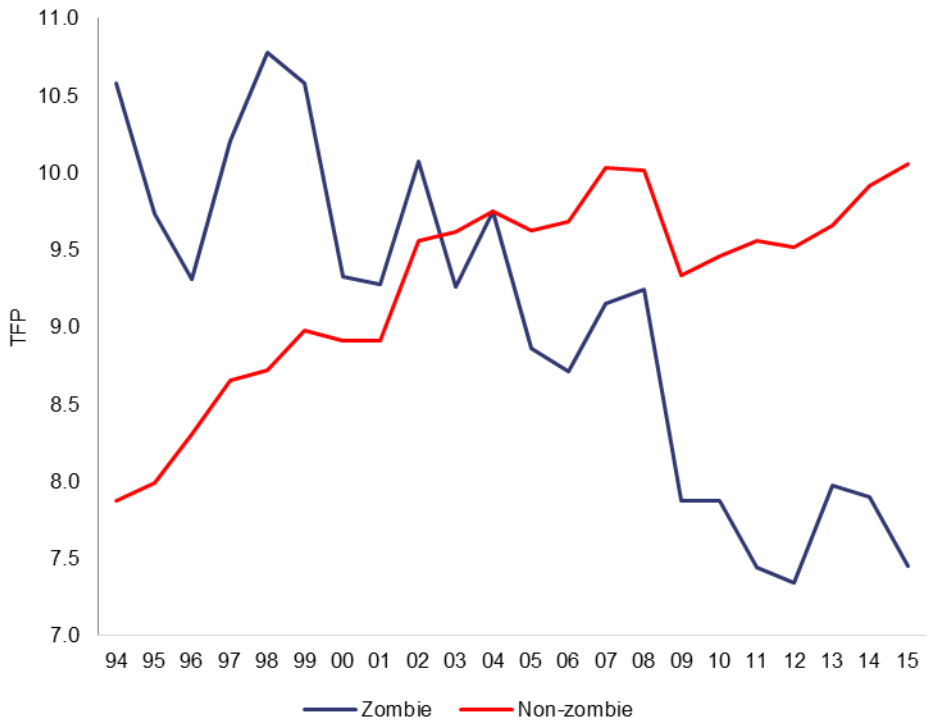
Source: AJPES and own calculations.

Note: Export share = export/total sales.

5.1.4. Zombie firms underperform

In zombie firms, TFP decreased by 30% over the whole period (1.4% annually) while it increased by 28% in non-zombie firms (1.2% annually). As a result, at the end of the period, the TFP of zombie firms was more than 20% lower than that of non-zombie firms. Zombie firms underperformed non-zombie firms in all three periods. In the first period, zombie firms' TFP shrank by 0.7% annually (+1.8% non-zombie) and in the second it shrank by 2.6% (-0.7% non-zombie). In the third period, the difference was even more pronounced (-3.3% vs. +2.1%). This was due to negative cash flows in zombie firms as banks reduced the financing of these over-indebted firms and tightened credit standards. These firms had to reduce the level of their operations and thus investments. The spike in 2013 can be attributable primarily to a survivorship bias, as the increased default rate of poor performing zombie firms (with lower TFP) increased the TFP of survivors in the following years.

Graph 5.6: **Firms' average TFP, zombie vs. non-zombie firms, 1994-2015**



Source: Firms financial reports and own calculations.

5.1.5. SOEs underperform in 5 out of 7 sectors

Graph 5.7 presents TFP growth in SOEs (state ownership above 50% - see Section 2) and compares it with that in private firms over the period 1995-2015. SOEs shows on average higher TFP and higher TFP growth than other firms, also explained by their average larger size. TFP increased by 38% in SOEs over 1994-2015 vs. 28% in all firms. Over the 21 years, SOEs underperformed in 8 years and outperformed in 13.

Out of the seven sectors in which SOEs represented a substantial share of value added (more than 25%); SOEs' TFP growth outperformed other firms in Hotels (by 28 p.p.) and Utilities (by 3.5 p.p.). SOEs' TFP increased less than other firms' in the ICT (by 24 p.p.), Arts & Entertainment (by 15 p.p.), Professional & Scientific Activities (by 12 p.p.) and Energy (by 4.3 p.p.) sectors.[8]

We then divide the SOEs where the state had a share larger than 25% in two groups: those with a share of export in total sales below 30% and those with an export share above 80%. These SOEs outperformed the other firms in both groups; in the first group by 10 p.p. (26.7% rise vs. 16.0%) and in the second by 37 p.p. (87% rise vs 50%).

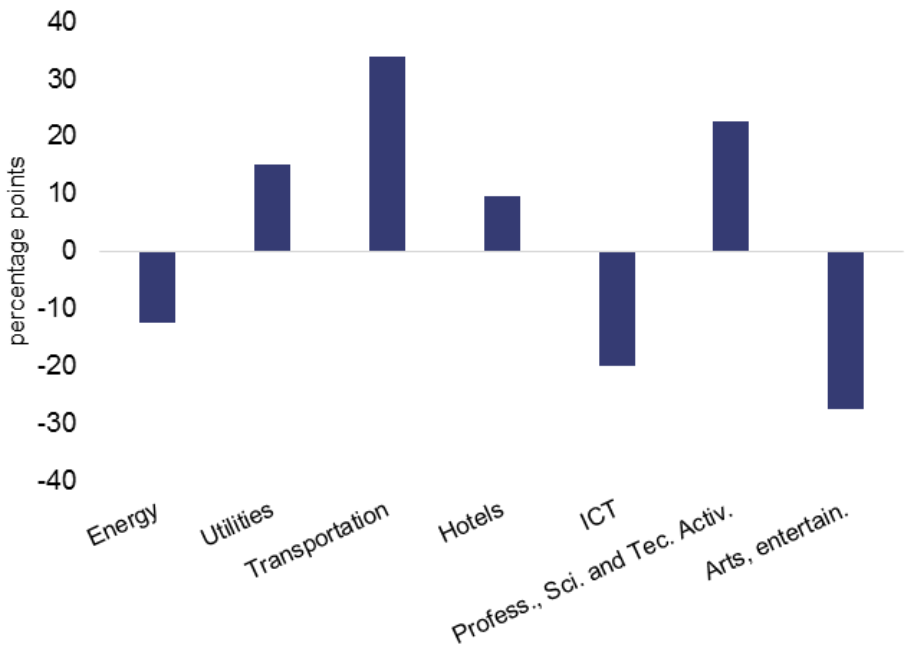
[8] It is important to highlight that the difference in TFP figures is very small if we define SOEs as those where the state has above 25% share compared to 50% threshold. Two exceptions are Hotels where TFP growth of all SOEs with a share above 25% was lower compared to those where state had a 50% share or above (by 5.5 p.p.). In ICT sector, on the other hand, SOEs with more than 25% of state ownership had a higher TFP growth (by 4.1 p.p.) if compared with SOEs with more than 50% of state ownership.

Graph 5.7: **Annual TFP growth, state-owned vs. other firms, 1995-2015**

Source: AJPES and own calculations.

