Central European Economic Journal

sciendo

ISSN: 2543-6821 (online). Journal homepage: http://ceej.wne.uw.edu.pl

Are subsidies for Polish enterprises effective: empirical results based on panel data

Beata Gosk, Natalia Nehrebecka

To cite this article: Gosk, B., Nehrebecka, N. (2019). Are subsidies for Polish enterprises effective: empirical results based on panel data. Central European Economic Journal, 6(53), 108-131. DOI: 10.2478/ceej-2019-0008.

To link to this article: https://doi.org/10.2478/ceej-2019-0008

Central European Economic Journal

Beata Gosk[1], Natalia Nehrebecka[1]

1 Faculty of Economic Sciences University of Warsaw, Warsaw, Poland, corresponding author: nnehrebecka@wne.uw.edu.pl

Are subsidies for Polish enterprises effective: empirical results based on panel data

Abstract: The objective of this article was to identify and evaluate the effectiveness of subsidies used by companies, as well as to develop an approach to assess the effectiveness of subsidies for the manufacturing sector of Polish economy. In order to organise the results obtained by researchers dealing with the efficacy of subsidies, a meta-analysis, i.e. a quantitative assessment of empirical literature, was carried out. Based on the data from the financial statements of medium-sized and large Polish companies, published in *Monitor Polski B* (a former Official Journal of the Republic of Poland), an evaluation study was conducted to verify the research hypotheses. Based on the obtained results, it was found that the aid in the form of subsidies did not have a significant impact on the productivity of the subsidised companies, growth rate of assets or profitability.

Keywords: subsidies for companies/public, evaluation study

JEL Codes: H25, H32, L25, L53

1 Introduction

In 2016, the Polish economy was struggling with negative investment dynamics. According to the National Bank of Poland report, the decrease in investment was the result of a reduction in expenditure on fixed assets both in the public finance sector and among private companies. The drop in investment was mainly related to the reduced use of European Union (EU) funds after the closure of the financial programmes under the 2007–2013 Funds, as well as to the high level of uncertainty about the economic situation, fluctuations of the zloty exchange rate and of prices as well as results of legislative changes, which were difficult to predict. Bearing in mind that apart from bank loans and leasing contracts, subsidies (Geruzel-Dudzińska, 2016) are popular external sources of investment financing in companies, it is worth considering their effectiveness.

From the early 1950s to the early 1970s, industrial policy was seen as a panacea for economic growth and development. At the beginning of the 1980s, it was shown that industrial policy may cause an incorrect allocation of resources, may not improve long-term growth and may lead to the so-called rent seeking. New economic theories (e.g. endogenous development, economic geography and strategic trade theory), developed and tested since the beginning of 1990, have shown that public support for companies should occupy an intermediate position between the two extreme ones. State planning and state intervention cannot be the main driving forces of economic development. At the same time, public action could be combined with private initiatives to stimulate restructuring, diversification and technological dynamics (Buigues & Sekkat, 2009).

The aim of the article was to identify and evaluate the effectiveness of subsidies received by companies, as well as to develop a method to assess the effectiveness of subsidies directed to the manufacturing sector of the Polish economy. In order to systematise the results obtained by researchers dealing with the effectiveness of

subsidies, a meta-analysis, i.e. a quantitative assessment of empirical literature, was carried out.

The added value of the article is the elements of analysis of the effectiveness of subsidies, hitherto unknown in the literature. For this purpose, we performed meta-analysis that deployed a graph method to identify the effect of publication selection: funnel plot and funnel asymmetry test. Meta-analysis allows a comprehensive estimate of results compiled from independent articles, thus enabling an accurate assessment of the impact of variables on the studied processes. The conclusions flowing from meta-analysis give the opportunity to explain the discrepancies in the relations observed by the researchers. Since the studies that reveal insignificant relationships between variables or insignificant findings are not very attractive and less readily published, we formulated the first main hypothesis (HG1) on the existence of the effect of selection of the publications, which evaluated subsidies for private companies.

Owing to the fact that Poland is one of the largest beneficiaries of EU funds, and the value of subsidies obtained by companies in 2015 reached almost 11 billion zlotys, this issue is important and up to date. Despite the enormous popularity of subsidies for firms, there have not been many empirical studies on this subject in Poland apart from the reports of institutions such as Polish Agency for Enterprise Development (PARP). In addition, it was noted that the literature on the subject lacks unequivocal research findings on the usefulness of financial support for companies. Sometimes subsidies can lead to inefficient allocation of resources and excessive employment growth, which is why, according to Cerqua and Pellegrini (2014) as well as Koski and Pajarinen (2013), subsidies cause a decrease in the company's productivity. Duch, Montolio and Mediavilla (2007) reported quite different outcomes: they showed that internal changes necessary to ensure successful implementation of projects for which the company receives grants increase its competitiveness and productivity. Interesting results were also found in the studies by Bernini and Pellegrini (2011), who noted a positive impact of public subsidies on added value and a negative impact on the total factor productivity and labour productivity, which was explained by unwarranted employment surges in the subsidised enterprises. This article asks the main question (MQ): to what extent do EU subsidies affect the production segment of Polish enterprises in terms of profitability and productivity? To obtain the answer to the above question, the following supporting hypotheses were also put forward: state support in the form of free, non-repayable financial assistance allows companies for investment leading to the development and modernisation of their activities, which is reflected in the productivity of the given business (HP1). The funds acquired by companies enable them not only to grow but also to change the size of their enterprise, thereby reducing the risk of doing business (HP2). Non-repayable financial assistance relieves the budget of the company and reduces the risk of profitability loss (HP3).

In order to verify the above hypotheses, based on the *Monitor Polski B* database, research samples were constructed using patterns for which the Propensity Score Matching (PSM) statistical method was applied.

The article consists of a theoretical and empirical section. In the theoretical part, based on empirical research we conducted a qualitative and quantitative review of the subject literature. The empirical part presents the methodology adopted in order to perform the econometric study, and the next section contains a preliminary analysis of the data used in the model and a description of the variables. The fifth section presents the results of the estimation, diagnostics and verification of research hypotheses.

1.1 Review of qualitative and quantitative literature

There is no consensus among economists on the effectiveness of state programs whose objective is to provide financial support to companies, which is why their thorough evaluation is so important. One of the basic tools of such economic policy is subsidies, the goal of which is to stimulate growth, improve the competitive position and increase employment in the firms, which are the beneficiaries. The recent financial crisis in the United States has caused a significant rise in the popularity of industrial policy; the EU has allocated as much as 100 billion euros to support business enterprises between 2014 and 2020, of which as much as 65 billion comes in the form of non-repayable aid (Lekki, 2013). In the

United States, government spending on the so-called corporate welfare totalled almost 100 billion dollars only in 2012 and was allocated to direct and indirect subsidies for small enterprises, large corporations and industrial organisations (DeHaven, 2012). China has been basing its development on subsidies for companies for a dozen or so years, with the industry receiving assistance worth more than 30% of its production. According to some economists, it is subsidies, not cheap labour, that are the source of the country's significant comparative advantage (Haley & Haley, 2013). As these subsidies consume substantial financial resources, evaluating their efficacy is key to guiding decision-making by policymakers and thus to ensuring the optimal use of taxpayers' money.

1.2 Definitions of the result variable in the literature

When it comes to evaluation studies on subsidies for companies, one can distinguish the main trends in measuring the performance of businesses. Most scholars aimed to examine the impact of the received aid on the company's productivity or growth rate. Bergström (2000), Duch et al. (2007) and Bernini and Pellegrini (2011) understand productivity as the added value of the company, i.e. the increase in the value of goods as a result of the production process. Girma, Görg and Strobl (2007) and Bernini and Pellegrini (2011) focus on the total productivity of the manufacturing factors, while Harris and Trainor (2005) simply analyse the value of gross production. The last approach, adopted e.g. in the studies of Cerqua and Pellegrini (2014) and Koski and Pajarinen (2013), is related to the productivity of labour; in this case, the indicators of productivity were divided by the number of employees.

The second trend visible in the analysed research articles focuses on the influence of subsidies on the growth of companies defined as a positive, measurable change in size. According to Sudoł (1999), the universal measure of the size of a company is the value of turnover, which was investigated in the research of Roper and Hewitt-Dundas (1999) and Cerqua and Pellegrini (2014), while Koski and Pajarinen (2013) and Criscuolo, Martin, Overman, and Van Reenan (2012) adopted the popular measure and analysed the number of employees. In addition, growth can also be calculated as the approximate rate of increase in profits (Roper & Hewitt-Dundas (1999)) or assets/balance sheet total (Tzelepis & Skuras (2004)).

There are also other explanatory variables from the literature review that cannot be subsumed under either productivity indicators or growth measure categories. Some authors were interested in the impact of subsidies on corporate profitability ratios such as return on assets (ROAs; Roper and Hewitt-Dundas, 1999 and Tzelepis and Skuras, 2004), return on equity (Ankarhem, Daunfeldt, Quoreshi and Rudholm, 2009) and net profit margin (Tzelepis & Skuras, 2004). Others like Criscuolo et al. (2012) and Cerqua and Pellegrini (2014) inquired whether aid in the form of subsidies boosts investment among the beneficiaries. However, Tzelepis and Skuras (2004) and Bernini and Pellegrini (2011) also tried to investigate the relationship between subsidies and debt and the cost of corporate debt.

