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The productivity of public and private sector in Poland

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In the article a concept of comparing public and private sector effectiveness is presented. It is based on an analysis of the productivity of capital and labour in both sectors. For this purpose, the authors build growth model in the general and intensive form, taking into account public and private sectors and their relationships in terms of gross value of fixed assets, and employment. Empirical analysis is carried out using a panel model for Polish provinces in the years 2002-2009. The analysis show that the size of the public sector in terms of labour and capital is negatively correlated with Gross Domestic Product and gross value added per employee. Research has shown that the productivity in the two sectors is different. The private sector has a higher productivity of both labour and capital in comparison to the public sector. The authors are of the opinion that the analysis in terms of labour and capital in both sectors substantially complements the more common approach aimed at measuring the effectiveness of public sector from the point of view of expenditures. Proposed analysis has the advantage that it expresses two sectors, which use different accounting categories, in the same economic terms - productivity.

JEL Classifications: E62, H10

Keywords: Public sector, productivity, growth model, NTS-2 region

Introduction

The issue of the impact public sector on the economy, its direction and ways to measure waited for the many views and approaches. Classic model of Baumol (1967) may imply that along with economic growth relative productivity of public to private sector may be very low. Spann (1977) tested the model and found evidence supporting it. In the literature, both views are present indicating a positive relationship between the size of the public sector and its impact on the economy or raising the lack of such a relationship (so-called neutral position) and statements quite different, clearly demonstrating the negative impact of the public sector on the national economy. Indicated ambiguity opens the same field for analysis taking the goal of establishing a clear answer to the question about the relationship between the public and the economy of a country undergoing analysis. Given the above, this paper proposes a bit different to most often used approach to measure the impact of the public sector on the economy. The subject of analysis performed in this article is to verify the relationship between the size of the public and private sector in Poland measured by a number of employees and gross value of fixed assets and the product of the country. Analysis of the size of the public and private sector in terms of labour and physical capital are found in the literature, see e.g. Peden and Bradley (1989) or Hansson and Henrekson (1994). The authors of more recent works, however, primarily focus on state spending, analysing the size of the private sector in this regard. The aim of this study is to investigate the productivity of labour and capital in both sectors of property as an example for the Polish data. To investigate these will be used depending on

the model based on panel data for the regional breakdown (NTS-2 level), taking into account the time scale of the years 2002-2009.

The undertaken issue is extremely important, not only from the point of view of the rapidly changing macroeconomic environment, but also because of the identification of the role of the public sector in the economy. A key question appears to be that of the direction of the sector and the impact on the economy. Thus, the relationship is considered extremely important in its universalism. This is due to the fact that the issue of the role that the public sector should play in the economy still remains unresolved. The issue taken in this article goes beyond the effects of purely national meaning, contributing to the general literature on the topic.

Literature review

In the beginning of the review of the literature devoted to the issue of the public sector and its linkages with the economy, analyses indicating neutral effects of the public sector should be cited. This view is supported by empirical data expressed in works such as Katz et al. (1983), who examined a relationship of taxation and economic growth; Korpi (1985), who analysed an impact of the social security system on the growth of the national economy; Ram (1986), who estimated a relationship between the government size and economic growth; and Conte and Darrat (1988) and Olukayode (2009), who assessed the effects of public expenditures on economic growth. Neutral nature of the relationship between the public and the economy is also clear from other research. Koester and Kormendi (1989) estimated the impact of taxation on economic activity and growth of the national economy. Levine and Renelt (1992) indicated a lack of relationship between fiscal expansion and economic growth. Levine and Zervos (1993) proved the lack of a statistically significant association between fiscal indicators and long-term growth of the national economy. In Easterly and Rebelo's (1993) opinion the effects of tax policy on economic growth cannot be interpreted as one-dimensional. They claimed that in determining and scale of the impact of fiscal policy on the economy it is important to not only assess the level of fiscal burden, but also its structure.

An opposed opinion is presented by many other authors who claim that the public sector has a positive impact on the economy. Lin (1994) proved that the public sector determines the positive economic effects through carefully targeted interventions (such as subsidies). Heitger (2001) suggests that public expenditure has a positive influence on economic growth, but warns that excessive public expenditure may trigger very different from the desired results, implying negative economic consequences. Dilrukshini (2002) argues in turn that public expenditures and economic growth are correlated, but not easy to analyse, while Bose et al. (2003) show that only those public expenditures which are spent on investments are able to stimulate positively the economic growth of a country. Finally, the idea of a strong positive impact of government expenditure on economic growth is also claimed by Jiranyakul and Brahmasrene (2007).

The presented findings do not provoke doubt if not for the fact that in addition to highlighting research neutral and sometimes outright positive impact on the economy of the public sector, research carried out in parallel lead to quite different conclusions. Smith (1975), says that the growth rate of real per capita GDP, assuming the exclusion of transfers, is negatively associated with the level of public expenditure. Inclusion of public transfers will indeed reduce the strength of this relationship, however, does not change the character of this dependence. Landau (1983) states that economic growth is strongly negatively correlated with the level of government expenditure on consumption. A similar statement provides Marlow (1986), arguing that the economy with large and growing public sector has an opposite effect on real economic growth. Benson and Johnson (1986), argue that high taxation (and thus the scale of fiscal interventions), reduces the process of capital formation adversely affecting economic activity in the economy. This view is shared research of Barth and Bradley (1988), claiming that by excessive spending, the government has a negative impact on long-run economic growth rate. Moreover, in

their opinion, the level of public expenditure, broken down by both consumer spending and in terms of overall has a strong impact on reducing the level of total factor productivity in the non-governmental sector. Finally, they argue that the growth in "government size" (defined in terms of administrative structures), is negatively associated with economic growth.

