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Journal of Policy Modeling 45 (2023) 895–909

www.elsevier.com/locate/jpm

The impact of public subsidies on investment and growth: Policy about evaluation, selection and monitoring

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Received 12 March 2023; Received in revised form 19 July 2023; Accepted 9 August 2023
Available online 16 September 2023

Abstract

Public subsidy, a frequently applied tool of economic development is often provided to the business sector assuming that it promotes investments, employment, and income generation. In this paper a micro economic model based empirical analysis is presented that shows the possible impact of public subsidy on economic growth. The outcomes are derived by investigating the investment decision of the enterprise with and without public subsidy. It is demonstrated that public subsidy may increase social welfare, but under certain circumstances it also may decrease it, partly because authorities deciding about them fail to consider the information on the investment projects that determines the outcome. The empirical analysis of corporate subsidies proves that both cases occur. The number of firms that performed well and presumably had not enough own resources to fund the investment was less than 10% of all subsidized firms. The programs had an overall negative impact on economic growth. We provide recommendations on how methods of evaluations, project selection and monitoring should be modified to achieve better results of subsidy programs.

JEL Classification: D22; D25; H25; H27; H43; H71; O12; O22; R38

Keywords: Public subsidy; Investment decision; Economic growth; Social welfare

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https://doi.org/10.1016/j.jpolmod.2023.09.003

1. Introduction

Public subsidy as a development instrument, its impact on the economy and usefulness is a debated issue. It is often regarded as a possible tool of accelerating economic development, while the main concern is that it distorts competition, provides advantage to some players and thus others lose markets, turnover, and profit. This aspect of public subsidy is regulated in international trade and investment agreements in the context of competition policy (Bourgeois et al., 2007) and is one of the fundamental pillars of the competition rules and the integrated internal market of the EU.[3]

Public subsidy is provided to a very wide range of investments and other development projects from start-up companies to innovation projects, to large firms implementing investments of multibillion-dollar budget. Public subsidy is most frequently applied in the field of.

a) the development of small and medium sized enterprises,
b) promoting innovation and
c) facilitating the catching up of less developed regions.[4]

The impact of public subsidy on income generation at social level, however, has not been in the focus of economic analysis, while the amount EU member countries spent on public subsidy exceeded 120.9 billion euros in 2019 or 0.76% of their GDP (European Commission, 2020), being 4.3% of the total private sector investment, exceeding 10% in some countries. Do public subsidies contribute to economic growth and enhancing competitiveness? When designing development programs that provide public funding to enterprises this is a key issue. Positive outcomes of economic development programs can hardly be imagined without a higher level of income generation even if the direct goal is to boost employment or develop specific regions. Measuring the change in social welfare should be an essential element of evaluations.

The main question we endeavor to answer in this study is: under what conditions do public subsidies increase social welfare? We also aim at addressing the following problems. How does public subsidy change the investment decision of entrepreneurs? Why do not the positive effects identified by several empirical studies at micro level add up at macro level? What can be the explanation of this apparent contradiction? How can the accuracy and relevance of evaluations of public subsidy programs based on comparing treated and non-treated companies be improved? Can public subsidy be an efficient tool of development programs? We present a model as a tool to find valid research results and provide policy recommendations on how the efficiency of development programs applying public subsidy as a tool can be improved.

[3] The Treaty on The Functioning of The European Union (TFEU) as a rule, does not allow subsidizing enterprises (point 1, Article 107, Aids Granted by States) putting the emphasis on avoiding distortion of competition affecting trade between member states.

[4] See among others the 11 investment priorities, also known as thematic objectives Title II Strategic Approach Chapter I Thematic objectives for the ESI Funds and Common Strategic Framework Article 9 Thematic objectives (regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013) that include strengthening research, technological development, and innovation, and enhancing the competitiveness of small and medium-sized enterprises (SMEs).

2. Literature overview

In the literature overview, we focus on the studies either providing empirical evidence or presenting theoretical models on the relationship between public subsidy and economic performance.

The experience of public subsidies is perceived differently in the literature. Some papers report basically positive impacts, while some present negative effects. Dvouletý et al. (2020) review studies investigating the effects of public grants on firm performance in the European Union's 28 member countries published since 2000, searching for the answer to the question if these public investments help supported firms to increase their performance and growth. The authors' findings show mostly positive outcomes of the grants on firm-survival, employment, tangible/fixed assets, sales/turnover with mixed findings for labour productivity and total factor productivity.