Size is an important factor to explain differences in the level and growth of TFP. We decompose all SOEs with a state share above 25% in three groups: small, medium and large SOEs. Small SOEs had a lower TFP than all small firms on average (by 3.4%) over the period under study. However, their TFP increased by 46%, which compares with some 24% increase for all small firms. The TFP in small SOEs increased by 2.0% annually in the first period (1.6% for all small firms), by 1.7% in the second period (-0.9%) and by 1.2% in the third period (1.9%). Only in the third period (2 years, post-crisis), small SOEs' TFP growth underperformed that of the whole set of small firms. TFP growth was lower in small SOEs than in all small firms in the Energy (-12 p.p.), ICT (-20 p.p.) and Arts & Entertainment (-27 p.p.), but stronger in Utilities (by 15 p.p.), Transportation (by 34 p.p.) and Professional, Scientific & Technical Activities (by 23 p.p.) sectors (see Graph 5.8).

Graph 5.8: **Difference in TFP growth of small SOEs compared with all small firms, by sector, 1995-2014**

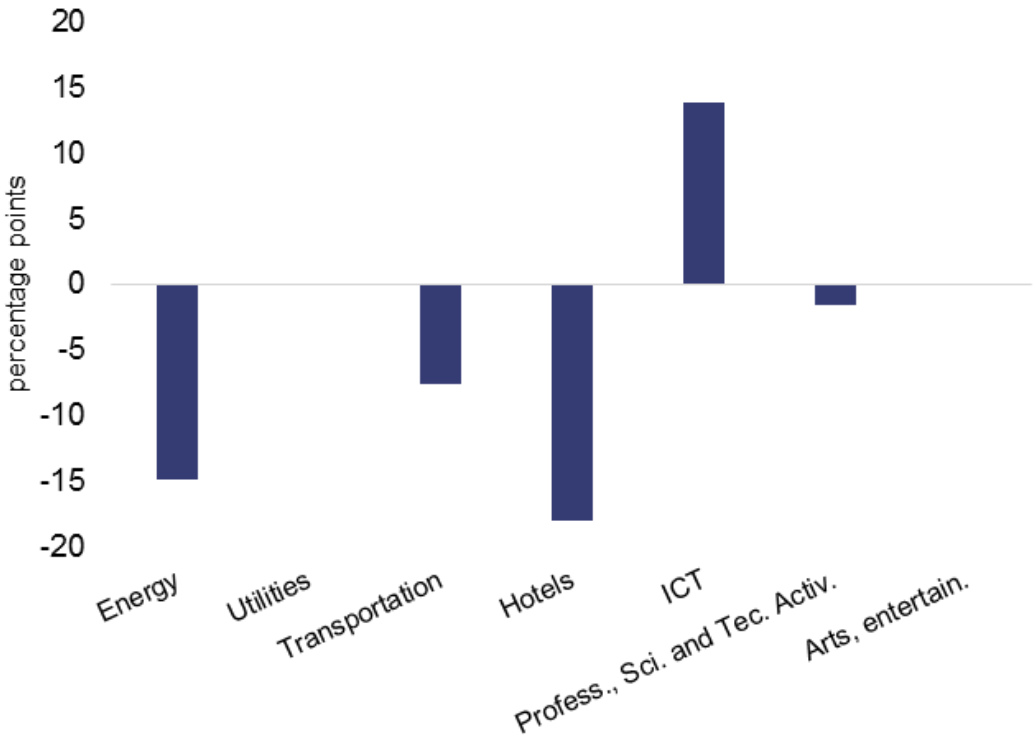


Source: AJPES and own calculations.

Note: Only the sectors where SOEs account for more than 25% of value added are displayed.

Medium-sized SOEs had a TFP 2.5% above the average of all medium-sized firms in the period under study (21 years). Their TFP increased by 40% in the observed period, underperforming all medium-sized firms (49%). Medium-sized SOEs increased TFP by 1.9% annually in the first period (compared to 2.5% in all medium-sized firms) and by 0.3% in the second period (0.2% in all medium-sized firm). In the third period, TFP in SOEs increased more (3.5% vs. 2.5%) than in their counterparts. Medium-sized SOEs TFP growth outperformed that of all medium-sized firms (Graph 5.9) in the Energy (39 p.p.), Arts & Entertainment (63 p.p.), Hotels (33 p.p.) and Transportation (18 p.p.), but underperformed in ICT (by 35 p.p.), Professional, Scientific & Technical Activities (by 5 p.p.) and Utilities (by 3 p.p.) sectors (Graph 5.9).

Graph 5.9: **Difference in TFP growth of medium-sized SOEs compared with all medium-sized firms, by sector, 1995-2014**

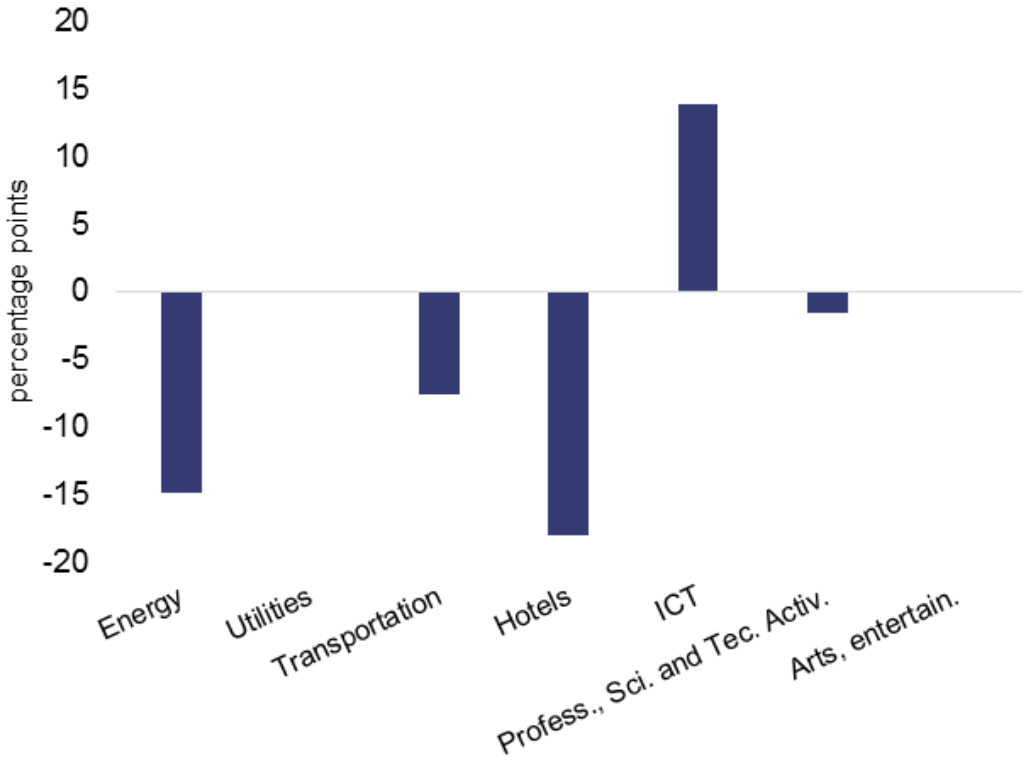


Source: AJPES and own calculations.

Note: Only the sectors where SOEs account for more than 25% of value added are displayed.

