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Do Business Subsidies Facilitate Employment Growth?

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Abstract:
We use data from 15 508 Finnish companies with 10 or more employees for the years 2003-2008 to explore the relationship between employment growth and three endogenously determined business subsidy types (i.e. employment subsidy, R&D subsidy and the group of other business subsidies). We find a positive contemporary relationship between all business subsidy types and employment growth. In addition, our findings suggest that R&D subsidies further contribute to the firms' employment for one year after and employment and other subsidies for three years after the reception of subsidies. After that, the differences between the subsidized and non-subsidized firms vanish. We further find in line with previous empirical studies that both product innovation and sales growth from a firm's old products contribute to the firm's employment growth. Innovation policy means successfully promoting product innovation should thus produce positive employment effects. Our empirical findings suggest that a positive employment effect of R&D subsidies is rather short-term though, and not likely a result of product innovation generated in the subsidized firms' R&D projects.

Keywords: Public subsidies ; enterprise policy ; industrial policy ; technology policy ; employment ; growth ; Finland

Jel codes: J23 ; L10 ; L53 ; O25 ; O33 ; O38

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1. Introduction

In industrial countries, various policy means are adopted to promote firm growth and employment creation.[1] Different government subsidy programs allocate money for companies to enhance firms' performance either directly or indirectly for instance via increased innovation. Although competition legislation in the European Union and many other economies prohibits state aid that has the potential to distort competition it does provide some exemptions that make various types of business subsidies eligible.[2] From the point of view of economics, subsidies should be only used to correct market failures or inefficiencies. The credit constraints of firms with growth potential may justify providing public funding for them. It may be particularly difficult for small and medium sized firms, recently established companies, or firms developing new technologies to raise funding from the private markets as, from the point of view of the private investors, the expected returns of a firm's activities may not fully cover the financing risks. Another justification for business subsidies are externalities. It seems justified to provide support for R&D projects in which benefits might spill over to other companies. In this case, though it would not be profitable for an individual firm to undertake the project without public support, the social benefits of the project exceed its costs.

Pressures to tighten government budgets in many countries stress the importance of the evaluation of the effectiveness of government subsidy programs. This study uses an extensive database of business subsidies in Finland during the years 2003-2008 combined with the firm-level data to explore the relationship between business subsidies and employment growth. [3] The data on 15 508 companies employing 10 or more employees and in total 74 601 observations are used in order to analyze whether different types of business subsidies (i.e. employment subsidies, R&D subsidies and the group of other types of subsidies) generate growth in firms' employment.

[1] Employment growth is also one of the top priorities on the EU policy agenda (see, e.g., Commission of the European Communities, 2010).

[2] See, e.g., article 107 of The Treaty on the Functioning of the European Union.

[3] Among the EU countries, total state aid for industry and services - excluding subsidies for agriculture, fisheries and transportation – as a percentage of GDP has been in Finland close to the EU-15 average during the sample years (Scoreboard data on state aid expenditures; http://ec.europa.eu/competition/state_aid/studies_reports/expenditure.html)

The strength of the reported study compared to the previously published articles concerning the effectiveness of business subsidies is that our data cover not only one subsidy program but all major subsidies allocated in one country during the sample years. This data feature allows us to study whether the observed complementarities of different subsidies (see Koski and Pajarinen, 2010) impact on the firms' performance. Furthermore, the firm-level dataset to which the subsidy allocation information is matched to, comprises the majority of firms in Finland. Thereby, our firm-level analysis of the effectiveness of subsidies basically captures the total business subsidy system of one country over six consecutive years.

The major methodological problem of the empirical studies aiming at evaluating the effectiveness of different public policies is that the selection to the subsidy programs is usually not random. It is not possible to find completely identical pairs to the treated units to observe what the outcome of the treated unit had been without the treatment. Non-random selection may also generate endogeneity of subsidies of which effect we try to assess. When the observed outcome is employment growth, endogeneity of a firm's subsidy reception may arise, for instance, if agencies aiming at generating employment growth via their allocated subsidies tend to select higher growth firms to the subsidy programs. Our analysis confirms that the variables capturing business subsidies are, indeed, endogenous, and we thus employ estimation methods taking into account endogeneity of the three subsidy variables.

We further investigate the dynamics of the relationship between business subsidies and employment by using the difference-in-differences estimation technique that removes biases that could originate from the permanent differences between the subsidized and non-subsidized firms and aggregate factors that would affect employment growth even in the absence of subsidies. In addition, to provide supplementary insight, we estimate a model focusing more directly on the relationship between innovation and employment growth. This model combines two streams of literature, one concerning the effects of public support on employment growth (see, e.g., Girma, et al. 2007) and the other inspecting the relationship between innovation and employment (see, e.g., Hall et al., 2008; Harrison et al., 2008).

The rest of the paper is organized as follows. Section 2 briefly discusses the relationship between business subsidies and employment in light of the arguments and findings of the previous empirical literature. Section 3 introduces the data and the variables used in the empirical analysis. Section 4.1 presents the econometric models, and Section 4.2 reports the estimation results and discusses the empirical findings. Section 5 concludes.

2. Why should business subsidies create new jobs?

There are two relevant streams of empirical literature explaining variation in the employment growth at the firm level. First, there are studies linking directly business subsidies and job creation (see, e.g., Girma, et al. 2007). Certain business subsidies are aimed at directly enhancing employment such as those allocated via the employment subsidy programs (see, e.g., Betcherman et al, 2010) and others may less directly (e.g., R&D subsidies) contribute to job creation (see, e.g., Ebersberger, 2004).