1.3 The impact of subsidies on individual analysed indicators

Based on economic theory, the expected impact of subsidies on business productivity cannot be clearly determined. Sometimes additional financial aid leads to inefficient allocation of resources and excessive production increase; consequently, according to the results obtained by Cerqua and Pellegrini (2014) and Koski and Pajarinen (2013), subsidising causes a decline in the company's productivity. Different conclusions were presented by Duch et al. (2007), who claim that internal changes necessary to ensure effective implementation of projects for which the company receives grants boost its competitiveness and productivity. Bernini and Pellegrini also obtained interesting results (2011), as they observed a positive effect of public subsidies on added value and a negative effect on the total productivity of manufacturing factors and labour productivity, which, in their opinion, results from disproportionate employment growth in the subsidised businesses. Many articles also reported a lack of a significant relationship between subsidies and productivity. When analysing the size of the company, a considerable influence of subsidies was observed. The examined subsidies had a mostly positive impact on employment growth, which is favourable at the national level because of reduction of unemployment, while from

the company's perspective, it may prove harmful in the long run if the number of employees is too high. On the other hand, as far as other measures of company growth go, such as the rate of turnover growth in Cerqua and Pellegrini (2014) or of assets increase in Tzelepis and Skuras (2004), the positive effect of received subsidies was definitely positive. Moreover, as expected, according to Criscuolo et al. (2012) and Cerqua and Pellegrini (2014), financial assistance received from the state effectively encouraged entrepreneurs to increase their investment. However, none of the authors stated that there was a significant relationship between subsidies and profitability ratios. Bernini and Pellegrini (2011) reported quite unexpected conclusions about the greater debt of businesses that received subsidies, speculating that the subsidised companies incurred higher costs by financing new investments.

1.4 Verification of the publication selection effect

Meta-analysis is a useful research tool based on literature review. This term was coined in 1976 by the American statistician Gene Glass (1976), who defined it as 'the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings'. The motivation for conducting a meta-analysis is the desire to pool information in order to obtain higher statistical power than imprecise results from a single study. Because of the so-called publication bias connected with the fact that studies with positive, relevant and interesting findings are more willingly published, reliable meta-analysis should account for the results of the funnel plot, which show the relationship between the study precision and the estimates of the effect. Precision can be measured by sample size or, as in this article, inverse standard error. If a publication is unbiased, we should expect a symmetrical distribution of studies around a total effect in the shape of a cone/inverted funnel. Studies that use smaller samples are characterised by higher values of standard errors, and thus lower accuracy, so their results are placed at the bottom of the graph, where greater dispersion is visible. On the other hand, if a publishing error appears, a disturbance of symmetry occurs when moving downward the graph, indicating the authors' preference for the bias or multiplicity of the findings (Stanley, 2008).

Table 1 is based on the previously presented literature review and selected empirical studies, which evaluated many econometric models assessing the effectiveness of state subsidies. It shows compiled outcomes and information on the analysed time period and the country. 15 articles were meta-analysed, out of which 301 observations were obtained for variables divided into four groups: variables measuring productivity (60 observations), productivity growth (74), company size (106) and company size growth (60).

Appropriate funnel plots were created, representing precision as 1/standard error on the vertical axis and placing the coefficient values on the horizontal axis. The first graph (Figure 1, left side) and the third (Figure 2, left side) resemble an inverted, asymmetrical letter T rather than a funnel, which indicates the bias of research analysing the impact of subsidies on the productivity and size of the company.

The even higher asymmetry of the funnel plot for variables related to increase in size (Figure 2, right side), where all estimates are located on the positive half-axis, confirms the existence of the publication selection effect.

The only exception seems to be the funnel plot for productivity growth (Figure 1, right side): were it not for two extremely negative observations, the graph would be a symmetrical narrow funnel. To confirm this, a statistical analysis was performed to verify the occurrence of the publication effect. A regression was carried out between the reported result (e.g. estimated elasticities, partial correlations, etc.) and standard error:

$$e_i = \beta_1 + \beta_0 Se_i + \varepsilon_i, \tag{1}$$

where e_i = estimated elasticity and Se_i = standard error.

Equation (1) was proposed by Card and Krueger (1995); in the absence of the effect of selection of publications, the observed effects should randomly differ from the 'true' value b_1 regardless of the standard error. When all studies were selected with regard to statistical significance, the selection effect should be proportional to the standard error $b_0 Se_i$. Economic scientific research uses samples of various sizes and methods; therefore, the random error from equation (1) can be heteroskedastic. In this particular case, the independent variable Se_i is a sample estimate of the standard deviation (SD) from meta-regression, so after dividing both sides of the

Tab. 1: Estimates of the impact of subsidies on the level and increase in productivity and size of the company in selected empirical studies

Article	Time period of the sample	Country	Parameters	Number of regressions
Productivity				
Harris and Trainor (2005)	1983–1998	North Ireland	(-1.735, 1.013)	7
Girma et al. (2007)	1992–1998	Ireland	(0.0199, 0.0668)	2
Gabriele, Zamarian and Zaninotto (2006)	1998–2003	Italy	(5.33, 17.51)	3
Criscuolo et al. (2012)	1986–2004	Great Britain	(-0.09, 0.026)	6
Koski and Pajarinen (2013)	2003–2010	Finland	(-0.064, 0.034)	18
Cerqua and Pellegrini (2014)	1995–2001	Italy	(-8.06, -2.14)	18
Sissoko (2013)	1998–2006	France	(0.151, 0.2)	6
Productivity growth				
Bergström (2000)	1987–1993	Sweden	(-4.57, 1.93)	8
Duch et al. (2007)	2000–2002	Spain	(0.011, 0.1325)	8
Bernini and Pellegrini (2011)	1995–2003	Italy	(-0.29, 0.284)	56
Sissoko (2013)	1998–2006	France	(0.143, 0.215)	2
Company size				
Adorno, Bernini and Pellegrini(2007)	1996–2000	Italy	(8.89, 39.89)	12
Gabriele et al. (2006)	1998–2003	Italy	(4.50, 5.32)	3
Ankarhem et al. (2009)	1990–1999	Sweden	(-53.46, 107.15)	78
Criscuolo et al. (2012)	1986–2004	Great Britain	(-0.07, 0.553)	12
Sissoko (2013)	1998–2006	France	0.168	1
Company size growth				
Roper and Hewitt-Dundas (1999)	1991–1995	Ireland, North Ireland	(-0.015, 0.201)	4
Tzelepis and Skuras (2004)	1982–1996	Greece	0.083	1
Gabriele et al. (2006)	1998–2003	Italy	(6.13, 10.07)	3
Bernini and Pellegrini (2011)	1995–2003	Italy	(0.28, 0.538)	16
Cerqua and Pellegrini (2014)	1995–2001	Italy	(4.45, 8.35)	36

Source: Own study based on literature review.

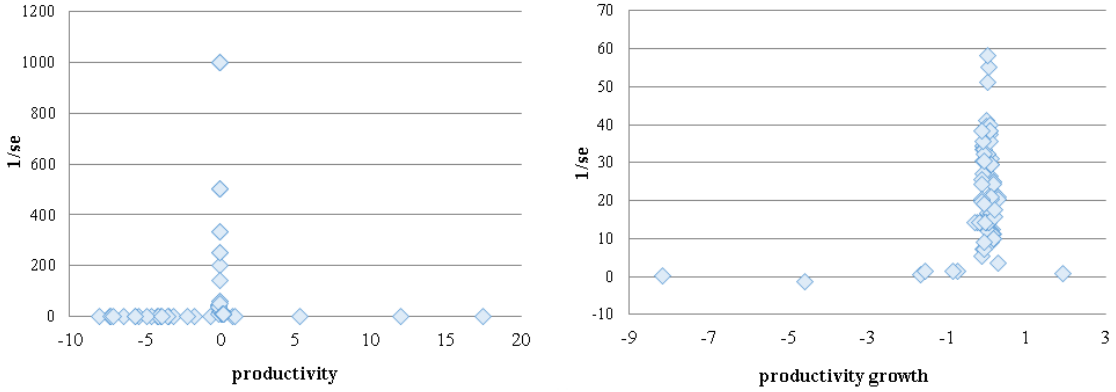

Fig. 1: Funnel plot for productivity and productivity growth. Source: Own study based on literature review.