Bergström (1998) analysis assumes that subsidies can lead to higher total output through an increase in capital, labour or through total factor productivity. The author provides empirical evidence to support the assumption. Hartšenko and Sauga (2013) also find empirical evidence of the positive impact of government assistance (state aid) on sales revenue and labour productivity of supported firms. Based on comparing the most similar subsidized and non-subsidized firms by sector, using a modified Cobb-Douglas production function (Duch et al., 2009) conclude, that subsidies contribute to the more dynamic growth of production factors that are positively related to value added, so they consider it indirectly verified that the firms which receive a subsidy become more dynamic.

Bernini and Pellegrini (2011) evaluates the effects of a subsidy program implemented in Italy, that is based on a law enacted in 1992. The companies subsidized in the programme were selected through an open bidding process, while the available amount of subsidy wary by region and by time. The authors selected a control group that proved to be very similar to the treated group. Results are contradictory; subsidized firms achieve higher growth in output, employment, and fixed assets, but their Total Factor Productivity grows slower than that of unsubsidized firms. The authors conclude that negative impact on long term productivity and growth reduces the positive temporary effects of regional subsidies. The assumption of positive effect of public subsidies (state aid) on the performance of firms at microeconomic level is supported by Berlinger et al. (2017) based on the moral hazard model of Holmström and Tirole (1997) generalizing it for the cases when public subsidy is combined with private external funding.

Tunali and Fidrmuc (2015) presenting a Solow model based statistical analysis covering 27 European Union countries over the period 1992–2011 conclude that state aid (public subsidy) does not make a significant contribution to economic growth at macro level. Furthermore, their results indicate that public subsidy may affect investment positively only if political stability exist. Polemis and Stengos (2020) analyzed the relation of state aid and economic growth in 28 member countries of the in the 2002–2017 period and found that it is statistically significant and negative. To the contrary Poulou et al. (2023) detected positive correlation between state aid and economic growth arguing for a more active industrial policy in the EU. Abdelhafidh (2013) tests causality between financial sources and economic growth in four North African counties and finds that grants may have both positive and negative impact on economic growth. Empirical analysis of the Hungarian economy in 2004–2011 shows that there is no direct relationship between the volume of public subsidies and the volume of investment or employment at macroeconomic level (Kállay, 2014). Petreski (2022) used a matching method to evaluate an innovation oriented and a general development program in North Macedonia and found that the former had a measurable positive impact while the latter one failed to make any.

A part of the literature investigates the problem of input additionality and crowding-out[5] effect in a range of countries and regions (Aerts and Schmidt 2006). The results diverge, some studies conclude that there is no detectable crowding-out effect, others find that is exists. The results vary by country and by the method applied. The most frequently applied school of methods aims at comparing treated (subsidized) and non-treated (not subsidized) firms trying to find the 'nearest neighbors' that is the closest firms. Applying these methods (Aerts and Schmidt 2006), found indications that R&D funding may replace private investment, while in their later article Aerts and Schmidt (2008) concluded, that R&D subsidies in Germany generated input additionality, i.e., there was no evidence of crowding-out effect. Regarding R&D support expenditure examining Finnish data Einiö (2013) concluded that the aid schemes generated additional private R&D expenditure. Aiello et al. (2019) also applied a "quasi experimental" matching method to find out the impact of public subsidies on firms' R&D activity, and concluded, that supported firms spent more on R&D than non-subsidized firms, however the number of patents registered shows no significant difference between the two groups.

Focusing on the effect on employment of different types of business subsidies on a large sample of more than 15 000 Finnish firms (Koski & Pajarinen, 2010) found that there is a positive relationship between getting subsidies and employment growth, but the duration of the impact varies by subsidy type. R&D subsidies generate employment growth for one year, other types of subsidies for three years, and after three years the impact of subsidies vanishes, i.e., the difference between subsidized and not subsidized firms disappears. Investigating the role of public funding for R&D in the Eastern part of Germany Czarnitzki and Licht (2006) concludes that it is the driving force of R&D activity, and it may not crowd out the own resources of companies but financial market mechanisms are replaced by these public funds and most importantly they do not have a significant impact on the contents of R&D activities of East German firms. Daunfeldt et al. (2022) found no statistically significant effects on employment and firm-level demand for high human capital workers of two Swedish programs targeted toward growth-oriented SMEs. Based on the results of 77 studies from several countries on the relationship between public R&D subsidies and private R&D investment Zúñiga-Vicente et al. (2014) found considerable heterogeneity of empirical results that were explained by the methodological issues of the studies.