There is a vast literature comprising both theoretical and empirical approaches for evaluating the effectiveness of employment subsidies (see Brown et al. 2011, for a brief review of the literature). The literature has used two primary approaches to assess the effects of employment subsidies. First, there are studies that base their conclusions on the effectiveness of subsidies on the estimated elasticity of labor demand. The major shortcoming of this approach is that the elasticity of labor demand does not fully capture the employment effects of subsidies when subsidies are at least partly shifted to employees (see, e.g., Betcherman et al. 2010). Our study contributes to the second empirical stream of literature, which aims to directly measure the effectiveness of employment subsidies (see, e.g., Wren, 1994; Kangasharju and Venektolis, 2002; Girma et al. 2007). Furthermore, our analysis simultaneously captures the employment impacts of other major types of business subsidies of which relationship to employment has previously been studied separately (see, e.g., Ebersberger, 2004).

The empirical findings on the relationship between business subsidies and employment, which employ data from different subsidy programs at different time periods, are ambiguous. For instance, Betcherman et al. (2010) provides evidence of the positive employment effects of labor subsidies at the regional level. The firm-level study of Kangasharju and Venetoklis (2002), instead, finds that, though labor subsidies relate positively to employment, they displace the firms' own employment expenditures. Similarly, three empirical studies using Finnish firm-level data from different time periods draw contradictory conclusions about the role of R&D subsidies in a firms' employment growth. Ebersberger (2004), using data for the years 1994-2000, finds a significant positive relationship between R&D subsidies and employment. Kangasharju and Venetoklis (2002) and Koski (2010) (the former study using data for the years 1995-1998 and the latter for the years 1999-2003) do not find any statistically significant relationship between a firm's reception of R&D subsidies and its employment growth.

The other relevant framework for our analysis is the one exploring the relationship between innovation and employment (see, e.g., Hall et al., 2008; Harrison et al., 2008). This literature states that a firm's employment growth depends primarily on i) the firm's sales growth that is separated into the two parts, arising from the sales of old and new products and ii) the firm's new product and process innovations. The empirical evidence on the effects of innovation on employment growth is mixed (see, e.g., Brouwer et al, 1993; Doms et al. 1995; Klette and Forre, 1998; Peters, 2004). Also the theoretical modeling concerning the relationship of innovation and employment growth suggests a possibility of two opposite outcomes: new products and innovations increasing the quality of a firm's existing products may boost the firm's sales and consequently have a positive influence on its employment, but particularly process innovations enhancing labor productivity may, instead, negatively affect the firm's employment. The relationship between innovation and employment growth is not so straightforward, however, but it also depends on the market structure and the firm's strategic actions. If the efficiency gains from process innovation are mediated to consumers via lower prices, process innovation may increase demand for the firm's products and its employment. And if the firm sets, due to its temporary monopoly power gained via innovation, higher prices

that maximize its profits and reduces its output, the employment effect of product innovation may be negative.

Our study combines the above discussed streams of literature similar to the empirical study of Koski (2010) exploring the relationship between R&D subsidies, innovation and employment growth among the Finnish companies from 1999 to 2003. This study, however, investigates not only the role of R&D subsidies but also that of employment subsidies and mixture of other business subsidies (largely targeted to support firms' investments or enlargement activities) and their interactions in the firms' employment growth, and also uses a more recent and exhaustive firm-level database from 2003 to 2008 to explore the impact of business subsidies on employment. According to our knowledge, though prior studies acknowledge the existence of complementarities in the provision of business subsidies (see Koski and Pajarinen, 2010), none of the prior studies have explicitly analyzed whether these complementarities have any impact on the firms' performance.

3. Data

We use a database concerning the allocation of business subsidies in Finland during the period of 2003-2008 by the following four major organizations: Finnvera, Tekes (the Finnish Funding Agency for Technology and Innovation), the ministry of employment and the economy[4], and the ministry of agriculture and forestry. Finnvera is the largest provider of public support covering in 2008 about 64 percent of the total support allocated for companies. It offers loans, venture capital investments, and it is the only public provider of guarantees in Finland. Tekes allocating R&D grants and loans and the ministry of employment and the economy distributing employment subsidies and various different types of grants covered each about 17 percent of public funds targeted for firms. The share of the ministry of agriculture and forestry of public funding was relatively small, less than 4 percent of the total funds.

[4] The ministry of employment was established in the beginning of the year 2008 as a merger of the two ministries, ministry of trade and industry and ministry of labor. Prior to 2008, our data comprise the total public support of the two merged ministries.

Information on business subsidies as well as the financial data concerning the sampled firms during the years 2003-2008 have been extracted from the database of Statistic Finland. In addition, we use data from the Community Innovation Survey (CIS) from the years 2004 and 2006 - obtained also from Statistics Finland and combined with the other firm-level data - in our empirical analysis. Firms employing less than 10 persons are not included into our database. The compiled database provides a rich source of information concerning both the government agencies' allocation decisions of business subsidies and the official statistics concerning the functioning of the firms.

We explore the role of three different types of subsidies in the firms' employment growth: i) employment subsidies, ii) R&D subsidies, and iii) the group of other business subsidies comprising direct subsidies, loans and guarantees which are largely aimed at supporting firms' investments and enlargement activities. A subsidy that should directly facilitate employment growth is the employment subsidy distributed via the Ministry of Employment and the Economy and targeted for the firms hiring unemployed persons. Employment subsidies aimed at hiring an unemployed person vary between 430 and 770 euro per month – depending on the length of the unemployment prior to hiring and education of the employed person[5] - and can be obtained for up to 10 months. The variable EMPL_SUBSIDY captures the order of magnitude of the unemployment subsidy allocated for a firm at a given year.

R&D subsidies may contribute to a firm's employment indirectly and with some time lag via innovation, but the expansion of a firm's R&D activities due to subsidies may also result in a contemporary increase in the firm's employment. There are several selection criteria for the projects eligible for R&D subsidies, among which the most essential are high-quality, advanced technology and effective networking. The expected effects on employment, along with some other factors (such as turnover and exports), are also considered important (see Koski 2010 for a more detailed discussion on the evaluation criteria for the projects). A firm may receive multiple R&D subsidies for different projects within the year. We measure the order of magnitude of a firm's R&D subsidy at a given year by the variable RD_SUBSIDY.