Large SOEs' TFP level was 17% above the average of all large firms in the period under study. However, their TFP growth was half of the growth of their peers. In large SOEs, TFP increased by 36% in the whole period, whereas in all large firms it recorded a 62% increase (26 p.p. difference). In the first period, the average productivity growth of all large firms was stronger than that oflarge SOEs (2.7% vs. 2.2%), and similarly in the second period (0.8% vs. -1.4%). In the third period, the average large SOE outperformed the average large firm (4.8% vs. 3.8%). Large SOEs generally underperformed in 4 sectors (Hotels, Energy, Transportation, Professional, Scientific & Technical Activities), matched the growth of the other large firms in Utilities and Arts & Entertainment, and outperformed them in the ICT sector (by 14 p.p.) – See Graph 5.10.

Graph 5.10: **Difference in TFP growth of large SOEs compared with all large firms, by sector, 1995-2014**

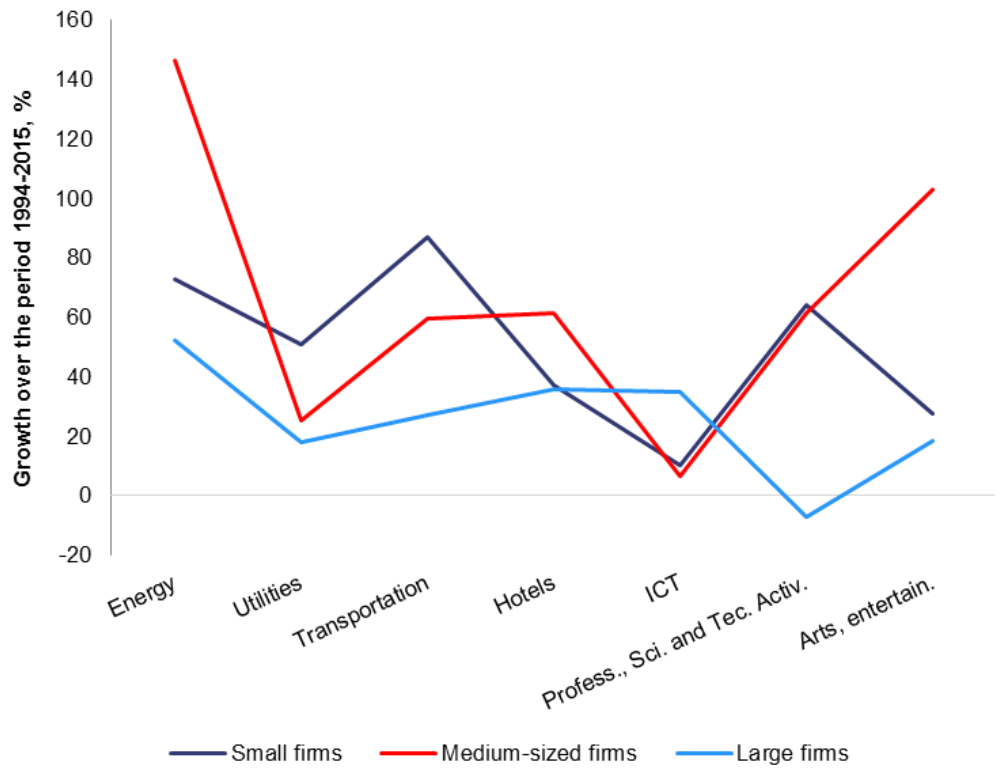


Source: AJPES and own calculations.

Note: Only the sectors where SOEs account for more than 25% of value added are displayed.

Further decomposing SOEs into different size groups and industries shows that in the Energy sector medium-sized SOEs (+146% TFP growth over the period) outperformed small (+73%) and large SOEs (+52%). In Utilities, small SOEs' TFP increased twice as much as medium-sized (51% vs 25%) while in large SOE TFP increased only by 18%. In Transportation and Professional, Scientific and Technical Activities, small and medium-sized firms outperformed large ones by a wide margin.

Graph 5.11: **SOEs' TFP growth, by industry and firm size, 1994-2015**



Source: AJPES and own calculations.

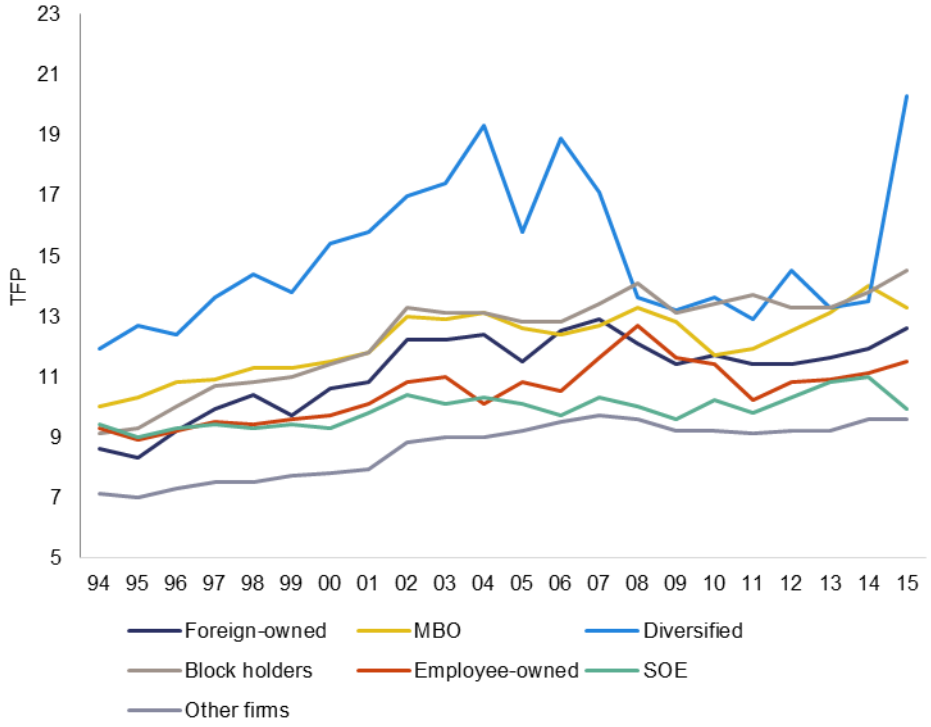
Note: Only the sectors where SOEs account for more than 25% of value added are displayed.

In Hotels, TFP in medium-sized SOEs increased by 62%, twice as much as that at small and large ones (37 and 36%). In ICT, large SOEs increased their TFP by 35%, followed by 10% increase in small and 7% in medium-sized. In Arts and Entertainment, TFP in medium-sized SOEs increased by 103%, far more than did in small ones (28%) and large ones (18%).

5.1.6. Management buy-out firms (MBOs) underperform

The analysis of different types of ownership is interesting especially with regard to the outcome of the privatisation processes during the 1990s. This analysis is performed using a smaller dataset, as described in Section 2. TFP in privatised firms increased by 45% over 1994-2015, clearly outperforming the average increase in TFP (+28%). The analysis shows that firms with block holders ownership were the most successful ones, as their TFP increased by 129% on average, followed by foreign owned firms (+100%). After 2008, firms with diversified ownership had the highest TFP increase (+69%), while MBOs and employee-owned firms experienced TFP drops (MBOs by 25% and employee-owned firms by 11%). This was also attributable to the high leverage of MBOs, with a large proportion of short-term debt (maturity less than one year). Such large short-term debt came to maturity during the crisis and had to be repaid, therefore reducing firms' potential to finance investment. Controlling firms transferred the free cash flow from their affiliate firms inducing drop in their R&D expenses and/or postponing critical investments.