Interventionalist industrial policy may set meta level goals as proposed by Mazzucato (2011) in her popular book and criticized by the authors of Wennberg and Sandström (2022) form several points of view. State intervention may be targeted to lower level following more pragmatic approach, providing subsidies to individual companies for funding their development projects. Although most frequently innovation and R&D are in the focus of state interventions, there are programs with general approach as well aiming at higher employment and income generation. After summarizing the findings of previous studies on the impact of R&D subsidies Czarnitzky and Licht (2006) notes that "it remains to be investigated whether the high level of public R&D funding leads to a corresponding innovation success in terms of market shares and sales of new products in many of these publicly funded firms."

A case study on the impacts of state subsidies for Chinese firms (Hu et al., 2019) suggests that providing government subsidies encourages the over-investment of firms already having sufficient funds resulting in inefficiency, although the purpose of the program is rather to

[5] In our interpretation, the crowding-out effect is when public subsidies replace either internal or external private resources instead of being used as additional funding.

promote investment activities at firms that could not finance their investment from their own resources. A case study analyzing the effectiveness of R&D subsidies provided to Chinese firms (Boeing & Peters, 2021) found several negative experiences concerning the misuse of R&D development resources due to getting the subsidy after weak project selection and monitoring. The social welfare loss stems not only from the misuse of public R&D funds, but it also from crowding out private financing of R&D. Investigations expanding upon longer periods find that the impact of public subsidies are temporary implicating the possibility that after the direct impact of subsidies ceases to exist the performance of the subsidized companies returns to pre-subsidy level.

Evaluations not only provide contradictory results but often their reliability and objectivity can be questioned. Collin et al. (2022) miss objective and critical approach after analyzing several evaluations of Swedish innovation programs. A part of the literature applies indirect logic assuming that if more production factors are used by a firm, its performance grows proportionally. Since subsidies may stimulate utilizing more capital and labor this approach leads to the conclusion that they contribute to higher income generation.

3. Modelling the impact of public subsidy on social welfare

For our analysis, we define public subsidy – following the state aid[6] definition of the European Union – as a selective intervention by the state, through public resources provided to enterprises. We analyze the forms of public subsidy when funds are directly provided to enterprises as grant or tax exemption. The subject of this analysis is the investment project. $R(I)$ is net real return function of the project. The change of net real return is usually shown and analysed over time (see e.g., Osawa & Miyazaki, 2006). For our model, we look at it as a function of investment cost I. Investment includes all the costs needed for production and its occurrence is not limited to the initial period of the project. We refer to the capital invested in the project as real investment I_r as opposed to financial investment I_f, which is the other option for the entrepreneur. An investment project is defined by its return function $R(I)$, the length of implementation period t, and the amount of own capital of the enterprise A.

We assume that the marginal rate of return of each investment project is negative below a certain investment size, in other words the investment might be small enough not to yield positive marginal return. The cumulative return may, but not necessarily turns into positive. Ford et al. (2007) argue that if only rational economic actors make decisions the so called "valley of death" cannot emerge. We accept the authors' argumentation assuming the enterprise is a rational economic actor. The financial intermediary system offers γ real return rate to uninformed investors; this rate is exogenously given,[7] so the enterprise having A amount of capital can realize $((1+\gamma)^t - 1)A$ net return as an alternative to investing it into the project.

A project is *economically viable* only if the maximum of its return curve is at least as high as the amount of return the enterprise would receive for its capital as an uninformed investor.

The enterprise being aware of the return function, the length of the implementation period as well as the amount of its own capital makes an investment decision $0 \leq A_r \leq A$ on how much he would invest into the project from its capital, while the rest of its money is financial investment: $A = A_r + A_f$.

[6] In the context of this paper the notion of state aid in EU law and policy documents is the synonym of public subsidy.
[7] As assumed by Holmström and Tirole (1997)

The minimum investment at which the enterprise implements the project from its own capital is denoted by I_E satisfying $R(I_E) = ((1+\gamma)^t - 1)I_E \mid r(I_E) > 0$. Where $r(I)$ is the derivative of $R(I)$. The project is feasible from the entrepreneur's own capital if $A \geq I_E$. The maximum amount the enterprise would invest into the project is I_M beyond what the additional investment would yield less income for him than the return of by financial investment. The entrepreneur's goal is to maximize the return on its assets:

$$\max_{A_r} \{((1+\gamma)^t - 1)(A - A_r) + R(A_r)\}$$

with respect to $0 \leq A_r \leq A$.[8]

The investment decision of the enterprise without public subsidy A_r is the following.