[5] Longer period of unemployment and lower level of education increase the amount of subsidy a firm can obtain for hiring a person.

Various other business subsidies in Finland are also targeted for the expansion of the firms' activities but our data do not comprise detailed information on the objectives of other subsidies allocated by the major public support agencies. As the public agencies allocating business subsidies have other project selection criteria of which relative importance compared to the employment effects are not known to us, the importance of the other subsidies for employment growth can only be determined empirically. We use the variable OTHER_SUBSIDY to cover all other business subsidies a firm has obtained at a given year. These include loans and guarantees provided by Finnvera and the mixture of different subsidies of the Ministry of the Employment and the Economy and the Ministry of Agriculture and Forestry. It is unclear whether multiple simultaneous subsidies for a firm generate growth. To tackle this question, we use the interactions of the dummy variables for different subsidy types as the explanatory variables.

It is possible that subsidy variables are endogenously determined in the equation explaining variation in employment growth as firms showing higher employment growth may also be more likely to receive and/or tend to receive more subsidies. This may happen, for instance, due to the employment goals and picking-up-the-winners strategies of those who make the subsidy decisions. We tested endogeneity of the three subsidy variables using the total annual subsidy budget for each type of subsidy a firm applied for as an instrument. We first estimated a model that explains the potentially endogenous variable with all exogenous variables and instruments. The saved residual from the estimated model was then included as an additional explanatory variable in the model explaining employment growth as a function of set of exogenous and potential endogenous variables. The estimated coefficient for residual appeared to be statistically significant in case of all three subsidy types. We therefore treat all the business subsidy variables, RD_SUBSIDY, EMPL_SUBSIDY and OTHER_SUBSIDY as endogenous variables in our estimations.

Table 1 shows that employment subsidies are most common subsidy type though the order of magnitude employment subsidies in total is relatively low compared to the other types of subsidies.

- TABLE 1 HERE -

As our database includes each year about 10,000 companies which received no funding from the major providers of business subsidies, we can compare the subsidized companies to those that have no reported subsidy income. We measure a firm's employment growth by the relative change in the number of the firm's employees between year t and t-1 (variable EMP_GROWTH). Table 2 suggests that employment in the subsidized firms has clearly grown more, on average, than in the non-subsidized firms. It is an empirical question, however, whether the relationship between business subsidies and employment growth is statistically significant when other relevant factors are controlled for.

- TABLE 2 HERE -

We measure innovation by various variables. As the data concerning product and process innovation are available only for a limited set of firms and for only two time periods, we estimate the instrumental variable models for years 2003-2008 using a firm's R&D intensity (variable RD) as a measure of innovation. Here, the growth in the production of a firm's existing products is captured by the firm's turnover growth deflated by the industry level producer price index[6] (variable SALES_GROWTH) that is likely to be positively related to the firm's employment growth.

We further expand the analysis to study the role of the sales growth due to the new products (variable SALES_GROWTH_NEW), or product innovation, following the approach of Hall et al. (2008) using a substantially reduced dataset.[7] We divide a firm's sales growth into two parts, growth arising from old and new products. This division is made using the CIS survey reports on the share of a firm's turnover in the last year of the survey that is due to new or significantly improved products introduced in the last three years. We capture the impact of process innovation by the dummy variable PROCESS that gets

[6] For industrial companies, the deflator is a producer price index (PPI) at 2-digit level. For service firms, as we lack information from various service sectors and as about 70 percent of GPD comprises services, we use the GDP deflator to deflate the sales of service firms.

[7] However, as the endogeneity test of the sales growth variable suggest that the variable is not endogenous in the estimated equation, we treat the sales growth exogenous, unlike Hall et al. (2008), in our empirical estimations. We also replicate the estimations of Hall et al. treating the variable SALES_GROWTH_NEW as endogenous in one of the estimated equations (see Table 6, first regression equation).

value 1, respectively, if a firm reports that it has introduced new or significantly improved production process but not any new or significantly improved products in the three years of CIS survey, and 0 otherwise.

- TABLE 3 HERE -

Previous empirical studies suggest that also the ownership of a firm may affect its growth (see, e.g., Beck et al. 2005). We use dummy variable FOR_OWN and GOV_OWN to distinguish firms that are, respectively, foreign-owned and government-owned from other firms. A firm's size is controlled by the dummy variables MEDIUM, LARGE and XLARGE that capture the firm's size in its first observation year in the sample, and age by the variable AGE that is the log number of years since the establishment of the firm. We further control for time-, industry- and location-specific variation in the firm's employment growth by the dummy variables. Financial performance may also have an influence on growth.[8] We control for both the profitability (ROI) and financial strength (EQUITY). Table 3 summarizes the variables used in the empirical analysis.

Instrumental variables:

As the order of magnitude of subsidies a firm may receive is bounded and affected by the government's subsidy budgets for the agencies allocating different types of subsidies, we use the total annual budgets of subsidy types a firm has applied for as the instrumental variables for the endogenous subsidy variables (see, e.g., Wallsten, 2000, for a similar kind of approach). The instrumental variables are basically measured by the government budgets allocated for R&D subsidies (TOTAL_RD_SUBSIDY), employment subsidies (TOTAL_EMPL_SUBSIDY) and other subsidies (TOTAL_OTHER_SUBSIDY) in Finland at a given year for types of subsidies which a firm has applied for. TOTAL_EMPL_SUBSIDY has variability across firms only in relation to application phase: in the case of the applied firms the instrument gets the value of the government budget for employment subsidies and for the non-applied

[8] It can be argued that firms are in a continual struggle to grow, and only those with superior financial performance will be able to gain additional market share, see, e.g., Dosi, et al. (2008), Marsili (2001) and Metcalfe (1998).

firms the instrument gets the value of 0, respectively. In the cases of two other instrumental variables we have more variability across firms that have applied for the subsidies. We are able to distinguish three sub-types of R&D subsidies: direct subsidies, loans and capital loans. The instrumental variable TOTAL_RD_SUBSIDY covers the total budgets of R&D subsidy sub-types a firm has applied for. For instance, if a firm has applied for direct subsidies and capital loans, the variable TOTAL_RD_SUBSIDY has the value of total government budget of direct subsidies and capital loans for R&D at a given year. Again, if a firm has not applied for any R&D subsidy at a given year, the value of the instrumental variable is 0.