Graph 5.12: **Firms' average TFP, by ownership structure, 1994-2015**



Source: AJPES and own calculations.

5.2. EXPLAINING THE PRODUCTIVITY OF SLOVENIAN FIRMS: RESULTS FROM THE ESTIMATION OF DYNAMIC PRODUCTION FUNCTION MODELS

In this section, we report the estimation of dynamic production function models (Equation 11 - see Section 4) with different control variables and different time periods using Arellano Bond System GMM estimator. Special estimates were done also on the sample of privatised firms. Estimates of the static model (Equation 11a) are presented in Appendix. We conclude this chapter with a multilevel analysis in order to check the robustness of our findings.

5.2.1. All firms, for the entire time period

Table 5.2 reports the estimated parameters of the augmented dynamic production function model (Equation 11), Table 5.3 presents the estimated short and long run elasticities of value added with respect to labour costs and capital. The (robust Huber) Ordinary Least Squares (OLS) specifications of the static production function models in levels and differences yield relatively similar results in different specifications (1-4), which are presented in appendix (see Tables 6.1 and 6.2 in appendix).

Table 5.2 shows that foreign owned firms and firms with R&D activities result to be more productive than their counterparts from the same industry and region, although the effects are statistically significant only in one and two specifications respectively (out of four). SOEs appear to be less productive (statistically significant in one specification), while firm size does not seem to make a difference. The fact that most coefficients are not significant is probably due to the long period considered. Arellano-Bond test for AR(2) in first differences did not reject the null hypothesis as well as Sargan test of over-identified restrictions.

The short run elasticity of value added to labour costs (Table 5.3) is in line with the elasticities reported in other studies on Slovene firms (see Domadenik et al., 2016, for example) but substantially higher than in the static model (see Appendix). Increase in labour costs by 1% led to 1.14% increase in value added in the short run and 0.94% increase in the long run, on average, ceteris paribus. On the other hand, short and long run elasticities of value added with respect to capital are not significant if we control for endogeneity.

Table 5.2: **Dynamic production function model, estimates 1995-2015**

Dep. v.: ln(Value added)			**Levels**	
	(1)	(2)	(3)	(4)
ln(value added)-1	0.102	0.141	0.139	0.134
	(0.092)	(0.138)	(0.842)	(0.0957)
ln(labour costs)	1.234***	1.143***	1.144	1.143***
	(0.084)	(0.193)	(1.894)	(0.161)
ln(labour costs)-1	-0.352***	-0.292	-0.292	-0.329***
	(0.069)	(0.228)	(1.206)	(0.100)
ln(capital)	0.051	-0.033	-0.034	-0.073
	(0.067)	(0.126)	(1.206)	(0.097)
ln(capital)-1	-0.002	0.044	0.044	0.082
	(0.052)	(0.111)	(1.085)	(0.079)
Investment_Diff_lagged		0.003	0.003	0.003
		(0.005)	(0.015)	(0.003)
Subsidies/assets_lagged			-0.008	-0.003
			(0.350)	(0.050)
R&D Activtiy			0.065	0.102*
			(0.202)	(0.060)
Privatisation dummy				-0.120
				(0.094)
Foreign owned	0.104***	0.104*	0.105	0.133
	(0.017)	(0.056)	(0.229)	(0.082)
State-owned	-0.046*	-0.006	-0.006	0.0123
	(0.026)	(0.116)	(0.388)	(0.115)
Small firms	0.132***	0.065	0.071	-0.040
	(0.050)	(0.259)	(1.266)	(0.110)
Large firms	-0.017	0.022	0.006	0.078
	(0.048)	(0.193)	(0.782)	(0.101)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	-0.268	-2.637	-35.65	2.686
	(0.368)	(53.431)	(127.836)	(67.204)
Observations	117,666	110,236	110,236	110,236
AR (1)	-5.86***	-7.55***	-7.52***	-7.40***
AR (2)	0.30	0.94	0.92	0.86
Sargan test	78.37	46.99	43.17	88.78

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.3: **Short and long term elasticities of value added to labour costs and capital, estimates 1995-2015**

	Elasticities – dynamic specification in levels			
	(1)	(2)	(3)	(4)
Short run elasticity w.r.t. labour costs	1.234***	1.143***	1.144	1.143***
	(0.084)	(0.193)	(1.894)	(0.161)
Long run elasticity w.r.t. labour costs	0.981***	0.990***	0.990*	0.936***
	(0.030)	(0.102)	(0.571)	(0.082)
Short run elasticity w.r.t. capital	0.051	-0.033	-0.034	-0.073
	(0.067)	(0.126)	(1.206)	(0.097)
Long run elasticity w.r.t. capital	0.054*	0.012	0.012	0.009
	(0.027)	(0.117)	(0.264)	(0.045)

Source: Firms financial statements.
Note: 1. Standard errors are in parentheses
2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

5.2.2. All firms, for two time periods

The recent economic crisis had a substantial impact on Slovenian firms. Therefore we estimate the dynamic productivity models over two periods, before the crisis (1995-2008) and after it (2009-2015). Results are reported in Table 5.4 and Table 5.5, respectively.

As shown in Table 5.4, firms with R&D activity appear to have performed better than their counterparts, before and after the economic crises. Before the crisis, foreign-ownership had a positive impact on TFP while firms that went through privatisation process during the 1990s underperformed de-novo firms. After the crisis, receiving subsidies and state-ownership appear to have a negative impact while above average investment has a positive impact. The negative coefficient on subsidies could be explained by the fact that, during the crisis, subsidies were given to firms in difficulties. Short-run and long-run elasticities with respect to labour and capital (Table 5.5) were similar in magnitude and significance to the estimates for the whole period (Table 5.3). The long-term elasticity on the cost of labour was however substantially higher in the post-crisis period.

Table 5.4: **Dynamic production function model, estimates 1995-2008**

Dep. v.: ln(Value added)	**1995-2008**			
	(1)	(2)	(3)	(4)
ln(value added)-1	0.193	0.139	0.139	0.131
	(0.146)	(0.093)	(0.093)	(0.093)
ln(labour costs)	1.139***	1.135***	1.136***	1.129***
	(0.113)	(0.104)	(0.104)	(0.104)
ln(labour costs)-1	-0.391***	-0.383***	-0.383***	-0.375***
	(0.106)	(0.078)	(0.078)	(0.078)
ln(capital)	0.090	-0.001	-0.000	-0.004
	(0.099)	(0.076)	(0.076)	(0.076)
ln(capital)-1	-0.024	0.047	0.046	0.051
	(0.074)	(0.058)	(0.058)	(0.058)

Investment_Diff_lagged		0.000	0.000	-0.000
		(0.003)	(0.003)	(0.003)
Subsidies/assets_lagged			-0.003	0.001
			(0.003)	(0.002)
R&D Activtiy			0.060***	0.094***
			(0.022)	(0.020)
Privatisation dummy				-0.141***
				(0.026)
Foreign owned	0.116***	0.132***	0.133***	0.130***
	(0.026)	(0.024)	(0.025)	(0.024)
State-owned	-0.041	0.031	0.029	0.017
	(0.031)	(0.048)	(0.048)	(0.043)
Small firms	0.095	-0.046	-0.038	-0.077
	(0.070)	(0.085)	(0.083)	(0.080)
Large firms	0.016	0.090	0.074	0.099
	(0.069)	(0.075)	(0.071)	(0.067)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	0.060	1.112	1.084	1.208*
	(0.590)	(0.678)	(0.672)	(0.658)
Observations	75,974	69,394	69,394	69,394
AR (1)	-4.13***	-5.93***	-5.94***	-5.87***
AR (2)	0.84	0.86	0.87	0.78
Sargan test	44.20*	11.08	10.91	20.45

Source: AJPES.