Case 1 He does not invest into the project if $I_E > A$ (as an alternative accepts the return offered for uninformed investors), $A_r = 0$.
Case 2 He invests its total own capital A if $I_E \leq A \leq I_M$, $A_r = A$.
Case 3 He invests I_M if $A > I_M$ and for the rest of its own capital accepts the return offered for uninformed investors; $A_r = I_M$.

If the entrepreneur's own capital is less than the reasonably maximum investment size i.e. $A < I_M$, its project may produce more social return with additional capital provided by the state as public subsidy (S).

The government-controlled income redistribution system can find alternative investment to public subsidy outside the business sector. An alternative investment might be a development project, e.g., in the field of education, health care, infrastructure or better governance improving the efficiency of state's core activity. These development projects may produce positive social externalities embodied in either savings in social expenditure or increased income generation capacity of the economy. The highest annual return rate of alternative investments is the opportunity cost of public subsidy denoted by ω. We assume that the opportunity cost of public subsidy is proportional, so the opportunity cost of a public subsidy decision is $((1+\omega)^t - 1)S$.

The opportunity cost rate of public subsidy is higher than the return rate offered to uninformed investors; $\gamma < \omega$, since if the return of the best alternative development project were less than γ the state can decide not to provide public subsidy to enterprises saving the cost of additional funding which must be higher than the return offered to uninformed investors.

We also assume, that providing subsidy to the enterprise has no impact on the factors defining the project (return curve, implementation time and entrepreneur's own capital), and the enterprise is better informed about the factors defining the project (return function, implementation time and entrepreneur's own capital), than the state.

If receiving public subsidy, the enterprise may invest only a part of its own capital into the project (real investment) denoted by A_r^S. The rest of the entrepreneur's own resources A_f^S serve as financial investment yielding the return provided for uninformed investors; $A_r^S + A_f^S = A$. The investment size is $I = A_r^S + S$.

As opposed to the private financial resources the capital part of public subsidy is not to be paid back. When the enterprise invests form its own capital its return is only the net cash flow of the project.

[8] The maximum is taken by the Weierstrass Theorem.

The subsidy received by a company is booked as turnover, and it is recorded as deferred income and accrued expenses. The subsidy covers a pre-set proportion of the investment costs. Companies activate the subsidy proportionally with the amortization rate applied for the subsidized machinery or equipment. Consequently, they book additional turnover throughout the amortization period. Firms do not provide any service or product for the turnover received as subsidy; therefore, the total amount of subsidy is net income. With public subsidy, the entrepreneur's return is $R_S(S) = R(A_r^S + S) + S + ((1+\gamma)^t - 1)A_f^S$. Under realistic conditions this is radically higher than the return of the investment itself would be.

The Entrepreneur's goal is $\max_{A_r^S}\{R(A_r^S + S) + S + ((1+\gamma)^t - 1)A_f^S\}$ with respect to $0 \le A_r^S \le A$.

If the enterprise has no sufficient capital to implement the project with high enough return, a certain amount of S_E subsidy can make the project feasible. The project, however, may not yield positive income at social level. The amount of subsidy that is needed for the positive social level income effect is denoted by S_L.

Additional public subsidy would decrease social welfare if the alternative investment of public money would yield higher social return, that the marginal return of the investment into the project. The maximum reasonable public subsidy denoted by S_M.Public subsidy may have both positive and negative impact on social welfare. When the impact of an investment implemented with public subsidy increases social welfare the resource allocation is efficient, while if it decreases social welfare, it is inefficient resource allocation. An enterprise making rational decisions may accept public subsidy even if by doing so social welfare will decrease. The enterprise will make the following investment decisions depending on the volume of public subsidy offered to him.

1. If $S < S_E$ he rejects public subsidy and does not invest into the.
2. If $S_E \le S < S_L$ he accepts public subsidy and invests into the project, and by doing so decreases social welfare.
3. If $S_L \le S \le S_M$ the enterprise accepts public subsidy and invests into the project, and by doing so positive or neutral effect on social welfare.
4. If $S > S_M$ the enterprise public subsidy aid and invests into the project, and by doing so decreases social welfare.

Out of the above possible cases D1 means that there is no investment since cannot realize profits even if public subsidy is provided so the entrepreneur rejects it. D3 is the only case with positive gross change in social welfare, and the enterprise accepts public subsidy in this range. If public subsidy is in the range of D2 or D4 the enterprise accepts public subsidy, realizes private benefit (and the gross change in social welfare is negative). There are three possible types of inefficient resource allocation (IRA) cases as follows.