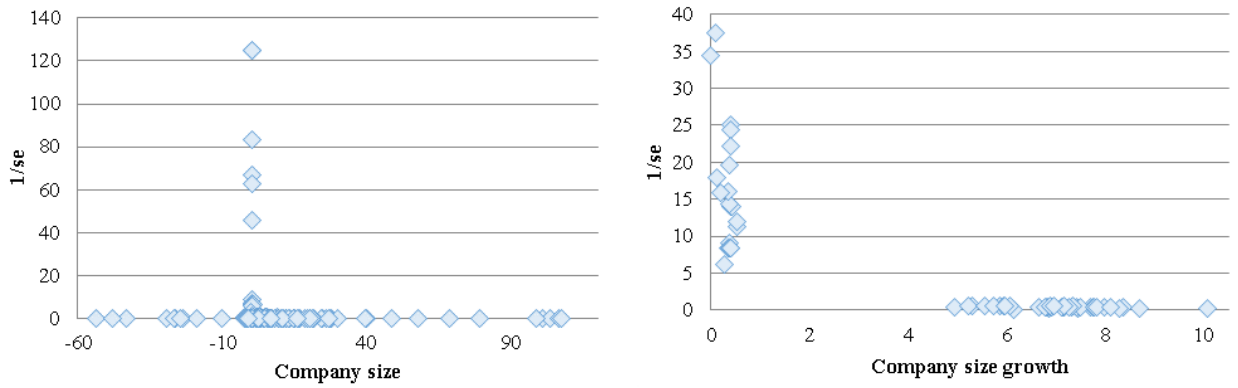

Fig. 2: Funnel chart for the size and growth of the enterprise size. Source: Own study based on literature review

Tab. 2: Test results for the effect of publication selection effect

Model of variables associated with the impact of subsidies on:	Constant			$1/Se_i$		
	Estimate	*t*	*p*-value	Estimate	*t*	*p*-value
Productivity	–0.53	–1.86	0.067	–0.00	–3.56	0.001
Productivity growth	0.15	0.27	0.791	0.02	1.06	0.294
Company size	0.86	7.91	0.000	0.13	26.03	0.000
Company size growth	3.02	10.72	0.000	0.07	2.89	0.005

Source: Own study based on literature review.

equation by the heteroscedasticity measure (Se_i), the following formula is obtained:

$$t_i = \beta_0 + \beta_1 \left(\frac{1}{Se_i} \right) + v_i \quad (2)$$

where t_i = value of statistic t, for elasticity e_i.

The constant and deviation coefficient are inverted, and the independent variable is the inverse of the standard error. The conventional *t*-test, for the constant from equation (2) b_0, is a test for the occurrence of the publication selection effect, and the estimate $\hat{\beta}_0$ indicates the bias and size of this selection. Thus, checking the significance of the b_0 coefficient may be considered a test for the asymmetry of the funnel plot (Doucouliagos & Stanley, 2009).

In order to verify the occurrence of the publication selection effect for the issues analysed in this paper, we carried out relevant regressions, the results of which are shown in Table 2. For variables describing the impact of subsidies on company productivity and its increase, there were no grounds for rejecting the null hypothesis that $b_0 = 0$ at the level of significance of 5%, so we can conclude that there is no publication bias in this case. On the other hand, different results were obtained for the categories of company size and the company size growth indices, where the null hypothesis about the constant insignificance was rejected. Both coefficients were positive, which proves that the studies that indicated a positive influence of subsidies on the analysed variables were favoured.

To sum up, on the basis of graphs and statistical analyses, the hypothesis about the occurrence of the effect of publication selection among research papers (HG1), which examined the impact of subsidies on productivity, was rejected, while in the case of the articles on the relationship between subsidies and the size of the company, there were no grounds to reject this hypothesis; a bias related to preference for positive results was noted.

2 Methodology

Based on the literature review, various methodological approaches were used to examine the effects of public subsidies granted to companies. The simplest method of least squares was used at some stage by Bergström (2000) and Duch et al. (2007); however, the authors emphasised the drawbacks of this approach, such as lack of resistance to outliers and the rigorous treatment of the classic linear regression model, and used them only for comparing results. Almost all studies made use of an equation describing the probability of receiving a subsidy, and the findings were most frequently particularised with the logit model (among others by Ankarhem et al., 2009). The main advantages of this methodology are that there is no need to posit a linear relationship between the explained and explanatory variables, as well as that there is a measure of the impact of a single variable on the probability of success, which is not dependent on the value of other variables (odds ratio). It may be problematic that logistic regression requires that the observations be independent of each other; otherwise, the model may exaggerate the influence of such observations on the estimates. In turn, Tzelepis and Skuras (2005) used the logit model with fixed effects for panel data, and they constructed their own indicators of strategic orientation of companies as their explained variables. This approach enables the control of unobservable heterogeneity and reduces the problem of self-selection. The concept of controlling the unobservable effect with regard to panel data arose from the threat of the so-called problem of 'overlooked variables'. This problem stems from obtaining biased least-squares estimators if significant regressors are not included in the model. Unfortunately, only constant heterogeneity control is possible, and interpretation of the findings is considerably limited.

In the context of subsidies, the issue of sample selection has often occurred due to the fact that the characteristics of individuals affecting the likelihood of intervention may also affect its outcome. Roper and Hewitt-Dundas (1999) dealt with this problem by using the Heckman selection model that allows making a distinction between the effects of selection and of aid. It is worth noting, however, that a selection equation that inaccurately describes the selection mechanism leads to inefficient estimates of the result equation. The covariance matrix generated by OLS (Ordinary Least Squares) estimates is inconsistent; correct standard errors and other statistics can be obtained, e.g. by using the bootstrap method. In addition, the canonical model assumes the two-dimensional normality of the random component.

A different approach, often encountered in evaluation studies – PSM – was applied in the article by Duch et al. (2007). PSM permits one to assess the impact of a stimulus, in this case subsidies for companies, by selecting a control group in such a way that it is similar to the group of beneficiaries. The scholars (Gabriele et al., 2006; Ankarhem et al., 2009; Bernini and Pellegrini, 2011; Sissoko, 2013) noticed, however, an additional problem of endogeneity resulting from selection based on time-constant unobservable effects and decided to solve it by combining the difference estimators in the differences from PSM (in some articles, this was called the conditional difference-in-difference method). Alternatively, Harris and Trainor (2005) and Girma et al. (2007) decided to use the systemic generalised method of moments. The obvious advantage of this method is the possibility of using endogenous variables.

In this study, in order to estimate the impact of subsidies on the operation of businesses, a data combining technique was used – PSM. Both the regular estimator and the difference estimator were used. The description of the methodology was made on the basis of the following publications: Rosenbaum and Rubin (1983), Konarski and Kotnarowski (2007), Trzciński (2009) and Strawiński (2014).

2.1 Idea and assumptions of the PSM method

Keeping in mind that the purposes of this article were to examine the effectiveness of subsidies and the utilised data are not treated, it seems appropriate to use PSM. This method is used to assess the effect of a stimulus that is not randomly assigned. There are two potential results of action for each unit:

$$Y_i = \begin{cases} Y_{1i} & \text{if} \quad T_i = 1 \\ Y_{0i} & \text{if} \quad T_i = 0 \end{cases}. \tag{3}$$

where T_i is the binary variable that takes the value of 1 when a given unit is treated (it belongs to the treated group) and 0 otherwise (it belongs to the sample from which the control group will be selected) and Y_i is the result of the treatment for object *i*.

Thus, each unit is assigned an observed and counterfactual effect, and the so-called average treatment on treated effect (ATT) can be defined as the difference between the potential outcomes observed in the state of intervention and in the control sample:

$$\text{ATT} = E(Y_{1i} \mid T_i = 1) - E(Y_{0i} \mid T_i = 1) \tag{4}$$

where $E(Y_{0i} \mid T_i = 1)$ is the average outcome of no stimulus for the treated group, i.e. a situation that is unobservable in practice. However, this value can be estimated using the average result observed after stimulation for units that have not been subjected to it $(E(Y_{0i} \mid T_i = 0))$. If all subjects were identical, the above effects would be equivalent, but in practice, there are many differences at both the levels of observable and unobservable traits.

3 Description of the database

The financial statements that make up the database used come from *Monitor Polski B*[1] – the former Official Journal containing the financial statements, legal acts and announcements of entrepreneurs specified by the Accounting Act.

To build econometric models verifying the effectiveness of public subsidies, we used a data panel covering the main items from the company's balance sheet and profit and loss accounts for the period between 2005 and 2012. We were interested in medium and large (according to the European Commission classification, companies employing more than 250 employees and achieving an annual turnover larger than 10 million euros or a total annual balance sheet exceeding 10 million euros) Polish companies that are not listed on the stock exchange. Based on the literature on the subject, as well as the Statistics Poland report, the examined samples did not include entities classified by the Polish Classification of (Business) Activities 2007 into sections A (agriculture, forestry, hunting and fishing), K (finance and insurance) and O (public administration and national defence). This selection is dictated by the specificity and clearly distinct character of these companies that should be analysed separately.

3.1 Patterns

In order to properly prepare the data for the *ex post* evaluation study, it was necessary to introduce standards and to use several research samples. According to the requirements of the PSM method, the control pool should include units that were not exposed to the stimulus at all during the analysed period, while the treated group should include records for before, during and after the intervention. This pattern was used for Sample 1, which analysed the impact of subsidies awarded in 2007 (Table 3). Higher subsidies are often paid out in instalments, so one subsidy can be included in several subsequent annual financial statements. To take this into account, we constructed Sample 2, in which the subsidised companies received money in 2006 and 2007, and Sample 3, where revenues from subsidies were non-zero in 2006, 2007 and 2008. Owing to the small number of the above tests, it was decided to apply additional patterns that include a one-time subsidy throughout the entire panel. Sample 4 comprised companies that received one-time support between 2006 and 2009: in this configuration, it was only possible to study the stimulus effect after a year; therefore, Sample 5 was used, which was less numerous but allowed for evaluation after 2 years. The last Sample 6, analogous to Sample 2, contained units that were receiving a subsidy for 2 subsequent years. In the final study, after integrating units based on the PSM method, it was noticed that in Samples 1 to 3, there was insufficient number of observations for correct statistical deduction; therefore, only Samples 4 to 6 were analysed in the remaining investigation.