Grier and Tullock (1989) also provide empirical evidence documenting a negative correlation between increase in the share of government expenditure in GDP and economic growth. Similar conclusions in their research also comes Barro (1989 and 1991), stating that the ratio of consumption expenditures of the consolidated public sector to real GDP is negatively correlated with per capita growth and the investment ratio. Peden and Bradley (1989), conducting research on the public sector in the United States found that the activity level of government in economy has a negative impact on its growth. The study also showed that increases in the shares of domestic product leads to a gradual erosion of the productivity. Grier and Tullock (1989) found that countries with highly extensive interventionism have a negative impact on GDP growth and Alexander (1990) demonstrated that the rate of increase in government spending referenced to GDP is negatively associated with the growth rate of real GDP per capita. Engen and Skinner (1992), based their research on the countries of Latin America have established the existence of a negative depending not only between the share of taxation (the scale of fiscal policy), and the growth rate of the economy, but also between public expenditure and changes in production.

Hansson and Henrekson (1994) present a slightly different approach to the issues of the impact of public sector size on the economy. The study clearly showed that the level of public expenditure for the purpose of transfer and consumption had a negative impact on the growth rate of total factor productivity. For even more precise conclusions in his work comes Scully (1994, 1998, 2000, 2002 and 2003), arguing that economic growth is greatest when public expenditure is roughly equal to 1/5 of the total income. At the same time he states that the excessive increase in public spending is unambiguously negative impact on economic growth.

Besci (1996), verifying the individual economies of scale fiscal policy, came to the conclusion that marginal tax rates have a statistically significant negative relationship with economic growth. Rahn and Fox (1996) and Guseh (1997) came to similar conclusions. The latter concluded that increase in the size of government and its involvement in the economy have a negative impact on its growth, and at the same time these negative effects are three times stronger in non-democratic systems than in democratic ones. Gwartney et al. (1998) conducted in the years 1960-1996 a survey on a sample of 23 OECD countries. They found that the extension of government activity beyond its basic function has a negative impact on economic growth for three reasons. The first one is a deterrent effect of high taxation and the effect of crowding out of private investment by public investment. The second reason relates to the fact that government may engage in inappropriate activities. Finally, the third reason is concerned with the negative consequences of intervention in the wealth generating process.

Yavas (1998) in his research shows that the growth in the public sector involvement in the economy contributes to better outcomes, but only at a low level GDP per capita. If per capita GDP is high, growth of the public sector undermines economic performance of the country. Bajo-Rubio (2000), referred to above, argued that the government size sector has a negative impact on economic growth, mainly due to bureaucratic inefficiency, excessive fiscal burdens and distortions in the incentives system and market intervention. Even more restrictive conclusions were reached by Fölster and Henrekson (2001) who examined the impact of fiscal spending and diversification on growth in rich countries in 1970 and 1995. They found a strong negative relationship between public expenditure and economic growth. Gupta (2001), looking for the ideal size of the sector, pointed out that the size of government is optimal when the marginal social cost of public funds equals to the marginal social benefits. Afonso et al. (2005) confirmed the above-mentioned findings

that in a situation in which the general government expenditure will exceed the ratio of 30% of the national income, economic growth is reduced. In addition, expenses in excess of the ratio indicated above, in practice, do not imply any improvement in social welfare. According to research carried out for the densely populated countries the necessary size of the public sector, measured by the share of public expenditure in GDP, is 20.9%. Dar and Amirkhalkhali (2002) showed that the smaller is the capital and factor productivity, the more powerful is the bureaucracy. Countries with lower load clerical body (and thus less extensive public sector) are characterized by a higher labour productivity, market discipline and efficient use of resources. Alesina (2003) notes that the increase in public expenditure in over-extended public sectors leads to an increase in labour costs in the private sector. What is more, studies have shown that the increase in taxation reduces profits and investment; however, the increase in public spending reduces them to a much greater extent. Therefore promoting economic growth should primarily include spending cuts, and only in the next order of changes in the level of tax burden. Alesina and Ardagna (2009) support this conclusion, analysing the relationship between the public sector deficit and economic growth. The authors verify the findings previously made on a sample of OECD countries evaluated at the turn of 1970-2007, taking as a starting point for comparisons tax incentives and fiscal adjustments (including policy expenditure). The results show that fiscal stimuli appear to be more effective than support the public expenditure. In addition, fiscal adjustments consisting of reducing spending instead of tax increases are more suitable for the reduction of deficit and public debt, rather than ensuring higher budget income. Finally, the adjustments on the expenditure side rather than taxes are less responsible for contributing to the reduction of economic growth.

Pevcin (2003, 2004 and 2008) found that the optimal size of the public sector, measured by the share of public expenditure in GDP, should be in the range of 36% to 42%. In 2008, he completed his analysis pointing to the exact limit public expenditure to optimize size of the public? sector amounting to 37.09% of GDP. Exceeding this limit implies a decreasing marginal productivity of public expenditure. Kustepelli (2005) came to similar effects. In his opinion, a smaller size of the government (and thus the sector) has a positive effect on the growth rate of the economy. Magazzino (2008) and Magazzino and Forte (2010) confirmed the position expressed by Kustepelli and verified the results obtained by Pevcin. According to estimates by Magazzino conducted for the period 1950-1998, to optimize the economic growth (from the point of view of public expenditures) the size of government should be 32.83%. Chobanov and Mladenova (2009) argued that 25% of GDP is the optimal size of government expenditure, which they based on the analysis of a sample of 28 OECD countries in the period 1970-2007.

De Witte and Moesen (2010) presented a slightly different approach to the analysis of the public sector to determine the effect of tax burden on GDP. According to the results of the optimal share of government amounts to 41.22% of GDP. In other analysis De Witte and Moesen (2010) determine the optimal average tax burden as 42.17% of GDP. Recent studies by Afonso and Jalles (2011) confirm the negative relationship between the size of the public sector such as its participation in the economy and the pace of its growth. Josheski et al. (2011) claim that the size of the public sector defined as the ratio of public expenditure GDP is negatively correlated with GDP per capita, and 1% grow in the share of government consumption in relation to GDP will result in a fall in the growth rate of GDP per capita by an average of 0.11%.

Methods of analysis

We start with the analysis of the relationship between gross value added and the ratios of private to public sector. Gross value added in the breakdown by sector of ownership (private and public) is unknown and so is their share in value added in the economy. Moreover, both sectors affect each other, and the effects of this influence are not directly measurable. In addition, public and private sectors operate in different types of accounting

categories. In the public sector there is no concept of sales revenue, making it impossible to directly compare the effects of the functioning of both sectors (see Diewert, 2011).

