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Effects of the Multilevel Policy Mix on Public R&D Subsidies:

Empirical Evidence from Japanese Local SMEs

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Abstract

Regional innovation policies have been implemented in several countries. In Japan, the controlled decentralization of traditionally centralized innovation policy is ongoing. Thus, we can observe the multilevel policy mix of public R&D (research and development) subsidies by national, prefecture, and city governments. However, empirical studies on multilevel R&D support, using panel data and considering the municipality level, are scarce. Based on original survey data and on the financial data for manufacturing SMEs (small and medium sized enterprises), we estimate their TFP (total factor productivity) and we empirically investigate the effects of public R&D subsidies by national, prefecture, and city governments. We employ firm-level fixed effect panel estimation to control for the effects of any unobservable time-invariant factors. We find that, with a two year lag, city and prefecture subsidies show positive and significant effects on TFP, which also persisted after the subsidy period. However, multilevel subsidies, especially those involving city subsidies, additionally and persistently increase recipients' TFP. These results suggest significant advantages for the multilevel policy mix, especially those involving the city subsidy.

Keywords: R&D subsidy; local authority; multilevel policy mix; SMEs; policy evaluation

JEL classification code: H71, O38, R58

1. Introduction

Innovation policies for local SMEs have been implemented in several countries. In these countries, SMEs are regarded as engines for regional innovation and development. However, it is well known that information asymmetry strengthens financial constraints for SMEs and for new start-ups, especially for financing R&D activities (Colombo and Grilli 2007; Czarnitzki and Hottenrott 2011). Therefore, R&D subsidy for local SMEs is widely recognized as an important policy to promote innovation and to increase productivity.

Not only the national government, but regional governments and local authorities, including state, prefecture, and city levels, are responsible for the development of local firms and innovation systems (Fernandez-Ribas 2009; Okamuro et al. 2019). Nonetheless, there is not sufficient empirical evidence on the relationship between the central and local governments in the discussion of regional innovation systems. On the one hand, while the central government is expected to plan national policies that consider the general welfare of the nation, local authorities play a complementary role, as they are often required to implement these national policies for local firms. On the other hand, local authorities are also expected to develop original policies that may be better suited to local conditions and needs (Perry and May 2007).

In Japan, under the Science and Technology Basic Plan, the promotion of regional innovation has been recognized as an essential policy issue since the beginning of this century. This is when the Ministries of Economy, Trade, and Industry (METI) and of Education, Culture, Sport, Science, and Technology (MEXT) started their cluster policies (Okamuro and Nishimura 2018a). In parallel, most prefectures announced their Science and Technology Vision based on the national government's requests and started their own R&D support policies for local SMEs independently. Additionally, the Japanese government is currently promoting a regional revitalization policy requiring and encouraging local authorities, including those at the municipality level, to plan and design their own strategies. Thus, Japanese innovation policy is undergoing a process of centralized decentralization, which may provide an important example for the empirical study of multilevel governance.

This trend of the decentralization of innovation policies from national to regional governments is not specific for Japan. Fernandez-Ribas (2009) argues that “in the last decade, the governance landscape of innovation policy has experienced deep changes in both Europe and the United States. … In Europe, governance changes have been intensified by an increasing involvement of the European Union (EU) and a gradual expansion of regional level governments” (p. 457). Fitjar et al. (2019) suggest that, in 2011, the EU Directorate-General for the Regional and Urban Policy (DG Regio) introduced the Research and Innovation Strategies for Smart Specialization (RIS3), “a place-based policy which foregrounds the role of regions and emphasizes research and innovation policy, building competitive advantage based on regional strength and potentials” (p. 1). In the period 2014-20, EU regions were required to develop their own smart specialization strategies as a condition for access to European Structural and Investment Funds. Thus, the multilevel policy mix in innovation policy is especially important in Europe.

Multilevel governance or multilevel policy mix refers to the relationship between public policies from different levels of government (supranational, national, regional, and local) (Fernandez-Ribas 2009; Okamuro et al. 2019). An OECD (Organization for Economic Cooperation and Development) report addresses the multilevel governance of innovation policies at different administrative levels and refers to some different patterns of governance among member and non-member countries (OECD 2011). Additionally, there are some conceptual papers on the multilevel policy mix on innovation (Flanagan et al. 2011; Laranja et al. 2008). However, despite increasing attention on regional innovation policies, concrete information about these policies is currently quite limited. Even internationally, although there are numerous studies on the national government’s policies, empirical studies on local governments’ policies are scarce, as mentioned later in more detail. Thus, research is limited regarding the effects of regional or local innovation policies and the relationship among them. Therefore, our study aims at empirically investigating whether R&D subsidies for local SMEs, from different levels of governments, may interact and increase recipient’s productivity.

2. Literature review

The effects of public R&D support (especially subsidies) have been empirically investigated in various ways. Until recently, empirical studies focused on the input additionality of subsidies and whether public R&D subsidies crowd out private R&D (David et al. 2000; Czarnitzki and Lopes-Bento 2013; Czarnitzki and Delanote 2015). Another research focus is on the output additionality of a R&D subsidy (i.e., its effects on innovation outcomes and firm performance of recipient firms) including growth and productivity (Bernini and Pellegrini 2011; Colombo et al. 2013; Czarnitzki and Delanote 2015; Karhunen and Huovari 2015; Cin et al. 2017; Czarnitzki and Hussinger 2018; Bellucchi et al. 2019) with mixed results depending on output measures, recipient firm characteristics, and support schemes. Some of these studies target regional policies in specific regions (Bernini and Pellegrini 2011; Belucci et al. 2019), but most studies focus on national programs. It is noteworthy that most studies focus on SMEs or young firms because the financial constraints in R&D and innovation are especially serious for such firms.

Several previous empirical studies focus on the local impact of national policies. Specifically, some scholars empirically investigate the local effects of national cluster policies in France (Martin et al. 2011; Fontagné et al. 2013) and Germany (Engel et al. 2013; Töpfer et al. 2017) at firm and local levels. For Japan, Nishimura and Okamuro (2011a; 2011b; 2016) empirically examined the effects of METI's cluster policy at the firm level. Using a unique dataset, Okamuro and Nishimura (2018a) provide a comparative econometric analysis of the project-level effects of METI's and MEXT's cluster policies that had similar aims, but contrasting schemes. However, these studies on cluster policies do not consider the role of regional or local governments[1].