4 Description of variables

In the article, on account of the available data, subsidies were defined as follows:

1 The journal was published until 1st January 2013.

Tab. 3: Patterns

2005	2006	2007	2008	2009	2010	Number
Sample 4 – the stimulus is a subsidy received in 1 year						
0	1	0	x	x	x	400
x	0	1	0	x	x	231
x	x	0	1	0	x	212
x	x	x	0	1	0	230
						Σ1,073
0	0	0	x	x	x	250
x	0	0	0	x	x	113
x	x	0	0	0	x	150
x	x	x	0	0	0	137
						Σ650
Sample 5 – the stimulus is a subsidy received in 1 year						
0	1	0	x	x	x	400
x	0	1	0	x	x	231
x	x	0	1	0	x	212
						Σ843
0	0	0	x	x	x	250
x	0	0	0	x	x	113
x	x	0	0	0	x	150
						Σ513
Sample 6 – the stimulus is a subsidy received in 2 subsequent years						
0	1	1	0	x	x	251
x	0	1	1	0	x	166
x	x	0	1	1	0	134
						Σ551
0	0	0	0	x	x	133
x	0	0	0	0	x	91
x	x	0	0	0	0	90
						Σ314

Source: Own study.
Legend: 1 – means that the company received a subsidy in the given year; 0 – means that the company did not receive a subsidy in that year; x – means that it is not known whether the company received a subsidy or not in a given year.

Subsidies for the construction/purchase of fixed assets and intangible assets together with advances for future deliveries = accrued liabilities - negative goodwill.

Based on the variable constructed in this way, we created a binary variable used in the logit model, which took the value of 1 if the value of accrued liabilities minus the negative value of the company was higher than zero, and the value of 0 in the opposite case.

In evaluation studies on subsidies, the result variables are various types of indicators of the performance of companies. Productivity, which can be understood as added value (Bernini & Pellegrini, 2011), total factor productivity (Girma et al., 2007) or gross production value (Harris & Trainor 2005) was most often analysed in the literature. Productivity was defined as follows:

$$\text{Productivity} = \frac{\text{Added value}}{\text{Total assets}}$$

Another group of result variables focussed on scrutinising the impact of subsidies on the growth and growth rate of the company. Similar to the study by Tzelepis and Skuras (2004), we used the asset growth rate:

$$\text{Asset growth rate} = \left(\frac{(\Delta \text{ total assets})}{\text{total assets}_{t-1}}\right)\times 100\%$$

In order to check how state subsidies affected the profitability of assets, following the lead of Roper and Hewitt-Dundas (1999), we applied the following variable:

$$\text{ROA} = \left(\frac{\text{net profit}}{\text{total assets}}\right)\times 100\%$$

The *company size*, which can be understood in many ways, was used as another determinant of the probability of receiving a subsidy. A popular approach using the logarithm of the number of employees was observed in the article by Roper and Hewitt-Dundas (1999), but unfortunately it was impossible to adopt in this paper due to the lack of relevant employment data in individual companies. Based on the PARP report (2009), the company size was approximated by using the logarithm of the balance sheet total.

$$\text{Company size} = \ln\left(\text{total assets}\right)$$

Additionally, based on the findings of the study conducted by Duch et al. (2007), the square form of the above variable was also attached to the model.

An important issue that may affect the decision to grant a subsidy seems to be the solvency of the company,

which is the measure of credit limits. According to Duch et al. (2007), a company may be willing to seek funding in the public sector if it encounters difficulties in the private sector; furthermore, some subsidies are specifically targeted at companies for which credit constraints act as a barrier to some activities, mainly innovation. In this case, we used the overall debt ratio:

$$\text{Liabilities} = \frac{\text{Long-term liabilities}}{\text{Total assets}}$$

Age is another basic and frequently used characteristic of companies in econometric models. The number of years of operation in the market can be treated as an indicator/coefficient of the company's experience and the possibility of obtaining external funds. Like Sissoko (2013), we defined the variable *age* as follows:

$$\text{Age} = \ln\left(1 + \text{company's age in years}\right)$$

Finally, in order to verify whether there is a relationship between public aid and profitability, in addition to the aforementioned ROA variable, in one sample, modelling the study on Colombo, Croce, and Guerini (2013), we used another popular indicator of the company's financial condition, which is *cash flow*.

$$\text{Cash flow} = \frac{\text{Net profit} + \text{depreciation}}{\text{Total assets}}$$

Based on descriptive statistics (Tables 4 and 5) of continuous variables from Sample 4, it was observed that the average level of *added value* a year before the distribution of subsidies differed significantly for the

Tab. 4: Basic descriptive statistics of variables from Sample 4

Variable	Mean	Standard deviation	First quartile	Median	Third quartile	Minimum	Maximum
Added value							
2005	76,120.45	99,897.67	19,569.96	37,873.50	80,821.06	4,420.79	404,733.40
2006	83,613.87	109,236.30	21,594.84	42,021.25	89,475.37	4,834.65	441,146.70
2007	94,629.00	123,088.10	24,375.05	49,093.20	101,819.00	4,881.37	496,364.00
2008	11,7970.8	175,793.30	25,224.33	50,964.54	112,233.9	5,275.76	716,159.30
2009	83,833.34	106,042.80	20,632.80	39,637.02	90,697.10	5,306.50	415,198.40
2010	104,954.10	142,875.80	24,125.26	47,695.07	110,198.70	4,654.68	568,563.00
Productivity							
2005	1.777	1.366	0.825	1.511	2.416	0.007	11.088
2006	1.673	1.247	0.803	1.471	2.195	0.001	7.840
2007	1.798	1.429	0.773	1.508	2.361	0.002	8.223
2008	1.785	1.549	0.806	1.454	2.280	0.001	12.628
2009	1.767	1.635	0.755	1.391	2.357	0.001	14.452
2010	1.705	1.523	0.737	1.417	2.168	0.005	13.670
Asset growth rate							
2005/06	14.562	28.806	0	8.408	24.043	0	241.968
2006/07	15.534	37.192	0	8.647	21.646	0	335.140
2007/08	16.832	71.702	0	5.467	18.693	0	586.462
2008/09	48.259	164.670	0	2.165	41.989	0	496.961
2009/10	86.137	199.951	0	6.950	91.379	0	575.263

Continued **Tab. 4:** Basic descriptive statistics of variables from Sample 4

Variable	Mean	Standard deviation	First quartile	Median	Third quartile	Minimum	Maximum
ROA (%)							
2005	9.212	10.042	2.393	6.129	11.957	0.070	49.916
2006	9.391	9.822	2.752	6.227	12.755	0.069	48.891
2007	9.894	10.364	2.792	6.5807	13.163	0.052	49.187
2008	9.211	9.667	2.500	5.968	12.866	0.059	44.743
2009	9.570	10.889	2.159	6.250	12.824	0.043	48.471
2010	8.547	9.460	2.313	5.574	11.256	0.047	41.475
Size							
2005	10.266	1.298	9.512	10.178	11.020	2.646	15.292
2006	10.389	1.388	9.555	10.249	11.167	5.032	15.2177
2007	10.513	1.360	9.757	10.407	11.379	5.157	15.488
2008	10.652	1.349	9.791	10.548	11.431	5.806	14.777
2009	10.525	1.316	9.705	10.376	11.250	5.315	15.471
2010	10.635	1.328	9.849	10.543	11.378	2.978	15.809
Liabilities							
2005	0.074	0.145	0	0.005	0.081	0	0.794
2006	0.075	0.153	0	0.004	0.071	0	0.986
2007	0.071	0.135	0	0.010	0.087	0	0.847
2008	0.070	0.133	0	0.005	0.082	0	0.884
2009	0.080	0.160	0	0.007	0.083	0	0.746
2010	0.063	0.125	0	0.003	0.070	0	0.837
Cash flow							
2005	0.113	0.117	0.051	0.094	0.165	0	0.686
2006	0.129	0.108	0.062	0.104	0.179	0	0.701
2007	0.112	0.112	0.050	0.096	0.160	0	0.683
2008	0.099	0.121	0.038	0.090	0.159	0	0.810
2009	0.106	0.137	0.040	0.093	0.161	0	0.767
2010	0.099	0.125	0.043	0.091	0.143	0	0.614
Ln(age+1)							
2005	2.523	0.459	2.302	2.564	2.772	1.098	3.555
Age							
2005	10.765	6.368	7	10	13	0	32

Source: Own study based on data from *Monitor Polski B*.
Legend: ROA – return on asset.