IRA Case1 The project is economically feasible, but the enterprise does not have sufficient capital to invest into the project $A < I_E$. If public subsidy is $S_E < S \le S_S$, the enterprise accepts the public subsidy and by doing so decreases social welfare. This can happen only in the early stage of the project.

IRA Case2 The project is not economically feasible, but public subsidy makes it attractive enough for the enterprise $S_E < S$.

IRA Case3 The project is economically feasible, but the public subsidy is too large $S > S_M$, and crowds-out private resources.

IRA Case 1 and 2 are both D2 decisions, i.e., public subsidy makes the project profitable for the enterprise. The difference is that in Case 1 the project is viable, but the subsidy is too small to reach the positive cash flow range, while in Case2, the project is not viable at all. IRA Case 3 happens when the entrepreneurs' decision is D4, that is at least a part of public funding is not needed to implement the project. If the entrepreneur accepts public subsidy while not spending a part of his resources internal crowding-out happens. It is reasonable to assume, that the entrepreneur prefers own resources to external funding from other privet sources, therefore if the own resources are crowded out, the so are the external resources. Dewatripont and Seabright (2006) define "wasteful spending" politicians engaging in projects that generate real benefits to their host economies but at a disproportionate investment cost. Cases 2 and 3 demonstrate how this can happen while providing private benefit for entrepreneurs. Providing public subsidy to the enterprise increases social welfare, if the entrepreneur's own funds are less than the optimal amount of investment into its project, and public subsidy is small enough not to reach the decreasing section of the return curve. So, the investment made by using the own funds of the enterprise and public subsidy increases both the return of the enterprise and social welfare. In this model, if the enterprise has sufficient own capital to implement the project, any amount of public subsidy decreases social welfare, since its opportunity cost is higher, than the return earned by the entrepreneur on its financial investment.

From the mode it concludes that the following three data adjustments are needed to get accurate information of the performance of subsidized companies.

Data adjustment 1 Turnover of the project and the implementing company is increased by public subsidy in the depreciation period by the amount of public subsidy. Total turnover of the investment project in the depreciation period: T_d, Turnover without public subsidy is $T_d - S$.

Data adjustment 2 Following adjustment 1, another adjustment is needed when evaluating profits of companies receiving public subsidy. Total profits of the investment project in the depreciation period: P_d, profits without public subsidy is $P_d - S$.

Data adjustment 3 There is a similar need for adjustment in terms of assets based on the same considerations. The assets of the company at the end of the depreciation period denoted by As_d the assets without public subsidy are $As_d - S$.

These adjusted indicators reflect the real performance of the investment project and the implementing companies providing a more objective database for evaluating the impact of public subsidy on the economy.

4. Empirical evidence about subsidized companies in Hungary

In this section we analyze the performance of a group of subsidized companies and attempt to identify the impact of subsidy on their income generation. The subject of the analysis is the business performance of Hungarian companies receiving state subsidy through open application procedures in 2016, registered in Hungary with more than HUF 12 million (approx. 43 thousand USD) annual turnover in 2016. The timeframe of the assessment is the 5-year period between 2016 and 2020. Companies receiving subsidies based on individual agreements are not included in this research. We selected the ones that pursue industrial activity and the project they received state subsidy for includes productive investment. The goal of the three subsidy programs were expanding the production capacity of small and medium sized companies by providing partial funding of the investments. We identified 1170 such enterprises.

4.1. Selecting the method

Our goal is to measure the effect of treatment on subsidized firms. The well-known problem is that the counterfactual outcome cannot be directly observed, therefore reference values are needed. When selecting the method, we also must consider the risk of selection bias. Selecting a random sample from non-treated companies for comparison would result in "reversed" selection bias, since project selection is part of the treatment, and it prefers firms with some features while excludes firms with some other characteristics, therefore the treated group is not a randomly selected set of firms. Comparing the treated firms to the most similar non-treated ones minimizes selection bias.