Lanahan (2016) targets state-level SBIR programs in the USA. Using a state-level panel dataset, it empirically examines the effects of states' additional support for the recipients of the federal SBIR program to find the complementary effects of regional

[1] As an exception, Falck et al. (2010) empirically analyze the firm-level impact of the regional cluster policy by the Federal State of Bavaria in Germany, without considering the roles of cities.

policies for national policies.

In 2007, a special issue in *Regional Studies* focused on the multilevel governance of science (and innovation) policy. Additionally, it provided a comparison of the changing balance between central government and regional governments towards greater decentralization by contrasting centralized countries (England, France, Finland, and Japan) with federal countries (Germany and Canada) (Perry and May 2007). The articles in this special issue provide descriptive studies on science policy in each country with program-level (Salazar and Holbrook 2007 for Canada) or regional case studies (Crespy et al. 2007 for France, Sotarauta, and Kautonen 2007 for Finland, Koschatzky and Kroll 2007 for Germany) and historical review (Perry 2007 for England, Kitagawa 2007 for Japan). It is noteworthy that the articles all target regions or states instead of cities or counties[2].

An OECD report addresses the multilevel governance (or multilevel mix) of innovation policies at different administrative levels (sub-national, national, and supra-national) and refers to some different patterns of governance among member and non-member countries (OECD 2011). There are some conceptual papers on the multilevel policy mix on innovation (Flanagan et al. 2011; Laranja et al. 2008), but there are few empirical studies on this research topic (Fernandez-Ribas 2009; Bondonio and Greenbaum 2014; Radicic and Pugh 2017).

Fernandez-Ribas (2009) compares the effects of R&D subsidy programs on innovation outcomes across different levels of governments (regional, national, and EU levels), using CIS (Community Innovation Survey) micro data from Catalonia, Spain. She finds that, based on the different aims and conditions of these programs, they show different outcomes. Yet, this study does not estimate the effects of policy mix (i.e., the combination of subsidies from different levels). Bondonio and Greenbaum (2014) compare the employment effects of the EU co-funded ERDF (European Research and Development Fund) and national/regional R&D subsidy programs using firm-level data from an Italian region. They find positive effects of policy mix for both subsidy programs, in addition to the effects of each of these

[2] The German study (Koschatzky and Kroll 2007) provides a case study on Bremen, which they do not regard as a city, but as a federal state.

programs. Radicic and Pugh (2017) evaluate the input and output additionality (R&D employment, R&D expenditure, patents, and innovative sales) of national and EU R&D programs using SME data from 28 European countries, and they find significant effects of policy mix on R&D input. These studies use cross-section firm datasets and do not distinguish between regional and local programs. Moreover, the productivity effect of the multilevel policy mix is not directly addressed.

Thus, our study investigates and compares the effects of public R&D subsidy programs at different administrative levels on the productivity of local SMEs, considering a multilevel policy mix of national, prefecture, and city programs. It shows a distinct originality in that it targets R&D support policies for local SMEs, not only by the national government, but by local governments. Moreover, this study is unique regarding the interaction of these policies, considering the endogeneity of receiving these R&D subsidies by fixed-effect panel analysis.

3. Policy Overview and Hypotheses

3.1. Policy Overview[3]

The multilevel governance of innovation support for local SMEs in Japan has changed over time to adapt to the changing external environment at the national, prefecture, and city/municipality levels. During the 1980s, the local nature of Japanese technological developments attracted international attention, often through show-case high-tech projects such as the *Technopolis* program. Local authorities, mostly prefectures, became increasingly involved in supporting basic science and advanced technologies, in addition to the traditional role of supporting standard technologies for SMEs.

Since the mid-1990s, the Japanese government enacted a series of acts in support of SMEs in local economic development, such as the Consortium R&D Program for Regional

[3] The overview of Japanese innovation policy in this subsection depends largely on Kitagawa (2007), Okamuro and Nishimura (2018b) and Okamuro et al. (2019).

Revitalization (CRDP) starting in 1997 (Nishimura and Okamuro 2016) in combination with the Science and Technology Basic Plan (since 1996). A special program of the CRDP for SMEs started in 2002, with a subsidy for local R&D consortia of up to 50 million yen for two years. The Japanese government also implemented cluster programs for regional innovation support, such as METI's Industrial Cluster Project in 2001 and MEXT's Knowledge Cluster Initiatives and City Area Program in 2002. These government programs aimed at creating R&D consortia between the university, industry, and government at the regional level (Nishimura and Okamuro, 2011a; 2011b).

Moreover, the Small and Medium Enterprise Agency (SME Agency) under the METI provides R&D subsidies to SMEs, part of which is implemented by local authorities, especially by prefectural governments. All 47 prefectures have developed their own science and technology plans with growing resource asymmetries since around 2000 (Kitagawa 2007).

In 2006, the SME Agency started a new support program for the SME's innovation strategy called Sapoin (Strategic Core Technology Advancement Program). In this program, R&D subsidy is competitively provided to acknowledged firms for at most three years with up to 97.5 million yen (up to two-thirds of the total R&D budget). In the same year, the SME Agency started another support program called Manufacturing Subsidy (Monozukuri) for increasing the productivity of SMEs in manufacturing, service, and commerce sectors by supporting capital investments for product/service and process innovation. This subsidy, which is implemented by SME associations in each prefecture, is limited to one year and to a half of the total budget with the final amount between one and ten million yen. These programs comprise a major part of the national R&D subsidies for SMEs.

Since 2013, the Japanese government has promoted a regional revitalization (Chiho Sosei) policy requiring and encouraging local authorities, including those at the municipality level, to plan and design their own strategies, often with competitive subsidies from central to local governments. Thus, Japanese innovation policy is currently undergoing a process of centralized decentralization involving the municipality level. Okamuro and Nishimura (2018b) found that, as of 2015, at least 131 cities among around 800 cities in

Japan have already implemented their own R&D subsidy programs for local SMEs with different program designs according to different local needs and conditions. Okamuro et al. (2019) discuss the multilevel governance of public R&D support in Japan with original survey data and some case studies, and they show some distinct differences in subsidy schemes between prefecture and city level programs.