In estimating the relationship between capital and labour in the public and private sectors and economic growth we will estimate the most often used functional form of a growth model - the Cobb-Douglas function, which, after taking the logarithm has the following general form for panel data:

$$y_{i,t} = \alpha_c + \theta a_{i,t} + \beta k_{i,t} + \gamma l_{i,t} + \delta' z_{i,t} + \varepsilon_{i,t}. \qquad (1)$$

Where $y_{i,t}$ is the natural logarithm of the Gross Domestic Product; $k_{i,t}$ is the natural logarithm of gross value of fixed assets; $l_{i,t}$ is the natural logarithm of employment; $a_{i,t}$ is the natural logarithm of expenditures on research and development (R&D); α_c, for $c = 0, i, t$, indicate possible constants1, to which in the general case may belong: α_0 - constant indicating the part of technological progress, which is not generated by research and development expenditures, α_i, for $i = 1, \ldots, 15$ and α_t, for $t = 1, \ldots, 7$-components representing specific cross-sectional (province i) and time t factors, characterizing the impact of the structural conditions of individual regions and economic situation in the respective years on the value added. $z_{i,t}$ is a vector of logarithms of variables, representing the size of the private and public sectors in terms of labour and capital, β, γ and θ are structural parameters which are subject to estimation, of which the first two are respectively capital elasticity of product and labour elasticity of product, while the latter measures the impact of research and development expenditures on value added, which were singled out of the total factor productivity $\alpha_0$2. δ is a vector of parameters that are of particular interest in this article, because they are constructed to get an answer to the question about the effectiveness of private and public sector. $\varepsilon_{i,t}$ is a homoscedastic and uncorrelated, normally distributed error term, which may, in the particular case, include individual random effects. In such a case $\alpha_i = 0$. The model will be estimated with the use of panel data. An attempt to estimate a model of GDP per capita will also be made, and its estimates will be compared to those obtained on the basis of other models.

Estimates of the parameters included in the vector δ in model (1) can be interpreted in terms of the impact of changes in the public and private sectors size on their relationship with the gross value added in each province, and also in the country as a whole. The specificity of the individual regions included in the component or α_i or $\varepsilon_{i,t}$ depending on whether model includes fixed effects or random effects. They may be analyzed but it is not the aim of this article, because they represent the structural properties of provinces in the creation of economic growth, rather than specific sectors of the property. Main factors affecting economic growth, i.e. labour, capital, expenditures in research and development and other technological factors will play a role of control variables in the model.

In the next step the hypothesis on the heterogeneity of capital and labour in the two sectors of property will be verified. In the case of capital the model (1) will take the form:

$$y_{i,t} = \alpha_c + \theta a_{i,t} + (\kappa kr_{i,t} + \lambda ku_{i,t}) + \gamma l_{i,t} + \xi_{i,t}. \qquad (2)$$

[1] The constants are exclusive.

[2] In the empirical part the estimates of constants will be given in the power form of the model, i.e. after reversing the logarithmic transformation.

Where $\mathrm{kr}_{i,t}$ is the logarithm of gross fixed capital in the private sector; $\mathrm{ku}_{i,t}$ in the public sector while $\varkappa$ and λ are parameters, depicting capital elasticity of product in private and public sector respectively and will be the subject of estimation. If these parameters are statistically significant at standard levels of significance and different from each other, it would mean that the capital elasticity of product in the two sectors is different. In such a case, marginal product of capital (marginal productivity of capital) in both sectors for each analysed year can be derived as $\partial \mathrm{y}_t / \partial \mathrm{kr}_t$ for the private sector and $\partial \mathrm{y}_t / \partial \mathrm{ku}_t$ for the public sector. It will enable to analyse the effects of unitary, not only percentage, changes of capital on the product. In this model homogeneity of the labour is assumed. For verification of hypothesis of heterogeneity of labour model (3) will be estimated:

$$y_{i,t} = \alpha_c + \theta a_{i,t} + \beta k_{i,t} + (\rho lr_{i,t} + \upsilon lu_{i,t}) + \eta_{i,t}. \qquad (3)$$

Where the notations are analogous to those in the model (2). In this case, it will be tested whether labour elasticity of product in both sectors is different. If so, marginal product of labour (marginal productivity of capital) in both sectors for each of the analysed years can be derived as $\partial \mathrm{y}_t / \partial \mathrm{lr}_t$ for the private sector and $\partial \mathrm{y}_t / \partial \mathrm{lu}_t$ for the public sector. It is assumed that employees from both sectors use homogenous capital stock (fixed assets). There is a temptation to link models (2) and (3), but in this case, we would get a model with a relatively large number of regressors, potentially correlated with each other, which can make it difficult to measure their impact on the dependent variable.

If we assume constant returns to scale, we can present the growth model in the intensive form, i.e. divide all the variables by the employment. Model (1) reduces then to the model of labour productivity:

$$lp_{i,t} = \phi_c + \varphi ap_{i,t} + \tau tew_{i,t} + \omega' z_{i,t} + \upsilon_{i,t}. \qquad (4)$$

Where $\mathrm{lp}_{i,t} = \mathrm{y}_{i,t} - \mathrm{l}_{i,t}$ is the logarithm of labour productivity; $\mathrm{ap}_{i,t} = \mathrm{a}_{i,t} - \mathrm{l}_{i,t}$ is the logarithm of R&D expenditures per employee; $\mathrm{tew}_{i,t} = \mathrm{k}_{i,t} - \mathrm{l}_{i,t}$ is the logarithm of technical equipment of labour (ratio of capital to labour); ϕ is an equivalent of α in equations (1)-(3), while φ, τ and ω are other parameters which are subject to estimation. In this model also, the technical equipment of labour can be broken down into the one in private sector and in public sector.