Note: 1. Standard errors are in parentheses. 2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.5: **Short and long term elasticities of value added to labour costs and capital, estimates 1995-2008**

	Elasticities – dynamic specification in levels			
	(1)	(2)	(3)	(4)
Short run elasticity w.r.t. labour costs	1.139***	1.135***	1.136***	1.129***
	(0.113)	(0.104)	(0.104)	(0.104)
Long run elasticity w.r.t. labour costs	0.925***	0.874***	0.874***	0.867***
	(0.062)	(0.055)	(0.055)	(0.054)
Short run elasticity w.r.t. capital	0.090	-0.001	-0.000	-0.004
	(0.099)	(0.076)	(0.076)	(0.076)
Long run elasticity w.r.t. capital	0.081**	0.053	0.053	0.053
	(0.037)	(0.035)	(0.035)	(0.035)

Source: AJPES.

Note: 1. Standard errors are in parentheses. 2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.6: **Dynamic production function model, estimates 2009-2015**

Dep. v.: ln(Value added)			**2009-2015**	
	(1)	(2)	(3)	(4)
ln(value added)-1	0.043	0.155	0.144	0.142
	(0.121)	(0.099)	(0.101)	(0.101)
ln(labour costs)	1.214***	1.018***	1.016***	1.012***
	(0.121)	(0.121)	(0.122)	(0.122)
ln(labour costs)-1	-0.241**	-0.090	-0.072	-0.066
	(0.118)	(0.128)	(0.130)	(0.130)
ln(capital)	0.027	-0.084	-0.083	-0.084
	(0.107)	(0.083)	(0.083)	(0.083)
ln(capital)-1	0.023	0.062	0.056	0.055
	(0.078)	(0.075)	(0.075)	(0.075)
Investment_Diff_lagged		0.004**	0.004**	0.004**
		(0.001)	(0.002)	(0.001)
Subsidies/assets_lagged			-0.183***	-0.181**
			(0.070)	(0.071)
R&D Activtiy			0.074*	0.081**
			(0.039)	(0.037)
Privatisation dummy				-0.029
				(0.019)
Foreign owned	0.050	0.021	0.023	0.022
	(0.033)	(0.032)	(0.033)	(0.033)
State-owned	-0.102**	-0.078**	-0.076*	-0.075*
	(0.039)	(0.039)	(0.039)	(0.039)
Small firms	0.125	0.103	0.110	0.101
	(0.080)	(0.081)	(0.076)	(0.074)
Large firms	-0.051	-0.019	-0.035	-0.030
	(0.090)	(0.092)	(0.084)	(0.083)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	-0.666	-0.592	-0.593	-0.555
	(0.666)	(0.691)	(0.681)	(0.674)
Observations	41,692	40,842	40,842	40,842
AR (1)	-3.87***	-4.68***	-4.64***	-4.60***
AR (2)	-0.35	0.64	0.53	0.50
Sargan test	36.97	49.96	48.81	48.95

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.7: **Short and long term elasticities of value added to labour costs and capital, estimates 2009-2015**

	Elasticities – dynamic specification in levels			
	(1)	(2)	(3)	(4)
Short run elasticity w.r.t. labour	1.214***	1.018***	1.016***	1.012***
	(0.121)	(0.121)	(0.122)	(0.122)
Long run elasticity w.r.t. labour	1.017***	1.098***	1.102***	1.101***
	(0.047)	(0.051)	(0.050)	(0.050)
Short run elasticity w.r.t. capital	0.027	-0.084	-0.083	-0.084
	(0.107)	(0.083)	(0.083)	(0.083)
Long run elasticity w.r.t. capital	0.053	-0.025	-0.032	-0.033
	(0.048)	(0.047)	(0.047)	(0.047)

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

5.2.3. Firms that were privatised in the early 1990s

Tables 5.8 and 5.9 present the results of the dynamic estimation of the production function over the period 1995-2015 only for firms that were privatised during the 1990s. For this subsample of 12,412 observations, we use the detailed information on ownership structure as described in Section 2. Compared to the estimation on the full sample (Table 5.3), we find lower short run and similar long run elasticities of value added with respect to labour, but higher and statistically significant elasticities with respect to capital. This result might be driven by the fact that the size of the average firm in this sample is more than twice that of the average firm in our initial population (over the studied period, privatised firms employed 146 employees on average, while in the full sample the average employment was 63.8 employees). Therefore, small firms appear to have been less constrained in adjusting their labour force to the changing economic conditions in comparison with big firms.

The effects of other explanatory variables are similar in magnitude to those for the whole sample and mostly statistically not significant also in this case. Regarding ownership structure, firms with diversified ownership had on average higher productivity, with coefficient being significant only in the post-recession period. They seem to represent the most vital part of Slovene business sector. Due to sound financial performance in the past they did not experience problems with over indebtedness during the crisis and were able to recover fast after the bust period. Firms being governed by different big owners (usually different investment funds and employees) reported significantly higher productivity over 1995-2008 and continued to perform better than average also in the period after the crisis. The results also indicate that foreign owned firms had higher productivity during the boom period and that SOEs had lower productivity in the post-crisis period and overall (the coefficients are not statistically significant in both cases, however).