3.2. Concept and Hypotheses

Due to the high risk and uncertainty of R&D activity, it is difficult for firms to attract external funding to overcome resource constraints (Czarnitzki et al. 2010). Public R&D subsidy is argued to provide firms with generic resources, such as financial support and infrastructure, rather than specific resources, such as tacit knowledge for specific innovation activity (Jiang et al. 2018). However, financial support through government enables firms to recruit talented researchers, which enhances R&D capability (Afcha and Garcia-Quevedo, 2016). These supports also increase firms' risk tolerance levels, which helps them conduct more challenging projects (Chapman and Hewitt-Dundas, 2018). Additionally, government endorsements will benefit recipient firms when accessing external financing (Kleer 2010) and when connecting with other organizations to promote formal partnerships between firms, universities, and research institutes (Jiang et al. 2018). Thus, public R&D subsidy alleviates resource constraints for innovation under information asymmetry (Jourdan and Kivleniece, 2017), which is especially important for local SMEs.

In the decentralization of innovation policies, national (central) government expects local governments to design and implement their own original policy programs that may better fit local needs and conditions. It is clear that no policy fits each region equally (Tödling and Trippl 2005). Due to information asymmetry between the national government and local firms, and since policy needs and conditions may differ significantly across regions, the national government cannot efficiently tailor local policy for each region. Therefore, under heterogeneity in local needs and economic conditions, decentralized decision-making in public policy has an advantage over centralized decision-making. This argument is supported by the concept of fiscal federalism or fiscal decentralization (Oates 1999).

However, local governments face budget and capacity constraints to different extents when initializing and implementing original innovation policies (Okamuro and Nishimura 2018b). Therefore, the implementation and design of local innovation support programs differs significantly across regions, especially between prefectures and municipalities and across municipalities (Okamuro et al. 2018). Although city governments may be more sensitive to local needs for public support and more efficient in innovation support by helping firms acquire specific resources (Lazzarini 2015), prefecture and national governments have advantages in providing more generic resources regarding budget size, administrative capabilities, and experiences (Arnoldi and Villadsen, 2015; Zhou et al. 2018).

Fernandez-Ribas (2009) considers the following three points as advantages for upper-level governments, which include cross-border externalities, scale economies, and the indivisibilities of R&D input. In contrast, the advantages of lower-level governments are a greater capacity to correct systemic dysfunctions and the ability to tailor programs to local conditions (hetetogeneity). Thus, both upper-level and lower-level governments have advantages in promoting regional innovation, although they are different in terms of function, interaction with recipient firms, sensitivity to local needs, and resource supplies (Qian and Weingast, 1997). Therefore, we propose the following hypothesis:

H1: Public R&D subsidies of each government level increase the recipient's productivity.

Often, public subsidies are designed exclusively in the sense that a recipient of a prefecture program cannot obtain a subsidy for the same project from the METI or a city. However, even with such constraints, it does not mean that public subsidies from different levels of governments are not complementary. Local SMEs may apply for and obtain multilevel subsidies for different, but related projects. In fact, due to the economies of scale in R&D, synergy, and reputation effect, multilevel subsidies may have complementary effects on the recipients' innovation. Therefore, we propose the following hypothesis:

H2: Recipients of multilevel subsidies increase productivity more than those of a single level subsidy and the non-recipients.

What kinds of multilevel subsidies are more efficient in improving the productivity of local SMEs? Although it is difficult to predict it as a priori, we assume that the multilevel subsidies involving local (city) governments may efficiently promote productivity, especially in the case of local SMEs.

Local governments are likely to have more interactions and information exchanges with local SMEs due to geographical proximity (Qian and Weingast 1997). Such a close relationship reduces information asymmetry and enables local governments to recognize local needs immediately. Thus, local governments can provide sophisticated specific resources to local SMEs to enhance their productivity. Local governments have higher incentives to promote local economic development because they have greater economic proximity to local firms (Walder 1995), and they commit their efforts to supporting local firms. Additionally, local SMEs are directly affected by the regulations and policies of local governments due to their higher administrative proximity (Zhou et al. 2018). Hence, local governments can adjust their regulations and policies to local needs because of the institutional flexibility in and fast response to reducing the uncertainty in local innovation activities. In these regards, local (city) governments are more likely to monitor and guide the recipient firms, which is generally not the case for upper-level governments that provide more generic (financial or hard) supports, but are less likely to give monitoring and guiding (soft) supports[4].

Following the aforementioned advantages of local (city) governments, we expect that the multilevel subsidies involving city government may be more effective than those by prefecture and national governments because of better adjustments to local needs and higher

[4] Nishimura and Okamuro (2011b) provide evidence that, even within the same public support program, soft support, including matching, networking, and consultation contributes to the innovation and business performance of supported firms at least to the same extent as hard (financial) support with a much smaller budget.

synergies between soft and hard supports. The interaction between prefectural and national subsidy programs would not affect the recipient firm's productivity if the economies of scale in R&D (hard supports) do not have a great effect.

H3: Among the multilevel subsidies, those involving city governments increase productivity more than those by prefecture and national governments.

4. Empirical Methodology

4.1. Data

To investigate the multilevel R&D subsidy effect on firm productivity (TFP), we employ econometric analysis (fixed-effect panel estimation) using original survey data and financial data from manufacturing SMEs in Japan. By estimating fixed-effect models using a panel dataset, we cope with the endogeneity issue by controlling for the effects of any time-invariants, unobservable firm characteristics to the effect of some observable factors, such as firm size and the expenditures for advertising, R&D, and other intangible assets. As Fernandez-Ribas (2009) discover, not only whether to obtain a public R&D subsidy, but which subsidy (from which administrative level) to obtain is endogenously determined.