The group of other subsidies covers four different sub-types of subsidies as well, and we have applied similar methodology as in the case of TOTAL_RD_SUBSIDY to the calculation of the instrumental variable TOTAL_OTHER_SUBSIDY. In addition, all above mentioned exogenous variables are used as instruments.

4. Empirical analysis

4.1 The econometric modeling

We use different econometric approaches to tackle the relationship between business subsidies and employment growth. There are three major econometric approaches to evaluate empirically the effectiveness of business subsidies: the instrumental variable method, the difference-in-differences estimation and the matching approach. We believe that the instrumental variable model captures well the contemporary relationship between different business subsidies and employment growth, while the difference-in-differences method detects the employment effects of subsidies over time or after subsidy reception. The major reason why we use the difference-in-differences method rather than the matching approach is that we believe that the rich control dataset that can be used in the difference-in-differences analysis provides advantages over the greatly limited number of control variables that can be applied when using the matching method. Though our dataset is large, the firms are highly heterogeneous, and the pair-wise comparison of similar firms would lead to a

small sample size, even if the only control variables would be age, size, industry and location.

In the first approach, we estimate the following two-stage least squares random effects model to capture the dynamics of firm-level employment changes from 2003 to 2008 and to enable the presence of endogenous business subsidy variables:

$$EMP\_GR_{it} = \alpha_0 + \alpha_1 RD\_SUBSIDY_{it} + \alpha_2 EMPL\_SUBSIDY_{it} + \alpha_3 OTHER\_SUBSIDY_{it} + \alpha_4 S_{1it} S_{2it} + \alpha_5 S_{1it} S_{3it} + \alpha_6 S_{2it} S_{3it} + \alpha_7 S_{1it} S_{2it} S_{3it} + \sum_j \beta_j C_{it} + u_i + \varepsilon_{it}$$

(MODEL 1)

, where on the right hand side, the first three explanatory variables are the fitted values of endogenous subsidy variables received from the first-stage of the estimation in which the subsidy variables are explained by the instrumental variables. The next four variables are interaction terms of dummy variables denoting a firm's reception of different subsidy types. S_i are dummy variables distinguishing the firms that received a subsidy type i = 1 (R&D subsidy), 2 (employment subsidy), or 3 (other subsidy), from the other companies. For instance, $S_{1it}S_{2it}$ gets value 1 if a firm has obtained both an R&D subsidy and an employment subsidy and value 0 otherwise. The idea here is to check – based on our empirical findings on the strong complementarities of business subsidies allocated by different agencies (see Koski and Pajarinen 2010), whether different subsidies have, in addition to separate effects, complementary influence on employment. Vector C comprises j control variables added to the estimated equation.

We estimate Model 1 first for the whole sample. After that we use a sub-sample of firms with R&D activities. Thirdly, we divide the employment of firms in three groups by educational background, namely high (academic), medium (college-level) and low education classes. We then estimate the growth of employment separately in each of these classes. The idea is to compare whether subsidies

affect similarly to all firms compared to innovative firms, and further for the employment of workers with different educational backgrounds.[9]

In the second econometric approach, for testing the robustness of the results and for evaluating the impact of different time lags, we estimate the model using the difference-in-differences method. The difference-in-differences technique removes sample selection biases which are potentially originating from the observable and unobservable time-invariant differences that affect the firm's reception of subsidies, between the subsidized and non-subsidized firms and from the aggregate factors affecting employment growth. In the model the (log) level of employment of firms that received a certain type of subsidy in 2004 is compared to the (log) level of employment of firms that did not receive the subsidy in 2004. The sample is restricted to those firms that did not receive any subsidies in 2003. We do estimations using different after-subsidy years – i.e. years 2005, 2006, 2007 and 2008 – to investigate the presence of possible lagged effects of subsidies to the firms' employment.[10]

The equation that is estimated for two cross-sections, before- and after-subsidy year, can be written as follows (after dropping the firm-specific i-indicators for simplicity):

$$
\begin{aligned}
EMP = {} & \alpha_0 + \alpha_1 S_1 + \alpha_2 S_2 + \alpha_3 S_3 + \alpha_4 S_1 S_2 + \alpha_5 S_1 S_3 + \alpha_6 S_2 S_3 + \alpha_7 S_1 S_2 S_3 \\
& + \delta_0 dT + \delta_1 dTS_1 + \delta_2 dT2S_2 + \delta_3 dTS_3 + \delta_4 dTS_1 S_2 + \delta_5 dTS_1 S_3 + \delta_6 dTS_2 S_3 \quad \text{(MODEL 2)} \\
& + \delta_7 dTS_1 S_2 S_3 + \sum_j \beta_j C_j + u
\end{aligned}
$$

, where the variable EMP denotes log number of employees of a firm. Coefficients α_1, α_2 and α_3 capture differences in employment between the subsidized firms and other firms *prior* to the reception of a subsidy type. Likewise, the coefficients of the interaction terms of subsidy dummies measure

[9] We have information about educational backgrounds only for firms that have at least 20 employees and thus the sample size is slightly smaller in estimations regarding the growth of employment by educational background.