Table 5.8: **Dynamic production function estimates for firms that were privatised during the 1990s**

Dep. v.: ln(Value added)	All years	1995-2008	2009-2015
ln(value added)-1	0.143*	0.136	0.224**
	(0.081)	(0.114)	(0.090)
ln(labour costs)	0.755***	0.774***	0.629***
	(0.115)	(0.137)	(0.206)
ln(labour costs)-1	0.098	0.074	0.139
	(0.146)	(0.166)	(0.240)
ln(capital)	0.124	0.226**	0.035
	(0.077)	(0.108)	(0.085)
ln(capital)-1	-0.054	-0.189*	-0.021
	(0.075)	(0.108)	(0.078)
Investment_Diff_lagged	0.002	0.003	0.005
	(0.003)	(0.005)	(0.004)
Subsidies/assets_lagged	-0.006	-0.004	-0.369
	(0.004)	(0.004)	(0.225)
R&D Activtiy	-0.045	-0.072	0.082
	(0.042)	(0.051)	(0.052)
Small firms	0.092	0.024	-0.014
	(0.121)	(0.126)	(0.112)
Large firms	-0.109	-0.084	0.057
	(0.067)	(0.071)	(0.096)
Foreign owners	0.057	0.079	0.0185
	(0.046)	(0.059)	(0.059)
MBO	-0.017	0.022	0.012
	(0.074)	(0.062)	(0.070)
Diversified owners	0.169	0.190	0.284*
	(0.103)	(0.124)	(0.153)
Block holders	0.050	0.077*	0.057
	(0.039)	(0.044)	(0.064)
Employee owned	-0.042	-0.012	-0.069
	(0.035)	(0.041)	(0.062)
State-owned	-0.010	0.033	-0.082
	(0.070)	(0.071)	(0.082)
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Constant	-0.644	0.079	
	(0.739)	(0.765)	
Observations	12,412	9,277	3,135
AR (1)	13,729	10,239	3,490
AR (2)	-4.65***	-3.88***	-2.31***
Sargan test	0.38	0.12	0.03

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.9: **Short and long term elasticities of value added to labour costs and capital for firms that were privatised during the 1990s**

	Elasticities – dynamic specification in levels		
	(1)	(2)	(3)
Short run elasticity w.r.t. labour	0.755***	0.774***	0.629***
	(0.115)	(0.137)	(0.206)
Long run elasticity w.r.t. labour	0.995***	0.981***	0.990***
	(0.074)	(0.077)	(0.112)
Short run elasticity w.r.t. capital	0.124	0.226**	0.035
	(0.077)	(0.108)	(0.085)
Long run elasticity w.r.t. capital	0.081*	0.042	0.018
	(0.049)	(0.048)	(0.096)

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

5.2.4. Comparing results in samples with and without zombie firms

This subsection analyses whether the previous results are robust to the elimination of so-called zombie firms (see Section 3 for a definition) from the sample. Results in the Tables 5.10 and 5.11 show that there are no differences with the results obtained with the complete sample. The only differences concern the results regarding the size of firms: in this case, small firms exhibited lower productivity and large firms higher productivity if compared with medium-sized firms. This result is obviously driven by the period before crisis.

Table 5.10: **Estimates with and without zombie firms in the sample, dynamic model**

Dep. v.: ln(Value added)	Levels		1995-2008		2009-2015	
	All firms	No zombie	All firms	No zombie	All firms	No zombie
ln(value added)-1	0.134	0.336***	0.131	0.160*	0.142	0.182*
	(0.095)	(0.057)	(0.093)	(0.093)	(0.101)	(0.106)
ln(labour costs)	1.143***	1.078***	1.129***	1.072***	1.012***	1.019***
	(0.161)	(0.073)	(0.10)	(0.103)	(0.122)	(0.123)
ln(labour costs)-1	-0.329***	-0.528***	-0.375***	-0.378***	-0.066	-0.116
	(0.100)	(0.049)	(0.078)	(0.076)	(0.130)	(0.132)
ln(capital)	-0.073	0.068	-0.004	0.034	-0.084	-0.095
	(0.097)	(0.050)	(0.076)	(0.074)	(0.083)	(0.094)
ln(capital)-1	0.082	-0.056	0.051	0.029	0.055	0.076
	(0.079)	(0.042)	(0.058)	(0.057)	(0.075)	(0.081)
Investment_Diff_lagged	0.003	0.000	-0.000	-0.001	0.004**	0.0039*
	(0.003)	(0.001)	(0.003)	(0.003)	(0.001)	(0.002)
Subsidies/assets_lagged	-0.003	-0.001	0.001	0.0020	-0.181**	-0.161**
	(0.050)	(0.005)	(0.002)	(0.002)	(0.071)	(0.072)
R&D Activtiy	0.102*	0.098***	0.094***	0.087***	0.081**	0.072*
	(0.060)	(0.014)	(0.020)	(0.018)	(0.037)	(0.037)
Privatisation dummy	-0.120	-0.027**	-0.141***	-0.133***	-0.029	-0.025
	(0.094)	(0.012)	(0.026)	(0.025)	(0.019)	(0.020)
Foreign owned	0.133	0.148***	0.130***	0.143***	0.022	0.028
	(0.082)	(0.016)	(0.024)	(0.025)	(0.033)	(0.034)
State-owned	0.0123	0.032	0.017	0.020	-0.075*	-0.077**
	(0.115)	(0.021)	(0.043)	(0.047)	(0.039)	(0.039)
Small firms	-0.040	-0.136***	-0.077	-0.095	0.101	0.110
	(0.110)	(0.025)	(0.080)	(0.079)	(0.074)	(0.074)
Large firms	0.078	0.187***	0.099	0.124*	-0.030	-0.033
	(0.101)	(0.031)	(0.067)	(0.069)	(0.083)	(0.084)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	2.686	1.272***	1.208*	1.401**	-0.555	-0.670

	(67,204)	(0.230)	(0.658)	(0.661)	(0.674)	(0.671)
Observations	110,236	104,771	69,394	65,650	40,842	39,121
AR (1)	-7.40***	-12.68***	-5.87***	-5.98***	-4.60***	-4.67***
AR (2)	0.86	0.50	0.78	1.11	0.50	0.85
Sargan test	88.78	48.95	20.45	17.19	48.95	52.69

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 5.11: **Short and long term elasticities of value added to labour costs and capital for all firms and sample with no zombie firms**

	Elasticities – dynamic specification in levels					
	(1)	(2)	(3)	(4)	(5)	(6)
Short run elasticity w.r.t. labour	1.143***	1.078***	1.129***	1.072***	1.012***	1.019***
	(0.161)	(0.0734)	(0.104)	(0.103)	(0.122)	(0.123)
Long run elasticity w.r.t. labour	0.936***	0.827***	0.867***	0.826***	1.101***	1.103***
	(0.082)	(0.027)	(0.054)	(0.054)	(0.050)	(0.055)
Short run elasticity w.r.t. capital	-0.073	0.068	-0.004	0.034	-0.084	-0.095
	(0.097)	(0.050)	(0.076)	(0.074)	(0.083)	(0.094)
Long run elasticity w.r.t. capital	0.009	0.018	0.053	0.076**	-0.033	-0.023
	(0.045)	(0.023)	(0.035)	(0.035)	(0.047)	(0.052)

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

5.3. MULTILEVEL REGRESSION

As a robustness check, we estimate the model with multilevel regression (see Marinšek, 2017). Multilevel regression is a statistical method that efficiently deals with time-series and cross-sectional dependency problems. Since each firm is observed more than once (firms are clustered within industries), multilevel regression is specifically suitable for our dataset. The method works as a maximum likelihood procedure, estimating standard errors as efficiently as any other econometric method. The multilevel regression confirms our baseline results obtained by dynamic estimations with all coefficients except one (subsidies in assets) being highly statistically significant.