Several empirical investigations apply quasi experimental matching methods to address this problem (see e.g., Aerts and Schmidt 2006, Aiello et al., 2019, Petreski, 2022). We applied the 1 Nearest Neighbor algorithm to find a non-subsidized company for each subsidized firm from the same industry (two-digits ISIC). The set of non-treated firms used for matching consist of all the Hungarian companies 153433 companies registered in Hungary with more than HUF 12 million (USD 42,638) annual turnover, that submitted financial reports in every year between 2016 and 2020. The variables used for matching the pairs are the ones that determine the performance of a firm (1) net turnover, (2) equity, (3) profits after taxation, and (4) number of employees. All the variables were standardized, and the usual Euclidean distances were used. The values of these variables also measure firm size; therefore, the matched non-treated companies are likely close to their treated counterpart in this respect. We used observations at the beginning of the treatment period, i.e., in 2016. We left out the pairs where the nearest neighbor was not near enough, i.e., when the proportion of any corresponding matching indicator was more than threefold. After applying this filter 819 pairs remained. We use the group of matched non-subsidized firms as a control group with the highest possible similarity with the group of subsidized firms to estimate counterfactual outcome.

The variables characterizing the firms' performance are collected from their financial reports submitted to the e-governance system and made available through the corresponding website. The data on subsidies are published on another e-governance website.[9] Considering the available data, we used a suitable version of DID (Difference in Differences) to analyze the impact of subsidies. The counterfactual outcome is estimated by observing the corresponding performance indicators of non-treated firms. We use the following statistics to measure the treatment effect of providing subsidies.

Treatment effect on profits is denoted by

$$E_{\bar{P}} = \bar{P}^T - \bar{P}^{NT}$$

where $\bar{P}^T$ is the cumulative profit of all treated firms in the 2017–2020 period divided by their number. $\bar{P}^{NT}$ is the cumulative profit of all non-treated firms in the 2017–2020 period divided by their number.

Analogously, the treatment effect on wages in the 2017–2020 period is $E_{\bar{W}} = \bar{W}^T - \bar{W}^{NT}$.

Treatment effect on net equity accumulation is denoted by

[9] The data were collected checked and organized into two separate databases by Opten Ltd, a data-processing company, who kindly made it available for this research. All responsibility for the analysis, and the interpretation of results belongs to the authors. The financial report data of the firms are available at https://e-beszamolo.im.gov.hu/ and the data on grants is published on https://www.palyazat.gov.hu/.

$$E_{\bar{eq}} = (\bar{eq}^{T}_{2020} - \bar{eq}^{T}_{2016}) - (\bar{eq}^{NT}_{2020} - \bar{eq}^{NT}_{2016})$$

where $\bar{eq}^{T}_{2020}$ and $\bar{eq}^{T}_{2016}$ denote the average equity of treated firms in 2020 and 2016 respectively, and $\bar{eq}^{NT}_{2020}$ and $\bar{eq}^{NT}_{2016}$ are the same for non-treated firms.

None of the above treatment effects is necessarily positive neither at individual nor at group level. Project selection is part of the treatment process and authorities deciding on providing or rejecting to provide subsidy may select firms that perform poorly in the subsequent period. Furthermore, firms that are not confident enough about their future performance may apply for subsidy, and the project selection may find them suitable.

The direct income effect of subsidies is the amount of subsidy activated by treated company i in year t, i.e., $DI_{i,t} = SA_{i,t}$. As we explained in section describing the model, companies activate the subsidy proportionally with the amortization rate applied for the subsidized machinery or equipment, consequently, they book additional turnover in the amortization period, and the total amount of subsidy is net income. We do not have information on the individual accounting policy and the amortization rate they apply for the subsidized project. Since a very high proportion of the companies apply a seven-year amortization period, we assumed that they activate one seventh of the amount of the subsidy every year in the amortization period of the machinery or equipment they purchased partly from the subsidy. If a subsidized company had implemented the same development project without subsidy, its turnover, and profits in 2020 would have been smaller by one seventh of the subsidy the firm received. The direct income effect is first applied in the year after receiving the subsidy. We define net treatment effect as the difference between treatment effect and the average direct income effect in the period of 2017–2020.

$$NT(\bar{P}) = E_{\bar{P}} - \frac{1}{n}\left(\sum_{i=1}^{n}\sum_{t=2017}^{2020} DI_{i,t}\right)$$

where $n = 819$ after leaving out the pairs that are too remote.

4.2. Estimations on the treatment effect of subsidies

The[10] effect of treatment on the profits at group level is $E_{\bar{P}} = 21.2$ million HUF, i.e., the average cumulative profits of the subsidized companies in the 2017–2020 period was higher by this amount. Cumulative activated subsidy in the same period $\frac{1}{n}\left(\sum_{i=1}^{n}\sum_{t=2017}^{2020} DI_{i,t}\right) = 48.8$ million HUF. Since the direct income effect of the treatment was higher than the treatment effect the net treatment effect on profits is negative $NT_{\bar{P}} = -27.6$.