[10] As the difference-in-difference method requires observations from each firm both before and after the reception of subsidies, it eliminates the firms exiting the market by the observed after-subsidy year from the sample. It is possible that larger firms more likely remain in the sample, while those employing less people more likely drop out of sample causing possible bias to the estimation results. For robustness check we calculated the average size of firms in the different year samples and found only a slight increase in the average size. In 2006 sample, for instance, the mean of the number of employees was 45, and in 2008 sample the mean was 47, respectively.

differences between firms that have received different types of subsidies simultaneously and other firms prior to subsidy reception. The after-subsidy time dummy dT measures the time-related changes (due to certain aggregate factors) in employment that would occur without subsidies. Coefficients δ_1, δ_2 and δ_3 capture the effects of three subsidies at after-subsidy year d2. Similarly, δ-coefficients for the interaction terms measure the after-subsidy effects of simultaneously received subsidies. Vector C comprises j other control variables added to the estimated equation.

In the third econometric approach, we replicate the study of Hall et al. (2008), by estimating the relationship between innovation and employment growth using the 2SLS model for the pooled data (MODEL 3)[11]. In this model, the sales growth due to old products is deducted from the dependent labor growth variable, and the endogenous sales growth due to new products variable is used in addition to the process innovation dummy to explain variation in the employment growth:

$$EMP\_GRH_{it} = \alpha_0 + \alpha_1 SALES\_GR\_NEW_{it} + \alpha_2 PROCESS_{it} + \varepsilon_{it}$$

(MODEL 3)

, where the dependent variable EMP_GRH is measured as in Hall et al. (2008): employment growth rate less real sales growth due to old products[12]. As in our data, according to the endogeneity test, the sales growth variable is not endogenously determined, we estimate the Hall et al. (2008) model, alternatively, using the OLS model with the exogenous sales growth. Thirdly, we further estimate the model with the 2SLS method using the endogenous business subsidy variables and other control variables as the additional explanatory variables. The idea of replicating the estimations of Hall et al. (2008) is to explore whether the Finnish data produce similar results with Hall et

[11] See Hall et al. (2008) for the details of the theoretical model producing the estimated equation. They presented several versions of the estimation model in the paper. We use in the estimation the model version which they eventually preferred.

[12] We measure all continuous variables in this model as three year moving averages. Real sales growth due to old products is calculated as $g_{old} = (1-s)g-s$, where g is real sales growth, and s is the share of a firm's turnover that is due to new or significantly improved products. Respectively, real sales growth due to new products is SALES_GR_NEW = s(1+g).

al. (2008) using Italian data and Harrison et al. (2008) using data from France, Germany, Spain and the UK. Further, the estimation of model with the number of control variables tests the robustness of the results when various potentially relevant control variables are added to the simplified model.

4.2 Empirical findings

The estimation results of the two-stage least squares random effects model suggests that all subsidy types relate positively and statistically significantly to the employment growth at the year of subsidy reception (see Table 4). The relationship between R&D and employment subsidies and employment growth seems to be similar among all sample firms and among firms reporting R&D expenditures, while other subsidies have no statistically significant impact among the sample of firms with R&D activities. The estimations among employees with different educational backgrounds do not bring much new information about the effects of individual subsidy types on employment growth.

The coefficients of interaction terms of the subsidy variables do not appear statistically significant in the whole sample. In the sample of firms with R&D activities only, the interaction of R&D subsidy and employment subsidy gets negative and statistically significant coefficient. The separate estimations for the employment growth of employees with low, medium and high educational level show some differences. It seems that when employment subsidies complement R&D and other subsidies, it has positive relation to the employment growth of the relatively highly educated persons in firms. The employment of persons with low educational level is not notably affected by complementary subsidies, except for the interaction of R&D subsidy and other subsidy. This combination relates negatively to the employment growth of persons with low educational level.

When we look at the other control variables, it is interesting to note that both foreign-owned and government-owned dummy variables get positive signs. Beck et al. (2005) also find that foreign-owned firms tend to grow faster, but in contrast to our results, they report that government-owned firms tend to grow slower than other types of firms. Their measure of firm growth was different from ours though – i.e. the sales growth - which may partly explain the

difference in the results. They neither had any observations from Finland in their sample of 54 countries. We also find that sales and capital growth, medium and large initial size, and profitability are positively related to employment growth, while equity ratio, age and R&D intensity are negatively related to employment growth. The sign of the coefficient of R&D intensity variable is, however, positive in the estimations among the sample of firms with R&D activities. This hints that firms with no reported R&D expenditures have generally grown more in terms of their employment than the firms with R&D activities, while among innovative firms, those firms with higher R&D intensity tend to have a higher employment growth.

- TABLE 4 HERE -

The difference-in-differences estimations (Table 5) provide interesting complementary information on the dynamics of the relationship between subsidy reception and employment growth. The estimated coefficients of the R&D and employment subsidy dummy variables capturing the differences between the subsidized firms and others prior to the reception of subsidies are positive and statistically significant indicating that the firms that receive R&D and employment subsidies tend to be larger or employ more people than other firms *prior* to their subsidy reception.

- TABLE 5 HERE -

The interaction terms of the three subsidy dummy variables and the time dummy one year after the employment subsidy get all positive and statistically significant coefficients. The estimated coefficients of interaction of R&D subsidy dummy with the year dummies two or more years after the subsidy are not statistically significant. These results hint that though R&D subsidies affect the firms' employment clearly positively in the short-run, their impact do not expand longer than one year after the reception of the subsidy. Instead, employment and other subsidies appear to statistically significantly contribute to employment

for three years following the reception of subsidy, while their impact has vanished by the fourth year after subsidy.