Table 5.12: **Dynamic production function model, estimated with multilevel regression, 1995-2015**

Dep v: Ln(Value added)	Multilevel regression	Econometric model
ln(value added)-1	0.735***	0.134
ln(labour costs)	0.836***	1.143***
ln(labour costs)-1	-0.621***	-0.329***
ln(capital)	0.074***	-0.074
ln(capital)-1	-0.042***	0.082
Investment_Diff_lagged	0.001**	0.004
Subsidies/assets_lagged	0.001	-0.003
R&D Activtiy	0.0349***	0.102*
Privatisation dummy	-0.039***	-0.120
Foreign owned	0.057***	0.133
State-owned	-0.003	0.012
Small firms	-0.016***	-0.041
Large firms	0.027***	0.078
Industry dummies	YES	YES
Year dummies	YES	YES
Regional dummies	YES	YES
Constant	0.322***	2.686

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

6. CONCLUSION

Our analysis suggests that the productivity of Slovenian firms, measured as the residual (unexplained) term of the production function, has been increasing over the period 1994-2015. Based on the Levinsohn-Petrin methodology, our results clearly confirm the hypothesis that size, export orientation, foreign ownership and R&D activity have been important drivers of firms' strong TFP growth during this period. SOEs underperformed in 5 of the 7 sectors where they accounted for an important share of value added. However, they retained higher absolute TFP mostly due to their above average size.

Our regression analysis confirms that foreign owned firms, firms with identifiable R&D activities and de-novo firms (firms that were not privatised during the 1990s) were more productive than their counterparts, with this effect being found to be significant in the pre-crisis period. In addition, firms with higher investment and R&D activity reported higher productivity also in the period 2009-2015. Interestingly, SOEs and firms that received subsidies between 2009 and 2015 reported significantly lower productivity in comparison with other firms of similar size, same industry and region. The robustness of these results was confirmed by the multilevel analysis.

Our results also reveal that Slovenia had a higher share of weak or "zombie" firms than in McGowan et al. (2017). In 2010, zombie firms made up 6.4% of the total sample of firms, employing 9.9% of all employees and 5.3% of capital stock and representing 7% of total added value. In 2013, the share of zombie firms was very close to the 2010 level, but it had fallen substantially by 2015. Results also reveal that the most zombie firms were large firms (more than 250 employees).

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ANNEX I

Table 6.1: **Estimates of static production function models in the period of 1995-2015**

Dep. v.: ln(Value added)			**Levels**	
	(1)	(2)	(3)	(4)
ln(labour costs)	0.820***	0.845***	0.843***	0.847***
	(0.00162)	(0.00184)	(0.00184)	(0.00183)
ln(capital)	0.115***	0.115***	0.114***	0.117***
	(0.000848)	(0.000909)	(0.000910)	(0.000909)
Investment_Diff_lagged		0.000278	0.000339	-0.000373
		(0.000325)	(0.000324)	(0.000324)
Subsidies/assets_lagged			-0.00725	-0.00248
			(0.00940)	(0.00935)
R&D Activtiy			0.0651***	0.0908***
			(0.00552)	(0.00555)
Privatisation dummy				-0.153***
				(0.00461)
Foreign owned	0.170***	0.165***	0.168***	0.150***
	(0.00527)	(0.00530)	(0.00530)	(0.00531)
State-owned	-0.0211***	-0.0413***	-0.0408***	-0.0540***
	(0.00792)	(0.00799)	(0.00799)	(0.00796)
Small firms	-0.000173	0.0294***	0.0325***	0.00649
	(0.00446)	(0.00470)	(0.00470)	(0.00474)
Large firms	0.120***	0.0854***	0.0737***	0.0694***
	(0.00745)	(0.00773)	(0.00779)	(0.00775)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	1.076***	0.567***	0.585***	0.530***
	(0.0200)	(0.0678)	(0.0678)	(0.0674)
Observations	130,485	111,395	111,395	111,395
R-squared	0.896	0.893	0.893	0.894

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 6.2: **Estimates of static production function models in the period of 1995-2015 in differences**

	Differences			
	(1)	(2)	(3)	(4)
ln(labour costs)	0.787***	0.760***	0.760***	0.759***
	(0.00305)	(0.00395)	(0.00395)	(0.00396)
ln(capital)	0.0588***	0.0508***	0.0508***	0.0507***
	(0.00185)	(0.00212)	(0.00212)	(0.00212)
Investment_Diff_lagged		-7.13e-05	-7.08e-05	-6.96e-05
		(0.000141)	(0.000141)	(0.000141)
Subsidies/assets_lagged			-0.000393	-0.000389
			(0.00320)	(0.00320)
R&D Activtiy			0.0147***	0.0163***
			(0.00469)	(0.00475)
Privatisation dummy				-0.00838**
				(0.00397)
Foreign owned	0.0227***	0.0157***	0.0162***	0.0153***
	(0.00452)	(0.00448)	(0.00448)	(0.00449)
State-owned	0.0115*	0.0133*	0.0132*	0.0127*
	(0.00682)	(0.00687)	(0.00687)	(0.00687)
Small firms	-0.00383	-0.00480	-0.00312	-0.00515
	(0.00317)	(0.00323)	(0.00327)	(0.00341)
Large firms	-0.00426	-0.00393	-0.00748	-0.00715
	(0.00614)	(0.00623)	(0.00633)	(0.00633)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	0.00492	0.0846	0.0822	0.0837
	(0.00700)	(0.0552)	(0.0552)	(0.0552)
Observations	117,666	99,831	99,831	99,831
R-squared	0.426	0.323	0.323	0.323

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 6.3: **Estimates of static production function models in the period of 1995-2008**

Dep. v.: ln(Value added)			**1995-2008**	
	(1)	(2)	(3)	(4)
ln(labour costs)	0.783***	0.804***	0.802***	0.809***
	(0.00200)	(0.00236)	(0.00237)	(0.00236)
ln(capital)	0.129***	0.130***	0.129***	0.133***
	(0.00113)	(0.00125)	(0.00125)	(0.00125)
Investment_Diff_lagged		0.00180***	0.00191***	-6.55e-05
		(0.000639)	(0.000639)	(0.000638)
Subsidies/assets_lagged			-0.00200	0.00240
			(0.00969)	(0.00963)
R&D Activtiy			0.0660***	0.0952***
			(0.00705)	(0.00706)
Privatisation dummy				-0.172***
				(0.00556)
Foreign owned	0.182***	0.190***	0.192***	0.168***
	(0.00663)	(0.00677)	(0.00677)	(0.00677)
State-owned	-0.0142	-0.0359***	-0.0366***	-0.0572***
	(0.0102)	(0.0104)	(0.0104)	(0.0104)
Small firms	-0.0148***	0.0128**	0.0157***	-0.00948
	(0.00552)	(0.00596)	(0.00597)	(0.00598)
Large firms	0.152***	0.126***	0.114***	0.102***
	(0.00893)	(0.00943)	(0.00951)	(0.00945)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	1.352***	0.904***	0.920***	0.812***
	(0.0239)	(0.0707)	(0.0707)	(0.0703)
Observations	86,564	70,113	70,113	70,113
R-squared	0.897	0.894	0.894	0.896

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 6.4: **Estimates of static production function models in the period of 2009-2015**