The treatment effect on wages is close to neutral $E_{\bar{W}} = -0.056$. The treatment effect on equity accumulation is $E_{\bar{eq}} = 46.7$ million HUF, what is slightly lower that the direct income effect, so the net treatment effect on equity accumulation is -2.1.

Net treatment effect and direct income effect show the two components of the business performance of subsidized firms. The former component is earned on the market and the latter one is gained as income transfer. Analyzing direct impact effect and net treatment effect by individual pairs we found that there are 368 pairs where the treatment effect is negative and 473 pairs where the net treatment effect is negative (see Table 1). The 105 pairs making the difference are the ones where the net income effect is higher than the treatment effect. There are

[10] The results of estimations are in million Hungarian forints (HUF).

Table 1
Number of pairs of treated and non-treated firm by positive/negative treatment and net treatment effect on profits.

Category	Treated firms with negative treatment effect	Treated firms with positive treatment effect	Total
Treated firms with negative treatment effect	368	105	**473**
Treated firms with positive treatment effect	-	346	**346**
Total	**369**	**451**	**819**

Source: authors' calculation

346 pairs where the net treatment effect is positive, i.e., where the performance of the treated companies proved to be better even without the net income effect. We define the following categories of pairs. C^+ pairs with positive net treatment effect (treatment effect is necessarily positive in this category); C^{+-} pairs with positive treatment effect but negative net treatment effect; C^-pairs with negative treatment effect (net treatment effect is necessarily negative in this category).

The average treatment effect in $C^+$is million HUF 270.9, million HUF – 215.5 in C^-while 28.0 in C^{+-} (see Table 2).

The average net treatment effect is in million HUF 224.7, million HUF – 263.8in C^-while – 30.6 in C^{+-} (see Table 3).

Equity accumulation also shows a diverse picture C^+ firms accumulated more equity than their non-treated counterparts (million HUF 250), and only one quarter of this amount was

Table 2
Average treatment effect of pairs of treated and non-treated firm by positive/negative treatment and net treatment effect on profits (million HUF).

Category	Treated firms with negative treatment effect	Treated firms with positive treatment effect	Total
Treated firms with negative treatment effect	-215.5	28.0	**-161.5**
Treated firms with positive treatment effect	-	270.9	**270.9**
Total	**-215.5**	**214.3**	**21.2**

Source: authors' calculation

Table 3
Average net treatment effect of pairs of treated and non-treated firm by positive/negative treatment and net treatment effect on profits (million HUF).

Category	Treated firms with negative treatment effect	Treated firms with positive treatment effect	Total
Treated firms with negative treatment effect	-263.8	-31.6	**-212.2**
Treated firms with positive treatment effect	-	224.7	**224.7**
Total	**-263.8**	**165.1**	**-27.6**

Source: authors' calculation

Table 4
Treatment effect on equity accumulation and its relation to the activated subsidies.

Category	Treatment effect on equity accumulation	Difference between equity accumulation and activated subsidies
C^{+}	200.6	154.4
C^{+-}	50.6	-9.0
C^{-}	-99.1	-147.3
Total	**46.7**	**-2.1**

Source: authors' calculation

Table 5
Estimated proportion of firms with sufficient amount of own resources to fund the investment in 2016.

Category	Firms with sufficient amount own resources to fund investment
C^{+}	76.9%
C^{+-}	43.8%
C^{-}	63.6%
Total	**66.7%**

Source: authors' calculation

funded by the direct income effect of subsidies (see Table 4). C^{-} firms accumulated less equity than their non-treated counterparts (million HUF –99.1), making the difference between equity accumulation and activated subsidies in this group million HUF – 147.3. In the C^{+-} category the treatment effect is positive but smaller than the amount of activated subsidies.

The model we presented earlier suggests that enterprises accept the subsidy even if they have sufficient own resources to fund the investment. We calculated the available own resources of the subsidized firms by adding up invested financial assets, securities, cash and subtracted short-term liabilities. We have no direct information on the amount of investment partly funded from subsidy, but we know that the typical subsidy proportion of the investment varies between 25% and 50%. Applying a conservative approach, we assume that if a firm had ten times as much own resources in 2016 as the amount of subsidy it received, there were sufficient own resources to fund the project. As is shown in Table 5 according to our estimation two-thirds of the subsidized firms had sufficient ow resources in 2016 to fund their investment. This proportion is the highest in the C^{+} category with 76.9% and the lowest in category C^{+-} with 43.8%.