Models will be estimated with use of Gretl program. For some models, additional variables and their lags will be used to obtain a model that meets the conditions of the error term. However, in the case of some models in the basic form sometimes it is not possible to add the abovementioned variables and achieve estimates of the productivity of capital and labour, for example, due to the addition of autoregressive variables, which would interfere with estimates of parameters defining productivities. Therefore, we decided to present models in a basic form and dynamic models. In addition, the panel data are highly susceptible to the occurrence of autocorrelation and heteroscedasticity of the error term, due to the fact that the properties of the error term vary between sections (provinces). Therefore, in particular in the case of the models estimated using OLS, to estimate the standard error of estimation we will use the method of Arellano (2003). It provides robust estimates of the covariance matrix in the presence of autocorrelation and heteroscedasticity (HAC) of the error term.

At first in every model fixed effects will be assumed. The method for estimation of such a model was OLS. For each model we will test, however, the use of the estimator of the

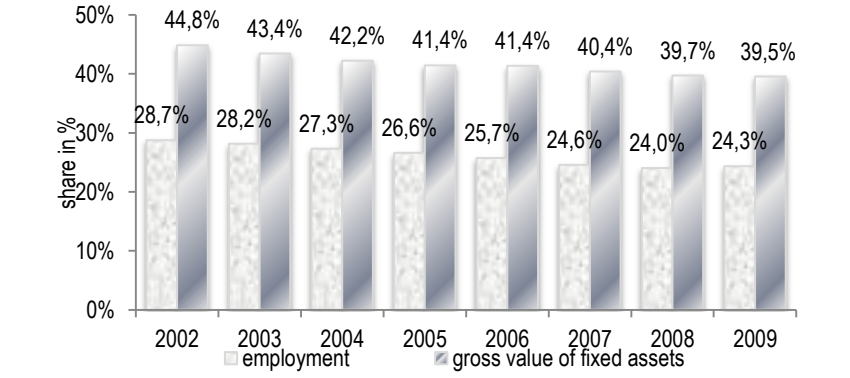
generalized least squares (GLS) method to estimate the random effects. In every case Hausman (1978) test will be used to check the validity of either method. The estimation of the random effects model will be done using the Nerlove (1999) transformation, sometimes for comparison purposes also the one proposed by Swamy and Arora (1972). In the case of model estimation with use of OLS estimator a standard F test of the significance of regressors will be used, while in case of application of GLS estimator Breusch-Pagan (BP) test based on the on the χ^2distribution will be used instead. To test for normality of distribution of error term Doornik Hansen, DH (1994) test will be used. Autocorrelation of residuals of the model will be tested with the use of t-Student test for the significance of regressors in an AR model of residuals. In some cases it is also justified to use the weighted least squares (WLS) estimator to eliminate the heteroscedasticity of residuals. To estimate dynamic models a generalized method of moments (GMM) estimator will be used.

Due to the fact that, in some models, right-hand-side variables may not be independent, and thus, endogeneity problem may occur, every model will also be estimated with the use of instrumental variables estimator (IV) or two stage least squares and compared with the basic model. In such cases, selected variables describing the public and private sectors will be used as the instruments (the set is given in every model description). The total significance of the parameters of such a model will be tested with the use of Wald test based on the χ^2distribution. A multitude of estimation methods used by us is aimed at confirmation of results of the basic models and obtaining robust results.

Data and period of analysis

The analysis covers the period of 2002-2009, which was dictated by the availability of data1. Time series included yearly observations. It covered 16 provinces, resulting in a total of 128 observations. Data come from the Local Data Bank of Central Statistical Office of Poland. The labour was measured as employment in each sector. The capital was measured as gross value of fixed capital in the ownership of each of property sectors. Gross value added, gross domestic product and expenditures on research and development were not available in sectoral breakdown according to the sector of property.

FIGURE 1. THE SHARE OF PUBLIC SECTOR IN TERMS OF THE EMPLOYMENT AND GROSS VALUE OF FIXED ASSETS IN POLAND



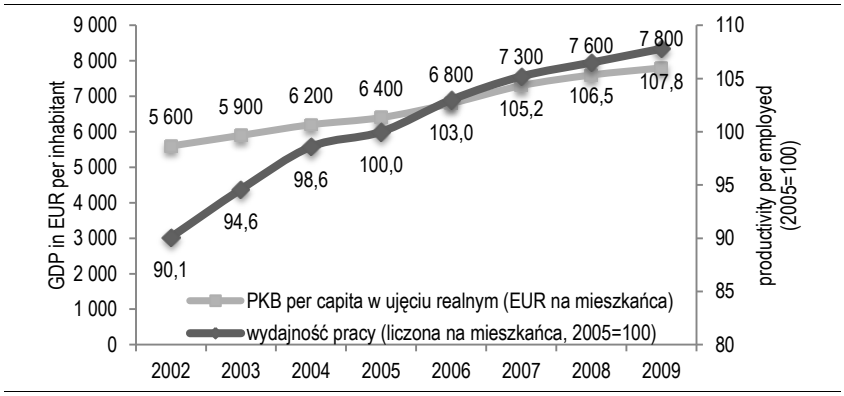
Source: Local data bank in Central Statistical Office of Poland.

After 1989, the Polish economy started the process of transforming its economic structure from a centrally planned economy to a free-market economy. Among other processes the transformation took the form of privatization of public-owned companies and the gradual

[1] Regional Accounts for Poland are available with 2-3-year delay.

reduction of the size of the public sector, especially in terms of the corporate sector. However, changes also occurred in the state administration. In 1999, administrative division of the country was changes, forming 16 out of 49 previously functioning provinces. It affected the size of the government. Since then, processes directed into creation of high economic growth have been continued, and, since 2004, also adjustments of the structure of the economy to the economy of the European Union. It also affected the size of the property sectors, as well as their relationship.

FIGURE 2. REAL GROSS DOMESTIC PRODUCT PER CAPITA AND REAL LABOUR PRODUCTIVITY FOR POLAND



Source: Eurostat.