To obtain public subsidy information, online surveys for 12,000 firms in the Japanese manufacturing sector were conducted from February to May 2017. Target firms were randomly selected from the company database COSMOS 2 of Teikoku Databank (TDB), which is the largest credit investigation company in Japan, and is equally stratified in three firm size groups (10-49, 50-99, and 100-300 employees). In this survey, we asked, among other questions, whether or not and in which fiscal years they obtained public subsidy from a city, prefecture, or national government (including public agencies and funds). We further asked for the names of the subsidy providers and programs, so that we could correctly identify the obtained subsidy programs[5]. For each of the municipalities (cities), prefectures,

[5] It was important because some firms incorrectly reported the public subsidy providers. For example, a

and national government programs, the respondents named the latest and the most recent subsidy program they received, with its starting and finishing fiscal years.

We also asked how often participants obtained public subsidies from each of the administrative levels to check whether they obtained another public subsidy before their most recent two subsidy programs, so we could collect this information from the survey. Although most SMEs in the sample obtained public R&D subsidies, once or twice during the observation period from 2004 to 2016, some firms obtained three or more subsidies. In some cases, we could not observe the early subsidies in our sample, so we may have underestimated the effects of some R&D subsidies. Therefore, we verify, in a later section, the estimation bias from unobserved early subsidies by simply excluding the firms that stated any public R&D subsidy in 2003 or before.

From these firms, 1,030 effective responses were obtained with a response ratio of 8.6%[6], among which 587 firms could be matched with the TDB COSMOS 1 financial database. We constructed an unbalanced panel dataset with approximately 5,000 observations for 14 years (fiscal years from 2004 to 2017)[7]. Due to several missing values, our final sample comprises of approximately 3,500 observations with 500 firms for an average of 7 years. The exact number of firms and observations differ across estimation models.

We check the possible sampling bias that may occur in two ways. First, respondent firms may be different from (i.e, larger than) non-respondent firms (response bias). Whereas the respondents (1,030 firms) are on average smaller than the non-respondents (10,970 firms) regarding capital, employees, and sales[8]. The average size measures are not significantly different between them according to the Wilcoxon rank-sum test (Mann-

national subsidy program, which is mediated by the Small Business Association in each prefecture, is often misunderstood as a prefecture program. Moreover, we had to exclude several (mostly national) subsidy programs from the responses because they are not related to R&D and innovation support (such as employment support).

6 This response ratio should not be regarded as too low since, in the survey, we asked mainly for the R&D activities and R&D subsidies of target firms. Thus, we may assume that SMEs with R&D expenditures, which account for only 6.8% among manufacturing SMEs (with less than 300 employees) according to the 2017 *Survey of Research and Development* in Japan, are overrepresented among the respondents.

7 We start the observation period from the fiscal year 2004 due to limited data availability for the period before 2003.

8 But they are similarly old with 46 years since foundation on average.

Whitney test) at the five percent level. Thus, we can reject the response bias regarding firm size and age.

Second, among the respondents, the firms that can be matched with the TDB COSMOS 1 financial database (587 firms) may differ from those that cannot be matched (443 firms) because the registration for the COSMOS databases is not random, but relies on company information demand. In fact, the former is significantly larger and older than the latter at the one percent level, according to the Wilcoxon rank-sum test (Mann-Whitney test)[9]. Thus, the matching bias cannot be rejected. Therefore, we have to consider the matching (registration) bias, especially by firm-level fixed effect estimation.

4.2. Model Specifications

In the first step, from the COSMOS 1 database, we estimate both the Cobb-Douglas and Levinsohn-Petrin production functions. From this, we calculate total factor productivity (TFP) as the performance measure. The latter production function enables productivity measurement, considering endogeneity with regard to firm survival, and changes in the input shared (Levinsohn and Petrin 2003). In calculating TFP, we use not only value-added, but gross margin as output measures (dependent variables) due to the limited availability of value-added data. As independent variables, we use the number of employees (labor input), the amount of tangible fixed assets (capital input), the expenses for water, lighting, heating, and fuels[10], and year and industry dummies. We employ firm level fixed-effect estimation models and take natural logarithms for all variables, except for dummy variables. Thus, we estimate TFPs for each firm in four ways, with two types of production functions and with two dependent variables (value-added and gross margin).

In the second step, we analyze the determinants of firm's TFP (in a natural logarithm) again using fixed-effect panel estimation to control for the effects of unobservable, time-invariant firm characteristics. Our online survey contains questions regarding company

[9] We do not show the detailed results of these bias checks to save space, but they are available from the authors upon request.

[10] We use these energy expenses only for estimating Levinsohn-Petrin production functions.

information, including the R&D subsidies they received from city, prefecture, and national government. Using this data, we examine the effects of R&D support from different levels of governments and their interaction on firm's productivity. Thus, the most important variables of the second step estimation are subsidy dummies of the national, regional (prefecture), and local (city) public subsidies. We define each of these policy dummies in the following three ways to examine the persistency of subsidy effects:

1) Taking one only during the subsidy period and zero otherwise;

2) Taking one during the subsidy period and for three years after that and zero otherwise[11];

3) Taking one during and after the subsidy period until 2017 (or as long as the recipient data can be observed) and zero otherwise.

Let us consider a case wherein a firm obtained a subsidy from a national program only in the fiscal years 2011 and 2012. By the first definition, the national subsidy dummy variable takes the value zero until 2010 and after 2013 and takes one in 2011 and 2012. By the second definition, the same dummy variable takes the value zero until 2010 and after 2016 and takes one from 2011 to 2015. Finally, by the third definition, the subsidy dummy takes the value zero before 2010 and takes one after 2011. If this firm obtained another national subsidy in 2008 (thus, before the subsidy in 2011 and 2012), the subsidy dummy takes zero before 2007, in 2009 and 2010, and again after 2013, and takes one in 2008, 2011, and 2012 by the first definition. It takes zero before 2007 and after 2016, and takes one from 2008 to 2015 by the second definition. It takes zero before 2007 and one after 2008 by the third definition.

Basically, the same rule applies even when the first subsidy finished before the observation period (in 2003 or before). In this case, the subsidy dummy would take the value one throughout the period. To cope with possible estimation bias, in a later section, we exclude these firms from the sample and estimate the same models as a robustness check.