The interaction terms of multiple simultaneous support reception and time dummies are not statistically significant indicating that complementary subsidies have no notable employment effects beyond the year of subsidy reception.

The variable SALES_GROWTH (see table 4) and the variable SALES_GROWTH_NEW (see Table 6) both get a highly significant positive coefficient. These findings are in line with the empirical studies of Hall et al. (2008) and Harrison al. (2008) and, interestingly, also the estimated orders of magnitudes of coefficients of the two variables are close to those that the two previous studies report. The good news for the previous studies - that had no data to control for capital - is that the inclusion of the order of magnitude of a firm's total assets, as well as other control variables, to the estimated model does not notably affect the estimation results of the key explanatory variables. Likewise, we find that process innovation does not relate significantly to the employment growth.

- TABLE 6 HERE -

It is possible that R&D subsidies also indirectly, via their effect on product innovation and sales growth, contribute to the employment. If R&D subsidies result in product innovation that is materialized generating a substantial increase in sales growth, the sales growth due to product innovation variable should have a larger coefficient among the sample of R&D subsidized firms. We tested this hypothesis by re-estimating the models presented in Table 6 with the sample of firms restricted to those that had received R&D subsidies one to three years prior to the year of observation[13]. The estimated coefficient of the variable SALES_GROWTH_NEW got, contrary to our expectation, clearly a smaller value (0.615) than it got among all firms hinting that product innovation had a

[13] Estimation results are available from the author. The restriction of sample to the firms that received subsidies one to three years prior to the year of observation was done to allow a (max) three years' time lag between a firm's reception of R&D subsidy and product innovation resulting in sales growth.

smaller role in the employment growth of R&D subsidized firms than among other firms.[14]

5. Conclusions

This study utilizes 74 601 observations from 15 508 Finnish companies with 10 or more employees from the years 2003-2008 to explore the relationship between employment growth and three endogenously determined business subsidy categories (i.e. employment subsidy, R&D subsidy and the group of other business subsidies). We find a clearly positive contemporary relationship between employment growth and both employment and R&D subsidies, while the relationship between other types of subsidies and employment growth is somewhat weaker. A more detailed analysis reveals that the receivers of R&D subsidies also grow more than other firms one year after the reception of subsidy, but their employment level during the following three years do not deviate statistically significantly from their before-subsidy employment level. The receivers of employment and other subsidies, instead, show higher post-subsidy employment levels for the three years following the reception of subsidy.

Overall, our findings suggest that business subsidies contribute to the firms' employment for one to three years after the reception of subsidy. After that, the differences between the subsidized and non-subsidized firms vanish. When employment subsidy complements R&D and other subsidies, it seems to promote contemporarily employment growth of the relatively highly educated persons. Complementary subsidies do not seem to have any impact on employment beyond the year of subsidy reception.

We further find in line with prior studies of Harrison et al. (2008) and Hall et al. (2008) that both product innovation and sales growth from a firm's old products contribute to the firm's employment growth. Process innovation, instead, does not seem to have any significant effect on employment. Innovation policy means successfully promoting product innovation should thus produce positive employment effects. Our empirical findings suggest that a positive employment

[14] We also observe that in Table 4, the coefficient of SALES_GR variable is smaller in the estimations among sample of firms with R&D activities than among all sampled firms.

effect of R&D subsidies is rather short-term though, and not likely a result of product innovation generated in the subsidized firms' R&D projects.

Our empirical findings concerning the relationship between business subsidies and employment growth should be assessed in the context of the overall objects of business subsidies. Employment growth is one of the key objectives of industrial and technology policy but certainly public agencies target business subsidies to various other objectives such as the firms' expansion of business activities and innovation. Therefore, to provide a more comprehensive picture of the overall impacts of different subsidies, it would be an interesting further object for the analysis to expand it to assess the effectiveness of business subsidies in regard to their other possible objectives.

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Table 1. Allocation of business subsidies, 2004-2008

		Number of firms (subsidies allocated in total, million euros, deflated by GDP price deflator, 2000 = 100)					
	Year	2003	2004	2005	2006	2007	2008
Subsidy type	R&D subsidy	462 (127)	499 (145)	461 (145)	457 (148)	409 (138)	368 (125)
	Employment subsidy	1 551 (10)	1 627 (12)	1 606 (12)	2 298 (14)	2 295 (16)	2 163 (16)
	Other subsidy	1 441 (404)	1 427 (466)	1 364 (452)	1 294 (464)	1 076 (398)	1 153 (399)
	No subsidy	11 057	10 610	10 422	9 752	9 768	9 863

Table 2. Employment growth of firms at the year of subsidy reception vs. growth of non-subsidized firms, %

Subsidy type				
Year	R&D subsidy	Employment subsidy	Other subsidy	No subsidy
2003	2.28	5.34	0.90	-2.80
2004	4.28	6.66	3.00	-1.95
2005	5.91	6.75	2.99	-1.45
2006	5.05	7.01	6.55	-0.08
2007	7.36	7.94	5.87	0.23
2008	3.53	4.05	1.42	-2.12
Average	4.74	6.29	3.46	-1.36