In 2002, the size of the private sector 2.5 times exceeded the size of the public sector in terms of number of employees and was about 23% higher in the value of fixed capital (Figure 1). In the following years gradual decline in the share of public sector in the economy proceeded. In 2009 39.5% all of the country gross value of capital and 24.3% of employment was provided by public sector. In the last years of this period, a decline in the growth of the public sector in terms of value of fixed assets weakened, while in the case of the number of employees even ceased. In 2009 there was a slight increase in employment in the public sector in relation to the private, partially due to a decline in employment in the private sector caused by the economic crisis.

In the years 2002-2009 Polish real gross domestic product grew by 39.2% and real labour productivity grew by 19.6% (Figure 2). In this respect, Poland is one of the poorest countries in the European Union, but it is a country with a relatively high growth rate of labour productivity. However, its growth slowed due to economic crisis in years 2007-2009.

Results and discussion

We start with estimation of growth model (Table 1). The model takes into account labour, capital and technological progress. However, it was supplemented with variables representing the ratio of employment and gross value of fixed capital in the private to the public sector. In the initial model (1a) we assumed fixed effects. This model identified the growing scale effects, not all of the parameters, however, were statistically significant (most interesting parameters were shaded). Positively on the standard level of significance was verified the hypothesis of random effects. The estimation of the model (1b) with random effects gave lower coefficients of both capital and labour elasticity of product. In terms of the ratio of both sectors (private sector in numerator) the coefficient indicating the relationship between economic growth and ratio of employment in both sector increased in comparison to the previous model and in the case to ratio of capital - decreased. Both coefficients were statistically significant at p=0.05 showing that increase

in both ratios is positively related with economic growth, though the relation is stronger between economic growth and employment than capital. Due to the possible endogeneity IV estimations were also given1. The results of the model (1c) show similar that in the previous model elasticity of relation between the gross value added and ratios of employment in both sectors. However, it also shown relative insignificance of the impact of capital ratio in both sectors on economic growth. Dynamic model (1d) confirmed this result. Fixed capital of the public sector includes the value of roads, highways and other means of public benefit, which strongly affect both sectors, hence their high importance for the economy. Positive and close to previous models relation between the ratio of the size of the private to the public sector in terms of employment and economic growth was confirmed. It leads to a conclusion that an increase by 1% of the relationship between employment in the private and public sector is related with an increase in the gross value added by about 0.22%.

TABLE 1. GROWTH MODEL WITH THE RELATIONS OF PRIVATE AND PUBLIC SECTORS

Variable	OLS (1a)	GLS (1b)	IV (1c)	GMM (1d)	OLS (2a)	IV (2b)	OLS (2c)
constant	*0.009	**0.04	*0.006	*0.13	**0.002	**0.002	*0.01
l	*0.36	**0.26	0.26	**0.20	**0.52	0.40	**0.44
k	***0.88	***0.86	***1.05	***0.46	***0.76	***0.95	**0.30
lr-lu	0.18	***0.23	*0.24	***0.22	**0.32	*0.31	***0.30
kr-ku	**0.15	**0.11	-	0.08	-	0.10	-
a	***0.06	***0.04	-	***0.03	***0.05	-	***0.03
a(-1)	-	**0.04	-	-	**0.04	-	-
y(-1)	-	-	-	***0.42	-	-	***0.47
F	***3890.3	-		-	***499.2		***618.2
Wald	-	-	***36.9	-	-	***2255.4	-
Breusch-Pagan	-	***183.0	-	*3.5	-	-	-
Hausman	-	6.5	-	5.3	-	-	-
Standard error	0.026	0.158	0.033	0.092	0.026	0.034	0.024
Adjusted R2	0.998	-	0.962	-	0.990	0.961	0.992
N distribution, DH [p]	-	-	-	3.60 [0.17]	-	-	2.93 [0.23]
AR(1), t [p]	-	-	-	1.46 [0.15]	-	-	1.24 [0.21]

Source: Own calculations.

Note: *** statistically significant at p=0.01, ** statistically significant at p=0.05, * statistically significant at p=0.10 OLS - least squares, fixed effects model; GLS - generalized least squares, random effects model; IV - instrumental variables; GMM - generalized method of moments, dynamic model.

In another model we analyze the relation between the relative size of sectors and GDP per capita. The hypothesis that increase in the ratio of private to public sector employment in the Polish regions is positively related with GDP per capita, as a measure of economic development is tested2. Model (2a) showed a statistically significant relation between these measures. The results we confirmed by the model (2b) estimated using IV method, giving a very similar estimate of the parameter of elasticity of GDP per capita in relation to the ratio of employment in the private and public sector3. On the basis of the Hausman test the hypothesis of random effects model was rejected ($\chi^2(6) = 11.9$ [p = 0.06] for the model with Nerlove transformation and $\chi^2(6) = 89.1$ [p <0.01] in the case of Swamy-

[1]Following variables were taken as instruments: capital and employment in both sectors, ratios of capital and labour in both sectors, as well as ratios of capital to labour in both sectors and first lags of all of the above variables.

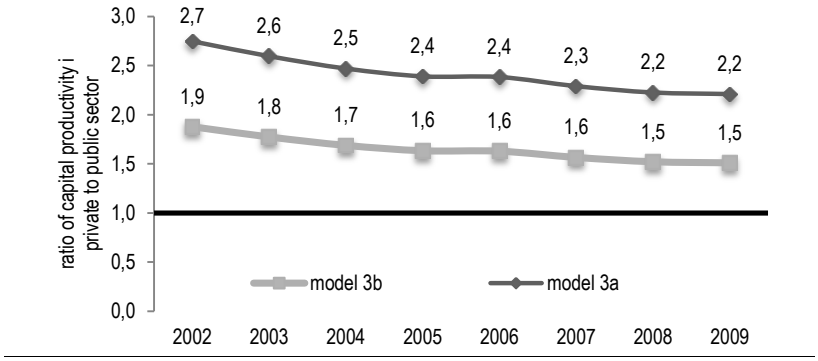
[2] GDP per capita is an imperfect measure of economic development. However, it is a relatively common measure, particularly at the level of provinces (NTS-2). Alternative measures of economic development in the Polish regions were not available for the analyzed years.

[3] The same instruments were used as the ones in the model (1c).