Dep. v.: ln(Value added)			**2009-2015**	
	(1)	(2)	(3)	(4)
ln(labour costs)	0.916***	0.921***	0.920***	0.918***
	(0.00280)	(0.00293)	(0.00294)	(0.00295)
ln(capital)	0.0943***	0.0970***	0.0962***	0.0969***
	(0.00124)	(0.00130)	(0.00131)	(0.00131)
Investment_Diff_lagged		-0.000291	-0.000191	-0.000347
		(0.000365)	(0.000365)	(0.000366)
Subsidies/assets_lagged			-0.161***	-0.148***
			(0.0496)	(0.0496)
R&D Activity			0.0514***	0.0644***
			(0.00872)	(0.00883)
Privatisation dummy				-0.0750***
				(0.00836)
Foreign owned	0.106***	0.100***	0.103***	0.0975***
	(0.00846)	(0.00839)	(0.00840)	(0.00841)
State-owned	-0.0794***	-0.0826***	-0.0801***	-0.0821***
	(0.0121)	(0.0122)	(0.0122)	(0.0122)
Small firms	0.0479***	0.0573***	0.0601***	0.0451***
	(0.00736)	(0.00750)	(0.00751)	(0.00769)
Large firms	0.0305**	0.0128	0.00279	0.00678
	(0.0133)	(0.0134)	(0.0134)	(0.0134)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	0.127***	0.0214	0.0407	0.0653
	(0.0379)	(0.0398)	(0.0399)	(0.0400)
Observations	43,921	41,282	41,282	41,282
R-squared	0.888	0.889	0.889	0.889

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 6.5: **Estimates of static production function models for firms that were privatised in nineties'**

Dep. v.: ln(Value added)	**Levels**	**First differences**	**1995-2008**	**2009-2015**
	(1)	(2)	(3)	(4)
ln(labour costs)	0.872***	0.829***	0.910***	0.815***
	(0.00602)	(0.0149)	(0.00722)	(0.0113)
ln(capital)	0.0940***	0.0611***	0.0962***	0.0799***
	(0.00410)	(0.00830)	(0.00483)	(0.00794)
Investment_Diff_lagged	0.004**	0.000	0.017***	0.001
	(0.00191)	(0.00081)	(0.00304)	(0.00260)
Subsidies/assets_lagged	0.00182	0.000305	0.00216	-0.478***
	(0.00838)	(0.00451)	(0.00800)	(0.175)
R&D Activity	0.0764***	0.00851	0.0592***	0.120***
	(0.00953)	(0.00764)	(0.0107)	(0.0201)
Small firms	0.0116	-0.00544	0.0549***	-0.0644***
	(0.0111)	(0.00726)	(0.0127)	(0.0231)
Large firms	0.0224*	-0.00909	-0.0312**	0.147***
	(0.0134)	(0.00940)	(0.0149)	(0.0291)
Foreign owners	0.106***	0.00271	0.137***	0.0356
	(0.0178)	(0.0143)	(0.0202)	(0.0366)
MBO	0.100***	0.00977	0.128***	-0.0154
	(0.0217)	(0.0173)	(0.0240)	(0.0470)
Diversified owners	0.365***	0.0253	0.321***	0.446***
	(0.0426)	(0.0334)	(0.0498)	(0.0817)
Block holders	0.151***	0.0195*	0.158***	0.121***
	(0.0147)	(0.0117)	(0.0168)	(0.0301)
Employee owned	0.0222	-0.00281	0.0360	-0.0344
	(0.0208)	(0.0167)	(0.0235)	(0.0428)
State-owned	-0.0234	0.00530	-0.0217	-0.0543
	(0.0284)	(0.0230)	(0.0328)	(0.0562)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Constant	0.154	-0.0341	-0.236	0.875***
	(0.291)	(0.215)	(0.281)	(0.143)
Observations	12,502	10,658	9,342	3,160
R-squared	0.919	0.271	0.921	0.917

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

Table 6.6: **Estimates with and without zombie firms in the sample, static model**

Dep. v.: ln(Value added)	Levels		Differences		1995-2008		2009-2015	
	All firms	No zombie	All firms	No zombie	All firms	No zombie	All firms	No zombie
ln(labour costs)	0.847***	0.828***	0.759***	0.726***	0.809***	0.785***	0.918***	0.888***
	(0.00183)	(0.00200)	(0.00396)	(0.00456)	(0.00236)	(0.00257)	(0.00295)	(0.00320)
ln(capital)	0.117***	0.113***	0.0507***	0.0513***	0.133***	0.141***	0.0969***	0.0842***
	(0.000909)	(0.00112)	(0.00212)	(0.00226)	(0.00125)	(0.00154)	(0.00131)	(0.00164)
Investment_Diff_lagged	-0.000373	0.0207***	-6.96e-05	-0.000955*	-6.55e-05	0.0129***	-0.000347	0.0326***
	(0.000324)	(0.000771)	(0.000141)	(0.000553)	(0.000638)	(0.000916)	(0.000366)	(0.00139)
Subsidies/assets_lagged	-0.00248	-0.127***	-0.000389	-6.41e-05	0.00240	-0.549*	-0.148***	-0.165***
	(0.00935)	(0.0371)	(0.00320)	(0.00600)	(0.00963)	(0.298)	(0.0496)	(0.0375)
R&D Activtiy	0.0908***	0.0736***	0.0163***	0.0107**	0.0952***	0.0645***	0.0644***	0.0758***
	(0.00555)	(0.00569)	(0.00475)	(0.00460)	(0.00706)	(0.00743)	(0.00883)	(0.00868)
Privatisation dummy	-0.153***	-0.104***	-0.00838**	-0.00691	-0.172***	-0.114***	-0.0750***	-0.0714***
	(0.00461)	(0.00527)	(0.00397)	(0.00432)	(0.00556)	(0.00673)	(0.00836)	(0.00849)
Foreign owned	0.150***	0.158***	0.0153***	0.00784*	0.168***	0.182***	0.0975***	0.119***
	(0.00531)	(0.00524)	(0.00449)	(0.00416)	(0.00677)	(0.00673)	(0.00841)	(0.00815)
State-owned	-0.0540***	-0.0480***	0.0127*	0.00491	-0.0572***	-0.0481***	-0.0821***	-0.0695***
	(0.00796)	(0.00840)	(0.00687)	(0.00682)	(0.0104)	(0.0115)	(0.0122)	(0.0122)
Small firms	0.00649	-0.00998**	-0.00515	0.000183	-0.00948	-0.0352***	0.0451***	0.0396***
	(0.00474)	(0.00508)	(0.00341)	(0.00347)	(0.00598)	(0.00658)	(0.00769)	(0.00785)
Large firms	0.0694***	0.0859***	-0.00715	-0.0104	0.102***	0.102***	0.00678	0.0576***
	(0.00775)	(0.00864)	(0.00633)	(0.00661)	(0.00945)	(0.0110)	(0.0134)	(0.0137)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.530***	1.020***	0.0837	0.218***	0.812***	1.301***	0.0653	0.321***
	(0.0674)	(0.116)	(0.0552)	(0.0780)	(0.0703)	(0.115)	(0.0400)	(0.0427)
Observations	111,395	70,803	99,831	60,688	70,113	40,510	41,282	30,293
R-squared	0.894	0.921	0.323	0.376	0.896	0.926	0.889	0.911

Source: AJPES.

Note: 1. Standard errors are in parentheses

2. ***, ** and * denote statistically significant values at 1%, 5%, and 10% on a two-tailed test, respectively

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