Other independent variables in the second step estimation include advertising

[11] It is noteworthy that several public subsidy programs follow the recipient firms' R&D projects for at least three years after the subsidy period. This is why we use this measurement of subsidy dummies.

expenditures, R&D expenditures, other intangible fixed assets, total assets (as a proxy for firm size), debt ratio to total assets, and industry and year dummies. These variables are expected to affect both TFP and the propensity to obtain public R&D subsidies, while industry and year dummies control for unobservable industry-specific characteristics and year-specific factors, such as macroeconomic conditions. Therefore, they should be included in the estimation models. All variables except for dummy variables and debt ratios take natural logarithms.

4.3. Sample

Sample statistics for the first step and second step estimations are shown in Table 1[12]. Here, we focus on the second step variables, especially public subsidy recipient variables. Moreover, since we report only the TFP values that are calculated using the Levinsohn-Petrin production function with value-added as the dependent variable, we show in Table 1 only the sample statistics of this TFP measure. Regarding public subsidy variables, we show sample statistics of the variables that take one during the subsidy period and for three years after that, and zero otherwise[13]. In the Appendix, we show the correlation matrix of the second step variables where we use the above definition for subsidy variables.

Table 1 demonstrates that firm-year observations with public subsidies are quite few, which is suggested by the considerably low level of mean values. The share of observations with municipality (city), prefecture, and national subsidy is 0.5%, 2.0% and 7.0%, respectively. Regarding simultaneous subsidization, which is suggested by the interaction of dummies at different levels of subsidies, the prefecture-national combination can be observed more often (1.0%) than municipality-prefecture (0.1%) and municipality-national

[12] In some observations, the debt ratio exceeds 100%, which may be outliers. However, even after excluding these observations, the estimation results do not change significantly. The results excluding outliers can be obtained from the authors upon request.

[13] Tables 3, 4, and 5 demonstrate the estimation results of the second step. We show different results according to the three definitions of subsidy dummies considering time lag and the persistency of subsidy effects. Here, we focus on this definition (including three years after the subsidy period) because some major national support policies follow the outcomes of the subsidized projects for three years after the subsidy period.

(0.2%) combinations. Thus, national subsidies seem to be more widely used among local SMEs than regional or local subsidies.

Indeed, 115 firms among the sample firms obtained a public subsidy for R&D, either from a city (12 firms), prefecture (32 firms), or national government (101 firms). Thus, a public R&D subsidy comes mostly from the national government rather than local authorities. Moreover, during the observation period, 32 firms obtained subsidies from different levels of government (not necessarily in the same fiscal year):

- Both from city and prefecture (4 firms)
- City and national government (8 firms)
- Prefecture and national government (26 firms)
- All three levels (3 firms)

Because of the availability of a panel dataset, we can estimate the interaction effects of public subsidies from different administrative levels. However, in the following estimations, we omit the interaction term of subsidies from all administrative levels due to a small number of observations and a high correlation with the city-prefecture interaction variable.

5. Estimation Results and Discussion

5.1. Effects of R&D Subsidies on TFP

We present the empirical results of the first step estimations in Table 2. It shows the estimated Cobb-Douglas and Levinsohn-Petrin production functions with different output measures, including sales profit (gross margin) and value-added in the natural logarithm. The number of observations and groups (firms) differs accordingly across estimations. We employed fixed-effect panel estimations to control for the time-invariant firm heterogeneity. All estimations include year dummies and industry dummies. These estimation results seem similar. Both labor and capital inputs have expected positive and significant coefficients.

Tables 3, 4, and 5 demonstrate the estimation results on the effects of different levels of public R&D subsidies on TFP. We employ the fixed-effect panel estimations to control for time-invariant firm heterogeneity regarding productivity, public subsidies, survey responses, and database matching. All models control for time-variant firm level factors, including advertising expenditures, R&D expenditures, intangible fixed assets, total assets (all in natural logarithms), debt-to-asset ratios, and year and industry dummies. The dependent variable of all estimations is the log TFP that is calculated from the Levinsohn-Petrin production function with value-added as the output measure[14]. The main independent variables are public subsidy dummies from municipalities (*m_support_d*), prefectures (*p_support_d*), and national governments (*n_support_d*), as well as their interactive terms (*mp_support_d* for municipality and prefecture subsidy, *mn_support_d* for municipality and national subsidy, and *pn_support_d* for prefecture and national subsidy)[15].

In Table 3, we use no time lags between the dependent and independent variables. To consider time lags for the effects of public subsidies on TFP, subsidy dummies are lagged for one year to TFP in Table 4 and for two years to TFP in Table 5. All other variables are lagged for one year in both tables. Due to these time lags, the number of observations and firms (groups) are reduced to 2,833 and 408 in Table 4 and to 2,449 and 381 in Table 5.

We show in these tables the estimation results in six different specifications. Models 1, 3, and 5 include only the single subsidy variables, while Models 2, 4 and 6 include their interactive terms (subsidy combination variables). Moreover, in these tables, we define subsidy dummies in three different ways and demonstrate the estimation results of these different definitions of subsidy variables as follows:

1) In Models 1 and 2, subsidy dummies take the value one only during the subsidy period and take zero otherwise (both before and after the subsidy period);
2) In Models 3 and 4, subsidy dummies take the value one during the subsidy period and also for three years after the period and take zero otherwise;

[14] To save space, we omit the estimation results using the Cobb-Douglas production function and sales profit (gross margin) as the output measures, which are similar to the results in Tables 3, 4, and 5. These results are available from the authors upon request.

[15] We construct the triple interaction term for obtaining municipality, prefecture, and national subsidy at the same time, and its effect on TFP is partially positive and significant. However, we do not show the results including this variable because it takes the value one for only a few observations.

3) In Models 5 and 6, subsidy dummies take the value one during the subsidy period and in all years after the period, and take zero otherwise (only before the subsidy period).

In this way, we can check the time lags and persistency in the effect of public R&D subsidies.