Arora transformation). After adding a lagged GDP per capita, illustrating the dependence of the development on its state in previous years, we get model (2c). It explains 99.2% of the GDP per capita variance. All three models gave similar estimates of parameter standing by the variable representing the relationship between ratio of employment in the private and public sectors and economic development - about 0.31. It shows that the increase in the ratio of employment in the private and private sectors by 1% in Poland would be accompanied by an increase in GDP per capita by ca. 0.31%. This result confirms findings of the models (1).

Previous tests have not given an answer on the productivity of capital in the two sectors. We received only a mean capital elasticity of product in both sectors jointly. To verify the differences in productivity of public and private sectors, they can be treated separately in terms of capital. Hausman test indicated that fixed effects model should be used($\chi^2(5) = 10.6$ [p = 0.06] for the model with Nerlove transformation and $\chi^2(5) = 35.4$ [p <0.01] in the case of Swamy-Arora transformation), thus OLS estimator was used to estimate model (3a) (Table 2). It takes into account the heterogeneity of the fixed assets of both sectors, and the use of homogeneous workers. Estimates indicate that the capital elasticity of product is considerably higher in the private sector than in the public sector. However, taking into account the possible endogeneity of the explanatory variables the model was estimated using IV estimator1.

FIGURE 3. THE RATIO OF CAPITAL PRODUCTIVITY IN PRIVATE TO PUBLIC SECTOR ACCORDING TO TWO MODELS



Source: Own calculations.

Model (3b) shows slightly smaller difference in capital elasticity of product in both sectors. According to the results of the gross value added in the country would increase by 0.67% according to a 1% increase in capital in the private sector, while in the case of public sector, this increase would be 0.29%. Dynamic model (3c) confirms the much higher capital elasticity of product in the private sector than in the public, even indicating that public sector capital statistically not significantly affects the value added in the economy. This model also indicated a similar overall labour elasticity of product that models (1).

To analyse the effect of gross fixed capital formation on gross value added we can compute marginal productivities of capital in both sectors. In Figure 3 the ratios of the productivity of capital in private to public sector were presented for models (3a)-(3b) (detailed results were presented in Table 4 in the appendix).

[1] As instruments we used ratios of capital and labour in private and public sectors, as well as ratios of capital to labour in both sectors and first lags of all of the above variables.

Estimates give clear answer that productivity of capital is higher in private than public sector. Although the difference continues to lower, it still is very high. According to the model (3b) estimated with use of IV method in year 2002 the change in gross fixed capital by 1 bln PLN in private sector would have increased gross value added in Polish economy by 541mln PLN, but analogous change in public sector would increase it by 288 mln PLN. In year 2009 these marginal productivities equaled 557 for private sector and 368 for public sector. The ratio of these productivities dropped from 1.9 in 2002 to 1.5 in 2009. Model (3a) gave even higher results.

TABLE 2. GROSS VALUE ADDED MODELS WITH PRIVATE AND PUBLIC SECTORS

Variable	OLS (3a)	IV (3b)	GMM (3c)	OLS (4a)	GLS (4b)	IV (4c)	GMM (4d)
constant	***0.0009	***0.0003	***0.06	0.006	0.15	***0.13	***0.06
kr	***0.71	***0.67	***0.31	***0.88	***0.89	***1.10	***0.44
ku	***0.21	***0.29	0.08				
lr	***0.54	***0.62	*0.27	***0.48	***0.42	***0.27	**0.20
lu				-0.08	***-0.28	***-0.28	0.13
a	***0.06	0.04	-	***0.04	***0.04	-	-
a(-1)	-	-	-	*0.04	**0.04	-	-
y(-1)	-	-	-0.17	-	-	-	*0.83
F	***3842.6	-	-	***3382.9	-	-	-
Wald	-	***3056.1	***49.0	-	-	***3289.4	***36.1
Breusch-Pagan	-	-	-	-	***188.1	-	-
Hausman	-	-	-	-	4.8	-	-
Standard error	0.027	0.029	0.022	0.026	0.114	0.992	0.023
Adjusted R2	0.998	0.971	-	0.998	-	0.961	-
N distribution, DH [p]	-	-	0.40 [0.82]	-	-	-	0.94 [0.63]
AR(1), t [p]	-	-	-0.67 [0.50]	-	-	-	-0.71 [0.48]

Source: Own calculations.

Note: *** statistically significant at p=0.01, ** statistically significant at p=0.05, * statistically significant at p=0.10 OLS - least squares, fixed effects model; GLS - generalized least squares, random effects model; IV - instrumental variables; GMM - generalized method of moments, dynamic model.

In the next model it was assumed that fixed assets at the disposal of the two sectors are homogeneous, but employees might not be. Model (4a) including fixed effects indicates insignificant labour elasticity of product in the public sector. Model (4b) with random effects, which indicated Hausman test, show capital elasticity of product similar to the one estimated with use of the models (1). It gave a slightly lower than model (4a), but positive labour elasticity of product in the private sector. In the case of public sector labour elasticity of product has proved to be negative and statistically significant (see also Table 5 in the appendix). This controversial conclusion is confirmed by the model (4c) estimated using the IV1. The difference between models (4c) and (4b) is lower, but still positive, labour elasticity of product in the private sector. The dynamic model (4d) does not support the conclusion on the negative labour elasticity of product in the public sector, however, it indicates that the employment in this sector statistically insignificantly affects the gross value added in the economy (it is also lower than the one for the private sector). According to the results of this model, an increase in employment in the private sector by 1% will result in an increase in the gross value added in the economy by 0.2%.