Tab. 5: Basic statistics of descriptive variables from Sample 4 broken down by subsidised and non-subsidised companies

Variable		Mean	Standard deviation	First quartile	Median	Third quartile	Minimum	Maximum
Added value								
A year before the subsidy	0	79,803.68	112,976.00	16,537.94	36,342.87	82,381.98	3,284.50	455,219.70
	1	88,695.01	112,648.00	21,720.75	44,171.46	102,177.20	3,284.50	455,219.70
A year after the subsidy	0	81,319.56	117,916.10	16,537.94	36,342.87	82,381.98	3,818.98	484,195.40
	1	90,074.90	117,138.50	21,720.75	44,171.46	102,177.20	3,818.98	484,195.40
Productivity								
A year before the subsidy	0	1.7470	1.448	0.721	1.437	2.336	0.001	11.088
	1	1.7690	1.366	0.885	1.511	2.303	0.001	12.628
A year after the subsidy	0	1.690	1.425	0.645	1.428	2.315	0.003	10.323
	1	1.779	1.757	0.823	1.412	2.250	0.001	35.423
ROA (%)								
A year before the subsidy	0	8.604	9.760	2.032	5.232	11.987	0.003	64.416
	1	9.489	9.908	2.840	6.539	12.609	0.001	77.003
A year after the subsidy	0	5.479	8.943	0.279	3.677	10.653	0	26.504
	1	5.814	9.185	0.469	4.473	10.568	0	26.504
Size								
A year before the subsidy	0	10.339	1.457	9.503	10.249	11.154	2.646	15.488
	1	10.485	1.273	9.687	10.362	11.254	6.791	15.446
A year after the subsidy	0	10.474	1.479	9.602	10.351	11.325	3.247	17.646
	1	10.608	1.282	9.807	10.506	11.355	3.336	15.446
Liabilities								
A year before the subsidy	0	0.069	0.138	0	0.004	0.071	0	0.794
	1	0.075	0.145	0	0.006	0.082	0	0.794
A year after the subsidy	0	0.063	0.141	0	0.002	0.056	0	1.309
	1	0.083	0.155	0	0.009	0.098	0	1.142
Cash flow								
A year before the subsidy	0	0.132	0.096	0.065	0.105	0.172	0.003	0.506
	1	0.140	0.096	0.072	0.117	0.185	0.002	0.507
A year after the subsidy	0	0.119	0.097	0.048	0.093	0.166	0.003	0.498
	1	0.129	0.094	0.054	0.102	0.161	0.012	0.457
Ln(age+1)								
A year before the subsidy	0	2.476	0.533	2.197	2.564	2.772	0	3.526
	1	2.439	0.529	2.197	2.484	2.708	0	3.555

Source: Own study based on data from *Monitor Polski B*.
Legend: ROA – return on asset.

Tab. 6: Results of estimations of logit models – probability of receiving a subsidy

Variables	Sample 4 (one instalment of the subsidy)		Sample 5 (one instalment of the subsidy)		Sample 6 (two instalments of the subsidy)	
	Parameter	***p*-value**	**Parameter**	***p*-value**	**Parameter**	***p*-value**
Added value$_{t-1}$	0.116	0.173	0.125	0.252	−0.072	0.154
(Added value$_{t-1}$)^2	−0.013	0.278	−0.0188	0.270	0.021	0.061
Size$_{t-1}$	1.263	0.000	1.315	0.001	3.908	0.000
(Size$_{t-1}$)^2	−0.053	0.001	−0.056	0.002	−0.183	0.000
Liabilities$_{t-1}$	0.775	0.067	0.966	0.039	1.087	0.055
Age$_{t-1}$	−0.125	0.227	−0.171	0.131	−0.178	0.176
Cash flow$_{t-1}$	0.0108	0.049	0.016	0.010	0.049	0.109
Sector (base level – industry)						
Construction	0.699	0.001	0.785	0.002	0.889	0.014
Other	−0.141	0.186	−0.123	0.303	−0.046	0.768
Constant	**−6.822**	**0.000**	**−6.937**	**0.001**	**−19.763**	**0.000**
Number of observations	1720		1354		850	
Pseudo R^2	0.023		0.027		0.035	
Balancing property	Fulfilled		Fulfilled		Fulfilled	
	Test statistics	***p*-value**	**Test statistics**	***p*-value**	**Test statistics**	***p*-value**
Linktest	−1.17	0.240	−1.09	0.274	−0.38	0.706
Hosmer–Lemeshow test	13.63	0.092	10.12	0.257	6.20	0.624

Source: Own study based on data from *Monitor Polski B*.
Legend: Mcfadden's Pseudo R^2 – balancing property described in the methodology; Linktest – a test checking the correctness of the functional form; the Hosmer–Lemeshow test – a test for the correctness of the functional form of the model.

treated group and the control pool. Nevertheless, these differences disappeared when the variable was scaled by the value of the balance sheet total, i.e. for the indicator of *productivity*. When there was no division of companies into groups (Table 5), the median of productivity-related variables was lower than the average, which means that more companies were characterised by lower levels of productivity than the average. After the separation of the companies according to interventions (Table 5), this was still observable. For the *rate of ROA* variable, the statistics seem to be distorted due to the occurrence of several extremely high outliers in each year; however, there was no evidence of these values being incorrect, so they were not removed from the research sample.

The average size of companies was characterised by a constant level throughout the entire studied period; moreover, the distribution of the variable broken down into subsidised and non-subsidised companies was similar. For the companies that were future beneficiaries of a subsidy, a higher debt ratio and a higher level of ROA and cash flow were noted, which proves the validity of the PSM approach, which allows the data to be matched in such a way that similar units can be compared.

In the logit model, in the case of numerous samples, discrete variables were also included in addition to continuous variables. Owing to the fact that an approval of an application for a subsidy may be related to the type of firm, the categories of the businesses were accounted for in the study. The division of the *sector* regressor into three levels was made on the basis of the Polish Classification of (Business) Activities 2007. The industry category as the base level encompasses sections B, C, D

and E; the construction category corresponds to section F and the 'other' category is assigned to sections G, H, I, J, L, M, N, P, Q, R and S.

$$\text{Sector} = \begin{cases} 0 - \text{if the company belongs to the industry category} \\ 1 - \text{if the company belongs to the construction category} \\ 2 - \text{if the company belongs to the category other} \end{cases}$$

5 Estimation results and verification of research hypotheses

This section describes the final stage of the study, consisting of the verification of research hypotheses formulated previously on the basis of economic theory and literature review. The results of estimates for the PSM model were presented, which allowed us to determine the impact of subsidies on individual indicators in medium-sized and large Polish companies.

Because of the insufficient number of observations in Samples 1 to 3 after matching, and thus the impossibility of reliable statistical inference, this article presents estimation results only for Samples 4, 5 and 6. Table 6 shows visible parameter estimates for individual models used to calculate *propensity scores* together with diagnostic test results. For each model, the results of Linktest led us to conclude that there were no grounds for rejecting the hypothesis about the correctness of the functional form; similarly, based on the high *p-value* in the Hosmer–Lemeshow test, there were no grounds for rejecting the hypothesis on the correct functional form of the model.

Table 7 presents the estimates of the magnitude of the average causal effect on treated units (ATT – the difference between potential results observed in the intervention and in the control treatment) for Sample 4, which included companies that received one-time (annual) support in the form of a subsidy between 2006 and 2009. The 'Better balance?' column provides information whether after performing the *t*-test for the equality of the mean of individual variables explained in two samples and after calculating the standardised bias of the variables, it was noticed that the balance of the sample improved after data matching. In turn, the column 'Are the results stable?' shows whether, based on the outcomes of the Rosenbaum Bounds test, it was found that the obtained results are free of latent bias, caused by the occurrence of unobservable factors that, at the same time, affect the potential results and the choice of the stimulated group. As noted by Caliendo, Hujer and Thomsen (2005), an analysis of sensitivity to insignificant ATT estimates does not make sense; therefore, it was skipped and the results were presented only in cases where the significance of the result variable was achieved at the level of 10% (statistics value $t \geq 1.64$).

In the case of stratification, diagnostics were applied in the form of calculating a standardised difference of the average values of the explained variables, which allowed us to determine the level of sample balance. In all Samples (4, 5 and 6), it was found that stratification consisting in sorting observations in an ascending order according to propensity scores and defining the layer so that the distribution of unit characteristics was balanced in each layer achieved a better balance of the studied groups. The above data only allowed us to study the stimulus effect after a year; therefore, Table A1 in Appendix shows the results of ATT estimates for Sample 5, which is less numerous, but enabled the evaluation of the effectiveness of the subsidy 2 years after the company received it. Estimates of the average causal effect treatment on units in the last Sample 6, which contained units that received a subsidy as part of a panel for 2 consecutive years, are presented in Table A2 in Appendix. In order to estimate the average effect of subsidies for companies, the area of the common range was used.

The common support area enables the elimination of companies that are a poor fit, ensuring that each unit has a chance to belong to both the treated and control groups. The number of groups used to calculate ATT varies depending on the proposed estimator; moreover, the requirements that must be met when using different estimators differ; therefore, the size of the treated group also changes. For example, for Sample 4, the number of groups that received the subsidy ranges from approximately 541 with the nearest neighbour with calliper method (0.25´SD) to 1070 with methods such as kernel and stratification. In the case of this article, when, before matching, there are fewer observations from the control group than from the stimulated group, using the nearest neighbour method

Tab. 7: Estimation of the mean causal effect treatment on treated units (ATT) for Sample 4