Estimation results in Table 3 suggest that, after controlling for time-invariant firm characteristics, year effects, and industry effects, no subsidy dummies as single terms have positive and significant effects on the recipient's TFP in any specifications. However, when we consider the interaction between subsidy programs, we find that, whereas the single term of municipality subsidy has negative and significant effects, the interaction terms of municipality and prefecture (*mp_support_d*) or national subsidies (*mn_support_d*) have positive and significant coefficients (Models 2, 4, and 6). Net effects of a municipality subsidy are positive or negative, depending on the combinations of subsidies and the measurements of the subsidy period.

Table 4 shows the subsidy effects with a time lag of one year. Similar to Table 3, no subsidy dummies, as single terms, have significant effects on TFP. However, a municipality subsidy does not have negative and significant effects in Models 2, 4, and 6 with interaction terms, so that net effects of a municipality subsidy with a prefecture or national subsidy are positive and significant. Specifically, the results in Model 4 suggest that a multilevel subsidy from a municipality and a prefecture (*mp_support_d*) and from a municipality and a national government (*mn_support_d*) increase the recipient's TFP in the following year by 26.8% and 28.5%, respectively, when we consider persistent subsidy effects for three years after subsidy periods.

Table 5 shows the subsidy effects with a time lag of two years. Unlike the results in Tables 3 and 4, the single terms of municipality subsidy and prefecture subsidy have positive and significant coefficients in Models 1 to 5 and Models 3 to 6, whereas a national subsidy has no effect on TFP (unless combined with a municipality subsidy). It is noteworthy that the coefficients of the single terms of municipality and prefecture subsidies become positive and significant when considering a time lag for two years.

The effects of interaction terms are weaker than those in Table 4, but are still present in a similar pattern. Thus, municipality and prefecture subsidies show complementary effects in Model 4, while municipality and national subsidies show complementary effects in Models 2, 4, and 6. Specifically, the multilevel effects with municipality subsidies are significant. In Model 4, the total effects of municipality and prefecture subsidies are a 30.0% increase in TFP (5.3% by municipality subsidies, 16.4% by prefecture subsidies, and 8.3% as a combined effect) compared to no subsidies for the subsidy period and the following three years. A national subsidy, by itself, does not increase a recipient's TFP significantly, but combined with a municipality subsidy, it increases the recipient's TFP by 13.3% in Model 2 (immediately), by 15.6% in Model 4 (middle term), and by 21.6% in Model 6 (persistently).

Regarding the effects of control variables, we find that firm size (measured as total assets in natural logarithms) and advertising expenditures (in natural logarithms) have positive and significant impacts, while the ratio of debt to total assets has negative and significant impacts on TFP in all specifications without time lags (Table 3). The effects of the debt ratio become insignificant, and advertising expenditures and firm size become weaker when considering time lags (Tables 4 and 5). Contrary to our expectations, R&D expenditures and intangible fixed assets, both in natural logarithm, show no significant effects on TFP in any specification, with or without time lags.

5.2. Discussion

In sum, among public R&D subsidies, city and prefecture subsidies show positive and significant effects on TFP, with a two year lag, that persists after the subsidy period. These persistent effects are particularly evident for the prefecture subsidy. Moreover, the multilevel policy mix, especially with a city subsidy, additionally and persistently increases the recipient's TFP. These estimation results support H1 (subsidy effects of each government level) with time lags (except for a national subsidy). Additionally, H2 and H3 (multilevel policy mixes) are supported especially regarding a city subsidy even without time lags. It is noteworthy that the estimation results significantly differ depending on the horizon (persistency) of subsidy effects, and the time lag between a subsidy and its impact on TFP.

Our estimation results are consistent with those of Fernandez-Ribas (2009) in that regional R&D support has a positive impact on firm performance (innovation outcomes). Our results are consistent with those of Bondonio and Greenbaum (2014) and Radicic and Pugh (2017), which find the positive and significant effects of multilevel R&D funding from national/regional governments and the EU, although they estimate the effects on employment growth and R&D input/output. Since these previous studies use cross-section datasets and different measures from ours as dependent variables, our study may contribute to the literature in that it uses a longitudinal panel dataset and examines directly the persistent policy effects on a firm's productivity with a time lag.

The above results suggest that local (city level) and regional (prefecture level) subsidies may be effective in increasing recipients' TFP and that multilevel policy support may contribute to productivity growth when a city subsidy is involved. It is noteworthy that the productivity impact of local and regional subsidies and multilevel subsidization is considerable. These results are supported by the argument that there are advantages of decentralized policy-making considering local and regional heterogeneity (Qian and Weingast 1997; Oates 1999). Such a large contribution of a city subsidy, despite a small subsidy volume on average, may be attributed to the proximity of local governments to target firms, including better policy fit to local needs and conditions, more sophisticated soft support with consultation and networking, and more efficient monitoring on site.

In the Japanese policy context, the findings of our estimation that national subsidies on average have no impact on firm productivity unless combined with city subsidies contradicts with Nishimura and Okamuro's (2016) results that Japanese national support for regional R&D consortia (CRDP) significantly increased participating SME's TFP. Different results may be partially explained by the composition of national subsidies in the sample. Our sample does not comprise of the CRDP supported firms, but several firms that were supported by other national subsidy programs, such as the Sapoin and Monozukuri (manufacturing) programs mentioned previously, which do not necessarily promote regional R&D consortia with universities and public research institutes[16].

5.3. Robustness checks

We conduct some additional estimations as robustness checks[17]. First, we alternatively use the Cobb-Douglas production function instead of the Levinsohn-Petrin production function and sales profit (gross margin) instead of value-added in the first step estimation to recalculate TFP for the second step estimation. Using these alternative measures for the dependent variable, we estimate again the effects of multilevel public subsidies on a firm's productivity, but the results are quite similar to those in Tables 3 to 5. Moreover, we estimate the same models by excluding a few outliers regarding the debt ratio without finding any remarkable changes in the results.