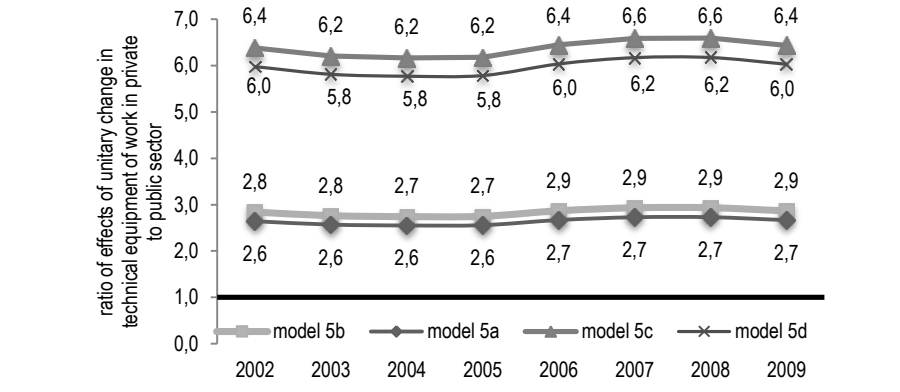
Transforming the basic growth model in an intensive form we get productivity as a function of capital to labour ratio. In this case the issue on the efficiency of the use of capital in both sectors emerges. It will be subject to testing. Similarly to the previous models we will include the relative expenditure on research and development in the model.

[1] The same set of instruments was used as the one in the model (3b).

Model (5a) estimated with use of OLS estimator indicates higher percentage impact of capital to labour ratio on labour productivity in private than in public sector (Table 3). The coefficients for both sectors are statistically significant. These results were confirmed by random effects model (5b), for which validity indicated the Hausman test. However, both models suffer from heteroscedasticity of the error term. In order to eliminate the non-uniformity of variance WLS estimator was used and model (5d) estimated. WLS estimator has higher variance than OLS estimator, hence the worse goodness of fit measures, but it gave unbiased estimates of parameters. They indicate that 1% increase in technical equipment of labour in the private sector will result in an increase in labour productivity in the economy by 0.86%. In the public sector it is 0.29%. IV estimator gave similar results (model 5c)1.

In terms of the effect of unitary changes in technical equipment of work on labour productivity in Poland all four models show the clear advantage of private sector over public sector (Figure 4). Models divide themselves into two categories. Models (5a) and (5b) show 2.5 to 2.9 times higher impact of capital per worker in private than public sector on productivity. Models (5c) and (5b) show 5.8 to even 6.6 times higher impact in private than public sector. From econometric point of view the latter models are more justified. However, from economic point of view it may also be true. Results of a model (5d) show that a unitary change in capital in PLN per worker in private sector would increase labour productivity in Poland in year 2009 by 0.507 while in the case of public sector it would be only 0.084 (see Table 6 in the appendix). In year 2002 the increase in private sector would have resulted in a 0.305 change in the productivity, while in public - by 0.051. Both sectors increased the efficiency of the use of capital during years 2002-2009, private sector by 67%, while public sector by 65%.

FIGURE 4. THE RATIO OF EFFECTS OF UNITARY CHANGE IN TECHNICAL EQUIPMENT OF WORK IN PRIVATE TO PUBLIC SECTOR ACCORDING TO FOUR MODELS



Source: Own calculations.

Another way to look at the influence of the two sectors of property on the labour productivity is by supplementing the productivity of labour model by the ratios of private and public sectors in terms of labour and capital. Model (6a) shows the initial estimations made with use of OLS estimator. However, the legitimacy of inclusion of the random effects in the model tested with use of Hausman test allows us to construct model (6c), which better reflects the modelled relations. It indicates that the increase in the number of employees is significantly more desirable in the private sector than in the public sector, and if their ratio on behalf of the private sector increases, the productivity of labour in the country will increase. The model also takes into account the lag of expenditures on

[1]Instrumental variables include: capital and labour in the public and private sectors, capital to labour relations in the public and private sector and the relations of private and public sector in terms of capital and labour.

research and development and labour ratio, indicating a delay in the period of return on invested capital. Estimation of IV (model 6b) confirmed the positive impact of the ratio of employment in the private sector to the public sector on the performance of the economy, while not indicating a statistically significant effect of such a ratio in the case of fixed assets1. The coefficient indicating the relative influence of the ratio of employment in both sectors (private sector in numerator) on labour productivity was similar to the one obtained in the model (6c) and the models (2), which can be a confirmation of the previous results.

TABLE 3. PRODUCTIVITY MODELS WITH PRIVATE AND PUBLIC SECTORS

Variable	OLS (5a)	GLS (5b)	IV (5c)	WLS (5d)	OLS (6a)	IV (6b)	GLS (6c)
constant	0.92	0.91	0.93	0.95	0.83	0.37	**1.31
kr-lr	***0.59	***0.62	***0.95	***0.86	***1.07	***1.06	***0.45
ku-lu	***0.45	***0.44	***0.30	***0.29			
kr-ku	-	-	-	-	***0.24	0.14	***0.19
lr-lu	-	-	-	-	-	*0.29	***0.30
a-l	**0.04	**0.04	0.01	***0.04	***0.06	-	***0.04
a-l(-1)	*0.04	**0.04	-	-	-	-	***0.04
k-l(-1)	-	-	-	-	-	-	***0.71
F	***300.5	-	-	***428.3	***347.9	-	-
Wald	-	-	***1196.7	-	-	***32.3	-
Breusch-Pagan	-	***211.5	-	-	-	-	***234.6
Hausman	-	4.4	-	-	-	-	6.9
Standard error	0.028	0.084	1.070	0.986	0.030	0.033	0.089
Adjusted R2	0.982	-	0.923	0.931	0.981	0.934	-
N distribution, DH [p]	-	-	-	0.17 [0.92]	-	-	3.37 [0.19]
AR(1), t [p]	-	-	-	1.41 [0.16]	-	-	1.27 [0.21]

Source: Own calculations.

Note: *** statistically significant at p=0.01, ** statistically significant at p=0.05, * statistically significant at p=0.10. OLS - least squares, fixed effects model; GLS - generalized least squares, random effects model; IV - instrumental variables; WLS - weighted least squares.