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Nearest-neighbour method (1:1) without replacement								
Productivity a year after the subsidy	0.069	0.077	0.071	647	647	0.91	No	–
DProductivity$t_{-1/}t_{+1}$	-0.333	0.052	0.055	647	647	-0.64		–
Asset rate growth$t_{/}t_{+1}$	-789,640	686,723	731,367	650	650	-1.15		–
ROAt_{+1}	4,017	2,846	2,721	554	554	1.41		–
DROA$t_{-1/}t_{+1}$	1,225	2,807	2,525	554	554	0.44		–
Nearest-neighbour method(1:1) with replacement								
Productivity a year after the subsidy	-0.293	0.100	0.102	1066	647	-0.29	Yes	–
DProductivity$t_{-1/}t_{+1}$	0.040	0.664	0.660	1066	647	0.61		–
Asset rate growth$t_{/}t_{+1}$	-164.064	263.881	142.815	1067	650	-0.33		–
ROAt_{+1}	2.046	1.818	1.845	919	554	1.13		–
DROA$t_{-1/}t_{+1}$	2.164	1.812	1.875	919	554	1.19		–
Nearest neighbour with calliper(0.25´SD) without replacement								
Productivity a year after the subsidy	0.059	0.082	0.816	631	647	0.71	No	–
DProductivity$t_{-1/}t_{+1}$	0.002	0.531	0.055	631	647	0.04		–
Asset rate growth$t_{/}t_{+1}$	-145.804	147.512	125.131	633	650	-0.99		–
ROAt_{+1}	3.823	2.914	1.999	541	554	1.31		No
DROA$t_{-1/}t_{+1}$	2.945	2.864	2.124	541	554	1.03		–
Nearest neighbour with calliper(0.1) without replacement								
Productivity a year after the subsidy	0.112	0.079	0.084	638	647	1.41	No	–
DProductivity$t_{-1/}t_{+1}$	-0.022	0.053	0.055	638	647	-0.42		–
Asset rate growth$t_{/}t_{+1}$	-164.339	143.685	164.803	640	650	-1.14	No	–
ROAt_{+1}	4.124	2.886	2.939	546	554	1.43		–
DROA$t_{-1/}t_{+1}$	1.314	2.846	2.643	546	554	0.46		–
Kernel matching								
Productivity a year after the subsidy	-0.006	0.075	0.065	1066	647	-0.08	Yes	–
DProductivity$t_{-1/}t_{+1}$	0.024	0.050	0.048	1066	647	0.49		–
Asset rate growth$t_{/}t_{+1}$	-82.209	149.109	91.829	1067	650	-0.55		–
ROAt_{+1}	1.511	1.765	1.632	919	554	0.86		–
DROA$t_{-1/}t_{+1}$	1.634	1.742	1.723	919	554	0.94		–

Continued **Tab. 7:** Estimation of the mean causal effect treatment on treated units (ATT) for Sample 4

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Stratification								
Productivity a year after the subsidy	0.001	0.074	0.073	1070	642	0.009		Yes
DProductivityt_{-1}/t_{+1}	0.021	0.050	0.049	1070	642	0.411		
Asset rate growtht_{-1}/t_{+1}	-97.280	102.287	97.256	1070	642	-0.951		
ROAt_{+1}	1.609	1.638	1.873	1070	642	0.983		
DROAt_{-1}/t_{+1}	1.703	1.623	1.588	1070	642	1.050		

Source: Own study based on data from *Monitor Polski B*.
Legend: ATT – average treatment of treated effect, stimulated sample – the number of units that received a subsidy; control sample – the number of units that did not receive a subsidy; better balance? – 'yes' means that after carrying out the *t*-test for the equality of the mean of individual variables explained in two samples and calculating the standardised bias of variables, it was noticed that the sample balance improved after using data matching, 'no' otherwise; are the results stable? – 'yes' means that based on the results of the Rosenbaum Bounds test, it was found that the obtained outcomes are free of latent bias, 'no' otherwise. ROA – return on asset; SD – standard deviation.

1: 1 without replacement leads to a worse balance of variables than before this procedure. Similarly, nearest neighbour with calliper (0.1) without replacement seems to be unsuitable for statistical inference due to the characteristics of the available data. Based on the results of the Rosenbaum Bounds test, it is found that the results are free of latent bias only for four out of the 17 significant estimates. One of the probable reasons why the obtained estimates cannot be considered stable may be omitting an important characteristic correlated with the assignment to the treated group or the result variable. Such characteristics may be unobservable or simply not present in the data set under examination. Based on the literature review, it can be expected that accounting for such variables as the number of company employees or information on the company's exports in the propensity model could have a positive impact on the results of the sensitivity analysis, but unfortunately such data was not available in this case. In addition, as noted by Smith and Todd (2005), high sensitivity of results to minor distortions may be caused by the small sample sizes used to estimate the effects of the program. It is also worth noting that the most significant estimates – as many as 15 – were recorded for Sample 5, mostly for the variables that examined the impact of subsidies after 2 years, not 1 year after receiving them, which may suggest the need for a long-term analysis.

In order to find the answer to the main research question posed in this article, one should start with the verification of the supporting hypotheses formulated in the introduction. The first supportive hypothesis (HP1) is that state aid in the form of subsidies allows companies to invest, thereby leading to the development and modernisation of their activities, which is reflected in the productivity of a given business. In both Sample 4 and Sample 6, all ATT estimates for the group of variables on company productivity a year after receiving the subsidy proved statistically insignificant, while in Sample 5, it was possible to obtain statistically significant but negative estimates for most variables measuring the level of productivity 2 years after receiving the financial aid. Accordingly, the first supporting hypothesis (HP1) was rejected. As noted by Bergström (2000), the lack of positive impact of subsidies, which were received from the state, may be related to the fact that subsidies may lead to allocative inefficiencies and type X inefficiencies,[2] caused by stagnation or the phenomenon of rent seeking. Furthermore, according to Bernini and Pellegrini (2011), businesspeople often make the decision to raise the number of employees in order to heighten the likelihood of receiving subsidies, which often results in a decrease

2 Type X ineffectiveness refers to a situation where producers, owing to the lack of competitive pressure, do not choose the cheapest method of producing the goods.

in productivity because of suboptimal employment. Another explanation for the lack of positive impact of subsidies on the productivity of companies, indicated by the same authors, may be the fact that having a choice between increasing investment and restructuring, under-subsidised companies mostly choose restructuring, which entails an productivity growth, while subsidised companies decide to invest, thus increasing production and employment.

According to the second hypothesis (HP2), the funds obtained by companies enable company growth, thus reducing the risk of doing business. Observing the results of the estimates for the asset growth rate, it can be seen that significant results were obtained only in four out of 24 cases, while based on the results of the Rosenbaum Bounds test, only for two of them, as we found a latent bias that negates the reliability of the obtained results. Therefore, the second supporting hypothesis (HP2) was rejected. Perhaps, the companies that did not receive subsidies did not give up investments but were forced to obtain funds by other means such as a bank loan and increasing the level of their assets.

The last examined indicator, ROA, is related to the third supportive hypothesis (HP3), i.e. the supposition that aid in the form of subsidies relieves the company's budget and reduces the risk of company's profitability loss. Of the 48 estimates obtained for this indicator in various samples and using different methods, only eight significant estimates were obtained and all of them were considered unstable based on the results of the Rosenbaum Bounds test; therefore, the third hypothesis (HP3) was rejected. Similar results were obtained by Tzelepis and Skuras (2004), who discovered that subsidised investments are ineffective, noting that even if market failure justifies the existence of subsidies, this does not mean that the funds received by businesses are allocated effectively. According to Ankarhem et al. (2009), the lack of subsidy impact on profitability ratios is closely related to the lack of their impact on productivity and casts doubt on the legitimacy of this instrument of state policy.

As all supporting hypotheses have been rejected, based on the obtained estimates, it was found that the subsidies granted to Polish companies did not significantly affect their productivity, size or profitability, which is the answer to the main research question (MQ1) of this article. The above results undermine the sense of using aid in the form of subsidies as a tool to improve companies' results. An interesting direction for future research is a verification of these results in a longer time perspective, as well as expanding the analysis with other result variables, such as revenue growth, innovation, market capitalisation and survival rates.

6 Conclusion

The article presents theoretical issues regarding the form of public aid, which is subsidies for companies, as well as a qualitative and quantitative review of empirical research, which was the basis for formulating the hypotheses and the research question. The aim of the study was to identify and assess the effectiveness of subsidies received by companies, as well as to develop a method for evaluating the effectiveness of subsidies related to the manufacturing sector of Polish economy. In order to systematise the outcomes obtained by researchers dealing with the efficacy of subsidies, meta-analysis, i.e. a quantitative evaluation of empirical literature, was carried out, which allowed the verification of the first hypothesis, mainly the study on the occurrence of the effect of selection of publications among the compiled articles. In the case of studies in which the impact of subsidies on productivity was examined, the above hypothesis was rejected, while for articles on the relationship between subsidies and the size of the company, there were no grounds for rejecting this hypothesis; there was a bias associated with the preference for publishing positive results.

Using panel data from the *Monitor Polski B* database covering the period between 2004 and 2012, for medium and large Polish enterprises, we created samples based on the patterns of received subsidies and estimated PSM models. The theories that are centred around market failure explain the validity of subsidies and point out potential problems related to their allocation and use. Based on theoretical issues and the outcomes of previous studies, it was not possible to establish a priori indicator of the relationship between subsidies and productivity, increase in size and profitability of companies.