Second, from the sample, we drop firms that obtained R&D subsidies from the same level of government (city, prefecture, or national government) three times or more (which means that they may have obtained at least one R&D subsidy that is not known to us and therefore cannot be controlled), and estimate the same models. The number of observations and firms are reduced by 8%-9% to 2,572 and 375, respectively, with a one year time lag, and we could not include the interaction terms of subsidy dummies due to a fewer number of observations. These results are similar to those in Table 5 with a two year lag and to those in Table 4 with a one year lag, while the coefficients of prefecture subsidy dummies became positive and significant in Models 3 and 5.

Third, from the sample for Models 5 and 6, we drop firms that obtained the latest or most recent R&D subsidy from any government levels in 2003 or earlier (before the

[16] Most of the CRDP firms participated in the Industrial Cluster Project promoted by METI as mentioned in Section 3.1. Participants in this cluster policy can obtain not only public subsidies, but also several kinds of soft supports, such as consultation, technological advices, matching or networking events, etc. from local cluster support organizations (sometimes local authorities) (Nishimura and & Okamuro, 2011b). Therefore, we expect that CRDP recipients can enjoy higher synergies between soft and hard supports to enhance their productivity. Our results imply limited effects of public subsidies by the central government on local SMEs, possibly due to information asymmetry and the crowding-out effect.

[17] We omit these results in this manuscript to save space, but the results are available from the authors upon request.

estimation period). In Models 5 and 6, subsidy dummies (by the third definition) take the value one throughout the observation period for these firms. Therefore, we checked only the changes in the results of Models 5 and 6, since only the long-term definition of subsidy effect is affected in this check. The number of observations and firms are reduced to 2,769 and 402, respectively, with a one year lag. The results are similar to those in Tables 4 and 5, except that the coefficients of the interaction term of municipality and prefecture subsidies become positive and highly significant.

6. Conclusion

Major implications from our study for researchers and policymakers are that:

1) We should pay more attention to the role of local R&D support (including at the city level), which may be more effective than national support for local SMEs.
2) A combination of local and national subsidies is important because of complementarity
3) We should consider the lagged and persistent effects of public subsidies.

A practical implication is that local SMEs should take advantage of public subsidies from different administration levels to increase productivity. According to our survey, more than half of respondent firms are not aware of city subsidy programs. Thus, it is important to disseminate information regarding public subsidies to potential recipients, so that local SMEs may proactively utilize innovation supports. Public subsidy programs should consider other levels of programs that are available to the same local firms and should coordinate better with other programs.

This study had some limitations. First, we controlled for the effects of time-invariant firm characteristics by using fixed-effect panel analysis, but did not completely control for the time-variant firm characteristics that might have affected both the probability of obtaining public subsidies and firm performance. However, we included in the models some variables for time-variant firm characteristics. To cope with this potential endogeneity, it is desirable for future research to use instrumental variables in empirical estimations. Second, we could not consider the variety of program designs and their effects on firm performance. It is known that local R&D support programs do not only differ from national programs in their aim, design, and content (Fernandez-Ribas 2009), but from each other across local authorities (Okamuro and Nishimura 2018b). However, since the number of recipient firms was small in our final sample, especially regarding the city subsidies, we may better utilize this program information for supplemental qualitative analysis.

However, despite these limitations, the current study has distinct original contributions to the literature, as this is the first empirical study on the effects of local (cities) and regional (prefectures) public R&D support programs, and we confirmed the complementary (interactive) effects of multilevel R&D support and the persistency and time lag of such effects. Future research would provide further implications by covering more firms. Specifically, it would be desirable to obtain full lists of recipient firms as the treatment group and to compare them with all other firms in the same region or industry. Furthermore, it would be beneficial to compare similar regions with different programs for R&D support.

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Table 1: Sample Statistics

First Step: Estimation of Production Functions

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
ln (*sales profit*)	5,061	12.8	1.13	6.43	16.4
ln (*value added*)	3,695	12.0	1.13	3.58	14.7
ln (*emp*)	5,123	4.27	0.81	0	6.07
ln (*tangible fixed asset*)	5,122	13.0	1.54	0	16.3
ln (*energy*)	3,835	6.12	3.20	0	12.2

Second Step: Estimation of Multilevel Subsidy Effects

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
ln (*tfp*)	3,453	8.206	0.888	1.399	10.3
m_support_d	3,453	0.005	0.072	0	1
p_support_d	3,453	0.020	0.139	0	1
n_support_d	3,453	0.070	0.255	0	1
mp_support_d	3,453	0.001	0.029	0	1
mn_support_d	3,453	0.002	0.045	0	1
pn_support_d	3,453	0.010	0.099	0	1
ln (*ad*)	3,453	6.265	3.118	0	14.8
ln (*rd*)	3,453	1.770	3.448	0	13.4
ln (*intangible fixed assets*)	3,453	7.505	2.361	0	13.3
ln (*asset*)	3,453	14.16	1.115	9.002	16.8
Debtr	3,453	67.89	25.73	0.785	399

Table 2: Results of the First Step Estimation (Production Functions)

Specifications	Cobb-Douglas		Levinsohn and Petrin	
Output measures	ln (sales profit)	ln (value added)	ln (sales profit)	ln (value added)
ln (*emp*)	0.467***	0.388***	0.529***	0.532***
	(0.078)	(0.096)	(0.058)	(0.045)
ln (*tangible fixed asset*)	0.091**	0.107**	0.124*	0.127*
	(0.040)	(0.051)	(0.069)	(0.066)
Constant	9.546***	9.244***		
	(0.561)	(0.681)		
year dummies	Yes	Yes	Yes	Yes
industry dummies	Yes	Yes	Yes	Yes
N	5,060	3,649	3,786	3,694
Number of groups	621	532	624	624
R squared (within)	0.122	0.069		

1) Standard errors are in parentheses under coefficients.

2) Levels of significance: ***1%, **5%, *10%.