Table 3. Description of the variables

Description of variable	Variable name	Mean	Standard deviation	Number of obs
Dependent variables:				
The relative change in the number of firm's employees between year t and t-1.	EMP_GR	0.001	0.273	74601
Log number of employees.	EMP	3.145	1.234	74601
Employment growth rate less real sales growth due to old products (ref. Hall et al. 2008)	EMP_GRH	0.045	0.263	3772
Explanatory variables:				
R&D intensity = log firm's annual R&D expenditures divided by a firm's turnover (public R&D subsidies subtracted)	RD	-13.933	3.285	74601
Dummy variable that gets value 1 if a firm has introduced new or significantly improved production process but not any new or significantly improved products in the three years of CIS survey, and 0 otherwise	PROCESS	0.124	0.330	3772
Log firm's R&D subsidy obtained from Tekes relative to its turnover at a given year.	RD_SUBSIDY	-14.542	2.423	74601
Dummy variable that gets value 1 if a firm has received R&D subsidy at the treatment year (2004) in dif-in-dif estimations, and 0 otherwise.	D_RD_SUBS	0.038	0.191	12728
Log firm's employment subsidy obtained from the ministry of employment and the economy relative to its turnover at a given year.	EMPL_SUBSIDY	-13.699	3.150	74601
Dummy variable that gets value 1 if a firm has received employment subsidy at the treatment year (2004) in dif-in-dif estimations, and 0 otherwise.	D_EMPL_SUBS	0.124	0.329	12728
Log firm's other public business subsidies obtained at a given year.	OTHER_SUBSIDY	-13.774	3.744	74601
Dummy variable that gets value 1 if a firm has some other public business subsidy at the treatment year (2004) in dif-in-dif estimations, and 0 otherwise.	D_OTHER_SUBS	0.110	0.313	12728
Interaction term that gets values 1 if firm received R&D subsidy and employment subsidy at a given year, and 0 otherwise.	RDSxEMPS	0.008	0.089	74601
Interaction term that gets values 1 if firm received R&D subsidy and other subsidy at a given year, and 0 otherwise.	RDSxOTHS	0.010	0.102	74601
Interaction term that gets values 1 if firm received employment subsidy and other subsidy at a given year, and 0 otherwise.	EMPSxOTHS	0.025	0.156	74601
Interaction term that gets values 1 if firm received R&D subsidy, employment subsidy, and other subsidy at a given year, and 0 otherwise.	RDSxEMPSxOTHS	0.003	0.056	74601
The relative change in the firm's sales between year t and t-1.	SALES_GR	0.051	0.363	74601
Firm's sales growth due to new products.	SALES_GR_NEW	0.088	0.205	3772
The relative change in the firm's total assets between year t and t-1.	CAPITAL_GR	0.062	0.353	74601
Dummy variable that gets value 1 if firm has in its first observation year in the sample 50-250 employees, and 0 otherwise.	MEDIUM	0.144	0.351	74601
Dummy variable that gets value 1 if firm has in its first observation year in the sample 250-1000 employees, and 0 otherwise.	LARGE	0.032	0.177	74601
Dummy variable that gets value 1 if firm has in its first observation year in the sample over 1000 employees, and 0 otherwise.	XLARGE	0.006	0.079	74601
Log firm's age.	AGE	2.720	0.772	74601

Return on investment	ROI	0.178	0.350	74601
Equity ratio	EQUITY	0.414	0.273	74601
Dummy variable that gets value 1 if firm has a foreign owner, and 0 otherwise.	FOR_OWN	0.086	0.281	74601
Dummy variable that gets value 1 if firm is owned by government or municipality, and 0 otherwise.	GOV_OWN	0.022	0.149	74601
+ 17 industry dummies + regional dummies for 5 provinces in Finland + year dummies for 2004-2008				

Table 4. The estimation results of the two-stage least squares random effects model for employment growth

Dependent variable: EMP_GR					
	ALL FIRMS EMP_GR Coef./S.E	R&D FIRMS EMP_GR Coef./S.E	ALL FIRMS HI_ED_GR Coef./S.E	ALL FIRMS MID_ED_GR Coef./S.E	ALL FIRMS LOW_ED_GR Coef./S.E
RD_SUBSIDY	0.004 ***	0.004 ***	0.004 **	0.000	0.004 **
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
EMPL_SUBSIDY	0.006 ***	0.005 ***	0.004 ***	0.003 ***	0.005 ***
	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]
OTHER_SUBSIDY	0.001 *	-0.000	0.002 **	-0.000	0.002 *
	[0.000]	[0.001]	[0.001]	[0.000]	[0.001]
SALES_GR	0.322 ***	0.234 ***	0.114 ***	0.166 ***	0.164 ***
	[0.003]	[0.006]	[0.006]	[0.003]	[0.007]
CAPITAL_GR	0.096 ***	0.119 ***	0.066 ***	0.130 ***	0.144 ***
	[0.003]	[0.007]	[0.005]	[0.003]	[0.006]
RD	-0.003 ***	0.001 *	-0.001 **	-0.000	-0.000
	[0.000]	[0.000]	[0.001]	[0.000]	[0.001]
MEDIUM	0.019 ***	0.006	0.047 ***	-0.013 ***	-0.034 ***
	[0.003]	[0.006]	[0.005]	[0.003]	[0.006]
LARGE	0.013 *	-0.025 ***	0.042 ***	-0.022 ***	-0.060 ***
	[0.006]	[0.009]	[0.010]	[0.006]	[0.012]
XLARGE	-0.003	-0.043 ***	-0.027	-0.062 ***	-0.095 ***
	[0.013]	[0.016]	[0.021]	[0.012]	[0.024]
ROI	0.008 ***	0.039 ***	0.005	0.012 ***	0.015 **
	[0.003]	[0.007]	[0.005]	[0.003]	[0.006]
EQUITY	-0.023 ***	-0.000	0.009	0.007 *	-0.012
	[0.004]	[0.009]	[0.007]	[0.004]	[0.008]
AGE	-0.014 ***	-0.013 ***	-0.002	-0.008 ***	-0.015 ***
	[0.001]	[0.003]	[0.002]	[0.001]	[0.003]
FOR_OWN	0.018 ***	0.021 ***	0.024 ***	0.001	0.010
	[0.004]	[0.007]	[0.006]	[0.004]	[0.007]
GOV_OWN	0.026 ***	0.041 ***	0.029 **	0.008	-0.010
	[0.007]	[0.012]	[0.012]	[0.007]	[0.014]
RDSxEMPS	-0.024	-0.046 **	-0.011	0.027 *	-0.020
	[0.016]	[0.018]	[0.028]	[0.016]	[0.032]
RDSxOTHS	-0.018	-0.012	0.010	0.014	-0.053 *
	[0.014]	[0.017]	[0.026]	[0.015]	[0.029]
EMPSxOTHS	0.006	0.008	0.005	0.018 **	0.015
	[0.008]	[0.015]	[0.014]	[0.008]	[0.016]
RDSxEMPSxOTHS	0.010	0.048	0.109 **	-0.041	-0.000
	[0.025]	[0.030]	[0.046]	[0.026]	[0.053]