Based on data analysis, it was observed that the average level of added value a year before the

distribution of subsidies clearly differed for the treated group and the control pool, while these differences decreased significantly when the variable was divided by the balance sheet total, i.e. the indicator of productivity. For companies that are future beneficiaries of subsidies, a higher level of debt ratio and a higher level of ROA as well as cash flow were noted, which suggests the legitimacy of the PSM approach, allowing data to be matched in such a way that similar units can be compared. The first stage of PSM was the estimation of logit models for constructed research samples. Sample 4 covered companies that received a single subsidy between 2006 and 2009 (and as a control group of firms that did not receive a single grant during this period); in this form, it was only possible to study the effect of the subsidy after a year; therefore, Sample 5 was used, which was less numerous but allowed evaluation after 2 years. The last Sample 6 included units that received a subsidy for 2 subsequent years. After the estimation of propensity scores, data were matched using methods such as nearest neighbour method (1:1) without replacement, nearest neighbour method (1:1) with replacement, nearest neighbour with calliper (0.25´SD) without replacement, nearest neighbour with calliper (0.1) without replacement, kernel matching and stratification. The output variables examined in this study were productivity, asset growth rate and ROAs. Considering that the use of the traditional PSM method may lead to biased results because individual factors are not taken into account, the PSM method with the difference in differences estimator was also used, which estimates the stimulus effect as the difference between the change in the value of the result variable (before and after intervention) for the treated and control groups.

Since the vast majority of obtained estimates were irrelevant, and only a few of them proved stable, all supporting hypotheses were subsequently rejected. Therefore, the answer to the main research question is subsidies for Polish companies did not affect their productivity, growth or profitability. In the literature, the lack of subsidy impact on business performance has been observed by many researchers and is usually explained by an inefficient allocation of resources: most often an excessive increase in employment resulting in a decrease in productivity and the phenomenon of rent seeking and lack of restructuring among the subsidised firms. Considering the volume of funds allocated to subsidies for companies every year, the above results are alarming and compel us to ponder on the legitimacy of these state support instruments. In light of the obtained results, it seems that an important direction for future research is to examine the effects of subsidies in the long-term perspective and expand the considerations with more result variables, such as revenue growth, innovation, market capitalisation and survival rates.

References

[1] Adorno, V., Bernini, C., & Pellegrini, G. (2007). The impact of capital subsidies: New estimations under continuous treatment. *Giornale degli Economisti e Annali di Economia*, 66(1), 67–92.

[2] Ankarhem, M., Daunfeldt, S.-O., Rudholm, N., & Quoreshi, S, (2009). Do regional investment grants improve firm performance? Evidence from Sweden. HUI Working Paper No 24, submitted to *Finnish Economic Papers*, 2009.

[3] Bergström, F. (2000). Capital subsidies and the performance of firms. *Small Business Economics, 14*(3), 183–193.

[4] Bernini, C., & Pellegrini, G. (2011). How are growth and productivity in private firms affected by public subsidy? Evidence from a regional policy. *Regional Science and Urban Economics, 41*(3), 253–265.

[5] Buigues, P., & Sekkat, K. (2009). *Industrial Policy in Europe, Japan and the USA. Amounts Mechanisms and Effecitivness*. UK: Palgrave Macmillan.

[6] Caliendo M., Hujer R. and Thomsen S. (2005). The Employment Effects of Job Creation Schemes in Germany: A Microeconometric Evaluation. IZA Discussion Papers from Institute of Labor Economics (IZA), 1512.

[7] Card, D., & Krueger, A. B. (1995). Time-series minimum-wage studies: A metaanalysis. *American Economic Review*, 85, 238–243.

[8] Cerqua, A., & Pellegrini, G. (2014). Do subsidies to private capital boost firms' growth? A multiple regression discontinuity design approach. *Journal of Public Economics*, 109, 114–126.

[9] Colombo, M. G., Croce, A., & Guerini, M. (2013). The effect of public subsidies on firm's investment-

cash flow sensitivity: Transient or persistent? *Research Policy*, 42(9), 1605–1623.

[10] Criscuolo, C., Martin, R., Overman, H., & Van Reenan, J. (2012). The causal effects of an industrial policy. NBER Working Paper No. 17842.

[11] DeHaven, T. (2012). Corporate welfare in the federal budget. *Policy Analysis*, No.703.

[12] Doucouliagos, H., & Stanley, T. D. (2009). Publication selection bias in minimum-wage research? A meta-regression analysis. *British Journal of Industrial Relation, 47*(2), 406–428.

[13] Duch, N., Montolio, D., & Mediavilla, M. (2007). Evaluating the impact of public subsidies on firm's performance: A quasi-experimental approach. Document de treball 2007/3 IEB.

[14] Gabriele, R., Zamarian, M., & Zaninotto, E. (2006). Assessing the economic impact of public industrial policies: An empirical investigation on subsidies. ROCK Working Papers 039, Department of Computer and Management Sciences, University of Trento, Italy, revised 12 Jun 2008.

[15] Geruzel-Dudzińska, B. (2016). Finansowanie inwestycji w środki trwałe w sektorze małych i średnich przedsiębiorstw w Polsce', *Contemporary Economy, 7*(1), 71–80, Electronic Scientific Journal.

[16] Girma, S., Görg, H., & Strobl, E. (2007). The effect of government grants on plant level productivity. *Economics Letters, 94*, 439–444.

[17] Glass, G. V. (1976). Primary, secondary and meta-analysis of research. *Educational Researcher, 10*, 3–8.

[18] Harris, R., & Trainor, M. (2005). Capital subsidies and their impact on total factor productivity: Firm-level evidence from Northern Ireland. *Journal of Regional Science, 45*(1), 49–74.

[19] Haley, U., & Haley, G. T. (2013). *Subsidies to Chinese industry: State capitalism, business strategy, and trade policy*. Oxford, England: Oxford University Press.

[20] Konarski, R., & Kotnarowski, M. (2007). Zastosowanie metody propensity score matching w ewaluacji ex-post. In A. Haber (Ed.), *Ewaluacja ex-post Teoria i praktyka badawcza*, Warszawa, Poland: PARP.

[21] Koski, H., & Pajarinen, M. (2013). Subsidies, the shadow of death and labour productivity. ETLA Working Papers, No.16.

[22] Lekki, M. (2013). Kto dostanie pieniądze z Unii w 2014 roku?, bankier.pl, 6 października 2013, Retrieved from http://www.bankier.pl/wiadomosc/Kto-dostanie-pieniadze-z-Unii-w-2014-roku-2954121.html [Access 20 May 2017].

[23] PARP (2009). Badanie efektów netto projektów wspierających wzrost konkurencyjności przedsiębiorstw.

[24] Roper, S., & Hewitt-Dundas, N. (1999). Grant assistance and small firm development in Northern Ireland and the Republic of Ireland. In *39th Congress of the European Regional Science Association: Regional Cohesion and Competitiveness in 21st Century Europe*.

[25] Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*, 41–183.

[26] Sissoko, A. (2013). R&D subsidies and firm-level productivity: Evidence from France. Institut de Recherches Economiques et Sociales (IRES) Discussion Paper 2011-2, Paris, France: IRES.

[27] Smith, J. A., & Todd, P. E. (2005). Does matching overcome Lalonde's critique of nonexperimental estimators? *Journal of Econometrics, 125*, 305–353.

[28] Strawiński, P. (2014). *Propensity score matching*. Warszawa, Poland: *Własności małopróbkowe*.

[29] Stanley, T. D. (2008). Meta-Regression Methods for Detecting and Estimating Empirical Effects in the Presence of Publication Selection *Oxford Bulletin Of Economics And Statistics*, 70, 1.

[30] Sudoł, S. (1999). *Przedsiębiorstwo, Podstawy nauki o przedsiębiorstwie. Teorie i praktyka zarządzania*, Towarzystwo.

[31] Trzciński, R. (2009). *Wykorzystanie techniki propensity score matching w badaniach ewaluacyjnych*. Warszawa, Poland: PARP.

[32] Tzelepis, D., & Skuras, D. (2004). The effects of regional capital subsidies on firm performance: An empirical study. *Journal of Small Business and Enterprise Development*, 11(1), 121–129.

[33] Tzelepis, D., & Skuras, D.(2005). Strategic performance measurement and the use of capital subsidies. *International Journal of Productivity and Performance Management*, 55(7), 527–538.