The results of our study on the impact of private and public sector on both GDP and productivity support this part of the literature, which found a negative correlation between the relative size of the public sector and the economic situation. Most of the literature focuses on the relation between government spending and the economy. Our analysis was conducted on the basis of the size of the property sectors in terms of capital and labour. Among the articles in which similar methodology was used we support the results for the U.S. economy by Peden and Bradley (1989), who analysed the relative impact of government spending including labour and capital and by Hansson and Henrekson (1994), who took into account the disaggregated data. This negative correlation is justified by a number of reasons (see Hansson and Henrekson, 1994). Some of the most prominent factors behind this can be lower productivity of labour and capital in the public sector in comparison to the private sector, associated with more effective targeting of expenditures in private than public sector spending. Why, however, is it so difficult to prove such differences? This is due to several reasons. The first is that the public sector is part of GDP. Thus, their growth will affect the growth of GDP. The second important reason is that public sector owns very important for the economy sectors such as fuel and energy sector, crucial investments for the development of the country, e.g. investments in highways and the pre-accession and structural funds from the European Union budget, which severely affected Poland in analysed years. However, the analysis of productivity of labour and capital of public and private sectors give insight into their efficiency.

[1] The same set of instruments was used as the one in the model (5c).

Conclusion

Issues of efficiency and optimal size of the public sector have been widely analysed in the literature. In general, it is pointed out that the public sector is less efficient than private, and increase in its size is negatively correlated with economic growth, although it is not a rule. The size of the public sector in the literature is most often measured by government expenditure or public sector spending, the size of the government, taxes, etc. In this paper we have analysed the performance of public and private sectors, on the Polish example, using panel data for the provinces. We analysed the productivity of capital and labour in both sectors, with their sizes in 2002-2009. This approach is a rarely used in the literature. It has the advantage of expressing both sectors, using different categories of accounting, in the same economic term- productivity. It allowed to compare both sectors in this respect of the results of investments in labour and capital. We used various estimation methods, in order to obtain robust results.

Our analysis indicate that the ratio of employment in the private to public sector is positively correlated with economic growth and development, as measured by GDP and GDP per capita. Estimation with use of both GLS as IV estimators gave similar results, so it is tempting to say that the increase of this ratio in terms of employment results in higher economic growth and development. However, these results should be treated with caution, and in our opinion speaking of such a causality is not sufficiently motivated. Therefore, further research is needed in this area. This is due to the difficult to resolve problem of endogeneity, even treated with robust methods of estimation. There is little doubt as to the situation in which the sizes of the both sectors increase in terms of the number of employees increases. Then increase in the difference between the two sectors in favour of the private one would increase economic growth and development. However, the situation in which the size of both sectors diminishes remains still undiagnosed.

Separating capital and labour in both sectors, we verified the hypothesis of heterogeneity of ownership sectors in terms of productivity. Our analysis showed that the productivity of the two sectors is different. The private sector has a higher productivity of both labour and capital in comparison to the public sector. The productivity of capital in the private sector was 1.5 times higher than in the public sector in year 2009. This difference diminished from 1.9 times higher in year 2002, but it is still visible. The analysis for labour productivity showed negative marginal product of labour in public sector and positive in the private one. It would mean that the size of government in Poland, especially regional governments, should be diminished in order to accelerate economic growth. This result has not been confirmed in the last model. However, this model showed statistically insignificant influence of public sector employment on gross value added. Further conclusions were provided by the analysis of the influence of technical equipment of work on labour productivity. All models showed significantly higher influence of private than public sector. The more robust results showed that a 1% increase in capital per worker in the private sector would increase labour productivity in Poland by ca. 0.9%, while in the public sector - by ca. 0.3%. In terms of unitary, not percentage changes it gives ca. 6-times higher impact of technical equipment of work in private than public sector on labour productivity in Poland. Also the results according to the ratio of employment in private to public sector and labour productivity, favourable to the private sector, correspond to those obtained for GDP per capita, which could be a confirmation of previous results.

The results of the analysis indicate higher productivity of the private sector than public sector in Poland. In order to obtain adequate economic growth in Poland, it is necessary to control size of the public sector in terms of number of employees and the value of fixed assets. It should be a basis of conducting appropriate policy of public employment and investment expenditures. It is also recommended to maintain proper relationship between the public and private sectors.

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Appendix

TABLE 4. MARGINAL PRODUCT OF CAPITAL IN MILLIONS OF PLN AS A RESULT OF THE CHANGE IN GROSS FIXED CAPITAL PER BLN PLN

Year	Model 3a		Model 3b		Model 3c	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
2002	209	573	288	541	-	250
2003	215	558	297	526	-	244
2004	234	578	323	545	-	252
2005	240	575	332	542	-	251
2006	247	589	341	556	-	257
2007	260	595	359	561	-	260
2008	265	590	366	557	-	258
2009	267	590	368	557	-	257

Source: Own calculations.

TABLE 5. MARGINAL PRODUCT OF LABOUR IN THOUSANDS OF PLN AS A RESULT OF THE CHANGE IN EMPLOYMENT PER PERSON

Year	Model 4a		Model 4b		Model 4c		Model 4d	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
2002	-	39	-56	34	-56	22	-	16
2003	-	40	-60	35	-60	23	-	17
2004	-	44	-68	38	-68	25	-	18
2005	-	45	-72	39	-72	25	-	19
2006	-	47	-79	41	-79	26	-	19
2007	-	49	-87	43	-87	27	-	20
2008	-	51	-95	45	-95	29	-	21
2009	-	56	-102	49	-102	32	-	23

Source: Own calculations.

TABLE 6. THE EFFECT OF THE CHANGE OF A UNIT OF TECHNICAL EQUIPMENT OF WORK ON A UNIT OF LABOUR PRODUCTIVITY

Year	Model 5a		Model 5b		Model 5c		Model 5d	
	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector	Public sector	Private sector
2002	0.079	0.210	0.078	0.220	0.053	0.337	0.051	0.305
2003	0.122	0.313	0.119	0.329	0.081	0.504	0.078	0.456
2004	0.129	0.330	0.126	0.347	0.086	0.531	0.083	0.481
2005	0.129	0.330	0.126	0.347	0.086	0.532	0.083	0.481
2006	0.128	0.342	0.125	0.359	0.085	0.550	0.083	0.498
2007	0.129	0.351	0.126	0.368	0.086	0.565	0.083	0.511
2008	0.128	0.350	0.125	0.368	0.086	0.564	0.083	0.510
2009	0.131	0.348	0.128	0.366	0.087	0.560	0.084	0.507

Source: Own calculations.