Constant	0.106 *** [0.018]	0.112 *** [0.035]	0.106 *** [0.032]	0.073 *** [0.018]	0.199 *** [0.036]
Industries	Yes	Yes	Yes	Yes	Yes
Regions	Yes	Yes	Yes	Yes	Yes
Years	Yes	Yes	Yes	Yes	Yes
Observatios	74601	12449	60435	60435	60435
Firms	15508	2473	13622	13622	13622
Wald[Model]	23422.709 ***	2855.865 ***	1164.592 ***	6804.659 ***	2406.217 ***
R2	0.242	0.187	0.017	0.101	0.038

Notes: The robust firm cluster-specific standard errors are reported in the parentheses. Significance levels are reported on superscripts, where *** denotes significance level of 1%, ** significance level of 5% and * significance level of 10%.

Table 5. The estimation results of the difference-in-differences models for employment

Dependent variable: EMP				
	T=2005 Coef./S.E	T=2006 Coef./S.E	T=2007 Coef./S.E	T=2008 Coef./S.E
dT	-0.085*** [0.005]	-0.099 *** [0.007]	-0.120 *** [0.008]	-0.147*** [0.009]
d_rd_subs	0.084 * [0.049]	0.094** [0.051]	0.099* [0.053]	0.079 [0.054]
d_empl_subs	0.166*** [0.023]	0.163*** [0.023]	0.164*** [0.024]	0.158*** [0.024]
d_other_subs	0.009 [0.029]	0.014 [0.029]	0.009 [0.030]	0.000 [0.031]
rd_subsXempl_subs	-0.178 [0.166]	-0.260* [0.158]	0.282 [0.179]	-0.327* [0.185]
rd_subsXother_subs	0.023 [0.137]	0.010 [0.135]	0.003 [0.139]	0.019 [0.143]
empl_subsXother_subs	-0.004 [0.079]	-0.004 [0.080]	-0.002 [0.079]	0.011 [0.082]
rd_subsXempl_subsXother_subs	-0.168 [0.376]	-0.086 [0.376]	-0.054 [0.386]	-0.210 [0.464]
dTxrd_subs	0.073** [0.031]	0.095 [0.074]	0.029 [0.049]	0.133 [0.091]
dTxempl_subs	0.059 *** [0.016]	0.042** [0.020]	0.051** [0.024]	0.034 [0.023]
dTxother_subs	0.043** [0.017]	0.044** [0.027]	0.049* [0.030]	0.033 [0.031]
dTxrd_subsxempl_subs	-0.125 [0.101]	-0.003 [0.138]	-0.371 [0.295]	0.061 [0.179]
dTxrd_subsxother_subs	-0.134 [0.106]	-0.201 [0.129]	-0.114 [0.128]	-0.317* [0.181]
dTxempl_subsxother_subs	-0.042 [0.047]	-0.050 [0.057]	-0.051 [0.063]	-0.016 [0.070]

dTxrd_subsxempl_subsxother_subs	0.197	0.180	0.394	0.241
	[0.234]	[0.218]	[0.379]	[0.379]
Observatios	18742	17988	17077	16355
Firms	9551	9238	8727	8355
Wald[Model]	257.31***	242.368***	254.765***	230.426***
Adj.R2	0.654	0.637	0.657	0.665

Notes: Control variables: Constant, log sales, log total assets, RD, ROI, EQUITY, AGE, FOR_OWN, GOV_OWN, and industry and regional dummies. The robust firm cluster-specific standard errors are reported in the parentheses. Significance levels are reported on superscripts, where *** denotes significance level of 1%, ** significance level of 5% and * significance level of 10%.

Table 6. The estimation results of the OLS and 2SLS models for the employment growth using pooled data for the years 2004 and 2006: the role of product and process innovations

Dependent variable: EMP_GRH			
	2SLS Coef./S.E	OLS Coef./S.E	2SLS Coef./S.E
SALES_GR_NEW	1.099 *** [0.103]	0.810 *** [0.051]	0.837 *** [0.052]
PROCESS	0.018 [0.013]	-0.009 [0.010]	-0.007 [0.010]
RD_SUBSIDY			0.002 [0.002]
EMPL_SUBSIDY			0.003 ** [0.001]
OTHER_SUBSIDY			-0.001 [0.001]
MEDIUM			0.019 ** [0.009]
LARGE			-0.022 * [0.013]
XLARGE			-0.050 ** [0.020]
CAPITAL_GR			-0.153 *** [0.043]
ROI			-0.014 [0.016]
EQUITY			0.029 * [0.017]
AGE			0.009 [0.006]
FOR_OWN			0.009 [0.011]
GOV_OWN			0.019 [0.016]

Constant	-0.055 **	-0.034	-0.016
	[0.025]	[0.025]	[0.052]
Industries	Yes	Yes	Yes
Regions	No	No	Yes
Years	Yes	Yes	Yes
Observatios	3752	3772	3749
Firms	2954	2971	2951
Wald[Model]	363.698 ***	24.626 ***	630.446 ***
R2	0.370	0.400	0.432

Notes: The robust firm cluster-specific standard errors are reported in the parentheses. Significance levels are reported on superscripts, where *** denotes significance level of 1%, ** significance level of 5% and * significance level of 10%.