Appendix

Tab. A1: ATT estimates for Sample 5

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Nearest-neighbour method (1:1) without replacement								
Productivityt_{+1}	0.069	0.086	0.097	512	512	0.81	No	–
Productivityt_{+2}	-0.096	0.096	0.099	510	510	-1.00		–
DProductivity$t_{-1/}t_{+1}$	-0.028	0.062	0.065	512	512	-0.46		–
DProductivity$t_{-1/}t_{+2}$	-0.183	0.074	0.071	510	510	-2.46		No
Asset growth rate$t_{/}t_{+1}$	-37.100	16.131	15.791	513	513	-2.30		No
Asset growth rate$t_{+1/}t_{+2}$	9.971	34.773	35.496	513	513	0.29		–
ROAt_{+1}	0.888	0.998	1.125	513	513	0.89		–
ROAt_{+2}	1.156	0.711	0.810	412	412	1.64		No
DROA$t_{-1/}t_{+1}$	-1.777	0.826	0.815	513	513	-2.15		No
DROA$t_{-1/}t_{+2}$	-2.303	0.791	0.883	412	412	-2.91		No
Nearest-neighbour method (1:1) with replacement								
Productivityt_{+1}	0.039	0.109	0.098	837	512	0.36	Yes	–
Productivityt_{+2}	-0.165	0.140	0.132	836	510	-1.18		–
DProductivity$t_{-1/}t_{+1}$	0.080	0.075	0.078	837	512	1.06		–
DProductivity$t_{-1/}t_{+2}$	-0.112	0.111	0.105	836	510	-1.00		–
Asset growth rate$t_{/}t_{+1}$	-10.788	18.795	20.691	838	513	-0.57		–
Asset growth rate$t_{+1/}t_{+2}$	46.294	40.202	29.200	838	513	1.15		–
ROAt_{+1}	0.866	1,242	1,051	838	513	0.70		–
ROAt_{+2}	-0.268	0.829	0.678	696	412	-0.32		–
DROA$t_{-1/}t_{+1}$	0,817	1,009	1,053	838	513	0.81		–
DROA$t_{-1/}t_{+2}$	-0,034	0.923	0.809	696	412	-0.04		–
Nearest neighbour with calliper (0.25´SD) without replacement								
Productivityt_{+1}	-0.004	0.089	0.082	498	512	-0.04	Yes	–
Productivityt_{+2}	-0.157	0.102	0.102	496	510	-1.54		–
DProductivity$t_{-1/}t_{+1}$	-0.015	0.063	0.064	498	512	-0.23		–
DProductivity$t_{-1/}t_{+2}$	-0.161	0.080	0.084	496	510	-2.02		No
Asset growth rate$t_{/}t_{+1}$	-16.426	16.711	17.092	498	513	-0.98	Yes	–
Asset growth rate$t_{+1/}t_{+2}$	4.967	33.532	35.613	498	513	0.15		–
ROAt_{+1}	0.094	1.026	1.054	498	513	0.09		–
ROAt_{+2}	-0.245	0.693	0.726	400	412	-0.35		–
DROA$t_{-1/}t_{+1}$	-0.476	0.811	0.780	498	513	-0.59		–
DROA$t_{-1/}t_{+2}$	-1.222	0.760	0.700	400	412	-1.61		No

Continued **Tab. A1:** ATT estimates for Sample 5

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Nearest neighbour with calliper (0.1) without replacement								
Productivityt_{+1}	0.040	0.086	0.093	504	512	0.47	No	–
Productivityt_{+2}	-0.156	0.095	0.102	502	510	-1.64		No
DProductivity$t_{-1/}t_{+1}$	-0.043	0.062	0.056	504	512	-0.69		–
DProductivity$t_{-1/}t_{+2}$	-0.232	0.075	0.076	502	510	-3.07		No
Asset growth rate$t_{/}t_{+1}$	-27.875	15.225	15.800	504	513	-1.83		No
Asset growth rate$t_{+1/}t_{+2}$	38.180	35.767	37.686	504	513	1.07		–
ROAt_{+1}	0.807	1.007	1.021	504	513	0.80		–
ROAt_{+2}	1.141	0.723	0.693	405	412	1.58		No
DROA$t_{-1/}t_{+1}$	-2.055	0.829	0.957	504	513	-2.48		No
DROA$t_{-1/}t_{+2}$	-2.630	0.791	0.787	405	412	-3.32		No
Kernel matching								
Productivityt_{+1}	0.006	0.084	0.076	837	512	0.07	Yes	–
Productivityt_{+2}	-0.172	0.096	0.076	836	510	-1.79		Yes
DProductivity$t_{-1/}t_{+1}$	0.017	0.059	0.061	837	512	0.28		–
DProductivity$t_{-1/}t_{+2}$	-0.152	0.074	0.070	836	510	-2.05		Yes
Asset growth rate$t_{/}t_{+1}$	-15.013	15.632	15.744	838	513	-0.96		–
Asset growth rate$t_{+1/}t_{+2}$	35.051	31.372	27.829	838	513	1.12		–
ROAt_{+1}	-0.104	0.946	0.867	838	513	-0.11		–
ROAt_{+2}	-0.919	0.637	0.578	696	412	-1.44		–
DROA$t_{-1/}t_{+1}$	-0.209	0.760	0.733	838	513	-0.27		–
DROA$t_{-1/}t_{+2}$	-1.042	0.689	0.685	696	412	-1.51		–
Stratification								
Productivityt_{+1}	-0.001	0.080	0.089	831	515	-0.014		Yes
Productivityt_{+2}	-0.185	0.090	0.098	831	515	-2.068		
DProductivity$t_{-1/}t_{+1}$	0.007	0.059	0.067	831	515	0.112		
DProductivity$t_{-1/}t_{+2}$	-0.172	0.069	0.066	831	515	-2.492		
Asset growth rate$t_{/}t_{+1}$	-17.199	15.675	14.735	831	515	-1.097		
Asset growth rate$t_{+1/}t_{+2}$	22.340	30.035	33.496	831	515	0.744		
ROAt_{+1}	2.230	2.069	1.967	831	515	1.078		
ROAt_{+2}	-0.531	–	0.679	831	515	-0.782		
DROA$t_{-1/}t_{+1}$	1.608	2.040	2.033	831	515	0.788		
DROA$t_{-1/}t_{+2}$	-0.980	–	0.764	831	515	-1.284		

Source: Own study based on data from *Monitor Polski B*.

Legend: ATT – average treatment of treated effect; stimulated sample – the number of units that received a subsidy; control sample – the number of units that did not receive a subsidy; better balance? – 'yes' means that after carrying out the *t*-test for the equality of the mean of individual variables explained in two samples and calculating the standardised bias of variables, it was noticed that the sample balance improved after using data matching, 'no' otherwise; are the results stable? – 'yes' means that based on the results of the Rosenbaum Bounds test, it was found that the obtained outcomes are free of latent bias, 'no' otherwise. ROA – return on asset.

Table A2. ATT estimates for Sample 6

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Nearest-neighbour method (1:1) without replacement								
Productivityt_{+1}	0.112	0.115	0.125	302	302	0.98	No	–
DProductivity$t_{-1/}t_{+1}$	-0.112	0.090	0.084	302	302	-1.24		–
Asset growth rate$t_{/}$ t_{+1}	-87.850	55.623	49.382	307	307	-1.58		Yes
ROAt_{+1}	-14.994	18.085	20.287	307	307	-0.83		–
DROA$t_{-1/}t_{+1}$	-17.203	17.715	17.676	307	307	-0.97		–
Nearest-neighbour method (1:1) with replacement								
Productivityt_{+1}	0.099	0.140	0.132	537	302	0.71	Yes	–
DProductivity$t_{-1/}t_{+1}$	0.054	0.104	0.094	537	302	0.52		–
Asset growth rate$t_{/}$ t_{+1}	-23.802	100.150	45.168	537	307	-0.24		–
ROAt_{+1}	2.514	5.515	4.076	537	307	0.46		–
DROA$t_{-1/}t_{+1}$	2.886	5.567	3.619	537	307	0.52		–
Nearest neighbour with calliper (0.25´SD) without replacement								
Productivityt_{+1}	0.973	0.125	0.122	286	302	0.78	Yes	–
DProductivity$t_{-1/}t_{+1}$	-0.001	0.1026	0.114	286	302	-0.01		–
Asset growth rate$t_{/}$ t_{+1}	-89.562	59.594	47.787	288	307	-1.50		Yes
ROAt_{+1}	1.117	3.403	3.273	288	307	0.33		–
DROA$t_{-1/}t_{+1}$	0.775	3.474	3.030	288	307	0.22		–
Nearest neighbour with calliper (0.1) without replacement								
Productivityt_{+1}	0.118	0.118	0.123	299	302	1.57	No	–
DProductivity$t_{-1/}t_{+1}$	-0.046	0.093	0.094	299	302	-0.49		–
Asset growth rate$t_{/}$ t_{+1}	-63.818	-64.134	53.133	304	307	-1.00		–
ROAt_{+1}	2.096	3.238	3.386	304	307	0.65		–
DROA$t_{-1/}t_{+1}$	-0.448	3.304	3.275	304	307	-0.14		–
Kernel matching								
Productivityt_{+1}	0.044	0.109	0.102	537	302	0.40	Yes	–
DProductivity$t_{-1/}t_{+1}$	-0.196	0.084	0.092	537	302	-0.23		–
Asset growth rate$t_{/}$ t_{+1}	-19.336	62.620	33.639	537	302	-0.31		–
ROAt_{+1}	2.411	3.374	4.133	537	307	0.71		–
DROA$t_{-1/}t_{+1}$	2.533	3.430	3.428	537	307	0.74		–

Continued **Table A2.** ATT estimates for Sample 6

Variable	ATT	Standard error	Standard error (bootstrap)	Stimulated sample	Control sample	Student's *t*-test	Better balance?	Are the results stable?
Stratification								
Productivityt_{+1}	0.093	0.113	0.113	542	302	0.819		Yes
DProductivity$t_{-1/}t_{+1}$	-0.027	0.094	0.093	542	302	-0.288		
Asset growth rate$t_{/}$ t_{+1}	-21.846	31.758	35.329	542	302	-0.688		
ROAt_{+1}	1.945	3.393	3.231	542	302	0.573		
DROA$t_{-1/}t_{+1}$	2.196	3.446	3.437	542	302	0.637		

Source: Own study based on data from *Monitor Polski B*. Legend: ATT – average treatment of treated effect; stimulated sample - the number of units that received a subsidy; control sample – the number of units that did not receive a subsidy; better balance? – 'yes' means that after carrying out the *t*-test for the equality of the mean of individual variables explained in two samples and calculating the standardised bias of variables, it was noticed that the sample balance improved after using data matching, 'no' otherwise; are the results stable? – 'yes' means that based on the results of the Rosenbaum Bounds test, it was found that the obtained outcomes are free of latent bias, 'no' otherwise. ROA – return on asset.