The results imply that the (internal) dead-weight effect exists, and it is the strongest in the category of well performing firms making it very likely that investments in this group would have been made without subsidy as well. Earlier we defined the four possible decisions of a firm in a situation where it can accept or refuse subsidy. Now we can give our estimation on what decision groups identified in the analysis made. The 368 firms in group C^{-} (45% of the subsidized firms) made decision type 2 (D2), i.e., they accepted subsidy that made their project attractive enough at micro level though the direct income effect. The number of C^{+} firms that performed well and presumably had not enough own resources to fund the investment is 78 or somewhat less than 10% of all subsidized firms. They can be considered as the ones matching decision type 3 (D3), when income generation at social level increases if public subsidy is provided to and accepted by the firm. The number of C^{+} firms that presumably had enough own resources to fund the investment is 268 (35% of subsidized firms) made decision type 4 (D4) i.e., accepted the subsidy although they could have funded the investment project from their

own resources. The 105 firms in group C^{+-} (13% of the subsidized firms) are close to decision type 3 (D3) that is by accepting the subsidy they had very small impact on macro level income generation. We can also identify the number of resource allocation cases described in Chapter 5. 78 subsidy transactions resulted in efficient resource allocation, meaning they increased income generation at social level. 368 subsidy transactions resulted in inefficient resource allocation case 1 or 2 (IRA1 or IRA2), meaning the subsidy made the project attractive enough for the firm to implement it, but impact on income generation at macro level was negative. 268 subsidy transactions resulted in inefficient resource allocation case 3 (IRA3), meaning the public subsidy was not needed for implementing the project. In 105 cases the resource allocation was close to a neutral effect.

5. Conclusions and policy implications

The result of our empirical analysis is that the treatment effect at group level on profits is positive, while it is smaller than the direct income effect of subsidies. Since the treatment effect on wages is slightly negative, the total net treatment effect in terms of income generation is negative − 27.6 million HUF. Positive primary and negative net treatment effect on income generation may explain the phenomenon we discussed in the literature overview, namely that macro level analyses often do not find positive treatment effect on income generation, while micro level analysis does. The difference may be contributed to the net income effect of subsidies that improves the performance of individual companies but has no impact on income generation at macro level. So the overall impact of the subsidy programs were negative on economic growth.

There are two large groups of treated companies with significantly distinct character, and one smaller group in-between. The well performing treated companies generated higher profits even without the direct income effect of subsidies and accumulated more equity than the amount of activated subsidy as their non-treated counterparts. The poorly performing treated companied earned less profits than their non-treated counterparts and even the direct income effect of subsidies could not compensate their more modest performance. The small group in-between shows positive treatment effect but is smaller than the direct income effect of subsidies. A significant proportion of subsidized companies earn less profits from the market and are still in better competitive position on the short run than non-subsidized companies. The diversity in the performance of treated companies is in line with what our model implies about the investment decisions of enterprises if subsidy is available. We can see from the analysis that companies with relatively poor performance also apply for subsidy and receive it getting competitive advantage against non-subsidized companies. The results also imply that it is not realistic to generally assume that public subsidies boost or stimulate investments since the firms receiving them may have sufficient own resources when deciding on implementing a project.

1. For measuring the real impact of subsidies evaluators must consider their direct income effect otherwise the results are distorted in favor of the subsidized firms.
2. There are two options for governments that intend to implement development programs providing subsidy if they want to have a positive impact on economic growth. a) If the goal of the program is meant to be general economic stimulus, they must build up the capacity of telling the difference between projects that increase income generation at social level and the ones that do the opposite. They must get sufficient information on the key attributes of the investment projects: the net return function, the length of implementation period, and the

amount of own funds of the enterprise furthermore the opportunity cost of public subsidy and select the projects that are generate income at social level, and the applicants do not have sufficient funding for implementing them. b) If the program has specific goals like promoting innovation or regional development governments may accept the fact that, achieving them may entail less efficient investment projects partly funded from public subsidy. In these cases, there is an intentional trade-off between the preferred goal and the short-term economic performance at macro level. Measuring the short-term negative impact and compare it to the expected longer-term benefits should be an important part of program evaluation.

Funding

This work was supported by the National Research, Development, and Innovation Fund of Hungary, financed under the Research Excellence Program funding scheme, grant number NKFIH-869-10/2019.

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