Table 3: Results of the Second Step Estimation 1 with Zero Lag Time

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
m_support_d	−0.079	−0.162*	−0.104	−0.357***	−0.098	−0.224*
	(0.097)	(0.090)	(0.101)	(0.090)	(0.102)	(0.088)
p_support_d	0.004	0.015	−0.017	−0.040	0.013	−0.028
	(0.057)	(0.060)	(0.058)	(0.082)	(0.069)	(0.086)
n_support_d	−0.006	−0.008	0.022	0.014	−0.004	−0.015
	(0.030)	(0.030)	(0.036)	(0.037)	(0.037)	(0.039)
mp_support_d		0.033		0.428***		0.182*
		(0.102)		(0.099)		(0.087)
mn_support_d		0.335***		0.352***		0.193*
		(0.097)		(0.102)		(0.086)
pn_support_d		−0.023		0.043		0.021
		(0.118)		(0.106)		(0.086)
ln (*ad*)	0.020***	0.020***	0.020***	0.020***	0.020***	0.020***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln (*rd*)	−0.001	−0.002	−0.001	−0.001	−0.001	−0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
ln (*int. fixed asset*)	−0.007	−0.007	−0.007	−0.007	−0.007	−0.007
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln (*asset*)	0.379***	0.379***	0.379***	0.379***	0.379***	0.381***
	(0.062)	(0.063)	(0.062)	(0.063)	(0.062)	(0.063)
debtr	−0.003***	−0.003***	−0.003***	-0.003***	−0.003***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
constant	3.889***	3.889***	3.899***	3.895***	3.886***	3.864***
	(0.888)	(0.889)	(0.888)	(0.891)	(0.887)	(0.891)
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	3,453	3,453	3,453	3,453	3,453	3,453
Number of groups	465	465	465	465	465	465
R squared (within)	0.140	0.141	0.141	0.142	0.140	0.142

1) Standard errors are in parentheses under coefficients.

2) Levels of significance: ***1%, **5%, *10%.

Table 4: Results of the Second Step Estimation 2 with a One Year Lag Time

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
m_support_d	0.044	−0.053	0.094	−0.087	0.101	0.011
	(0.119)	(0.080)	(0.098)	(0.063)	(0.100)	(0.072)
p_support_d	0.017	0.013	0.073	0.076	0.068	0.055
	(0.059)	(0.063)	(0.047)	(0.058)	(0.058)	(0.063)
n_support_d	−0.010	−0.016	−0.010	−0.012	−0.028	−0.033
	(0.034)	(0.036)	(0.037)	(0.040)	(0.047)	(0.052)
mp_support_d		0.079		0.268***		0.075
		(0.082)		(0.079)		(0.088)
mn_support_d		0.183*		0.285**		0.165*
		(0.094)		(0.141)		(0.090)
pn_support_d		0.014		−0.008		−0.018
		(0.082)		(0.093)		(0.077)
ln (*ad*)	0.012*	0.012*	0.012*	0.012*	0.012*	0.012*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ln (*rd*)	−0.004	−0.004	−0.005	−0.005	−0.005	−0.005
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)
ln (*int. fixed asset*)	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln (*asset*)	0.228***	0.230***	0.228***	0.228***	0.228***	0.229***
	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)
debtr	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
constant	5.631***	5.599***	5.681***	5.681***	5.618***	5.607***
	(0.821)	(0.823)	(0.827)	(0.828)	(0.819)	(0.822)
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	2,833	2,833	2,833	2,833	2,833	2,833
Number of groups	408	408	408	408	408	408
R squared (within)	0.090	0.091	0.091	0.091	0.091	0.092

1) Standard errors are in parentheses under coefficients.

2) Levels of significance: ***1%, **5%, *10%.

3) All of the independent variables, except for year dummies, have a one year lag to the dependent variables.

Table 5: Results of the Second Step Estimation 3 with a Two Year Lag Time

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
m_support_d	0.149***	0.094**	0.144***	0.053**	0.155***	0.062
	(0.037)	(0.031)	(0.043)	(0.026)	(0.046)	(0.044)
p_support_d	0.066	0.093	0.125***	0.164***	0.122**	0.160***
	(0.058)	(0.070)	(0.037)	(0.038)	(0.053)	(0.049)
n_support_d	0.019	0.024	−0.047	−0.037	−0.060	−0.046
	(0.036)	(0.038)	(0.041)	(0.045)	(0.052)	(0.060)
mp_support_d		0.063		0.083*		0.028
		(0.055)		(0.045)		(0.075)
mn_support_d		0.133**		0.156**		0.216**
		(0.057)		(0.077)		(0.073)
pn_support_d		−0.121		−0.116		−0.113
		(0.096)		(0.092)		(0.071)
ln (*ad*)	0.012*	0.012*	0.012*	0.012*	0.012*	0.012*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ln (*rd*)	−0.002	−0.003	−0.002	−0.002	−0.002	−0.003
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln (*int. fixed asset*)	0.000	0.000	0.000	0.000	0.000	0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
ln (*asset*)	0.186**	0.188**	0.186**	0.185**	0.187**	0.187**
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)
debtr	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
constant	6.050***	6.034***	6.049***	6.086***	6.039***	6.069***
	(0.890)	(0.893)	(0.888)	(0.891)	(0.892)	(0.893)
year dummies	Yes	Yes	Yes	Yes	Yes	Yes
industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	2,449	2,449	2,449	2,449	2,449	2,449
Number of groups	381	381	381	381	381	381
R squared (within)	0.084	0.085	0.086	0086	0.085	0.087

1) Standard errors in parentheses under coefficients.

2) Levels of significance: ***1%, **5%, *10%.

3) Subsidy dummies have a two year lag and other variables, except for year dummies, have a one year lag to dependent variables.

Appendix: Correlation Matrix (Second Step Estimation: Models 3 and 4)

	Variables	1	2	3	4	5	6	7
1	ln (*tfp*)	1						
2	*m_support_d*	0.02	1					
3	*p_support_d*	0.01	0.08	1				
4	*n_support_d*	0.01	0.09	0.24	1			
5	*mp_support_d*	0.01	0.41	0.21	-0.01	1		
6	*mn_support_d*	0.03	0.62	-0.01	0.16	0.00	1	
7	*pn_support_d*	0.01	-0.01	0.70	0.36	0.00	0.00	1
8	ln (*ad*)	0.37	0.02	0.02	0.00	0.00	0.03	0.01
9	ln (*rd*)	0.22	0.00	0.11	0.04	0.01	0.01	0.06
10	ln (*intangible fixed asset*)	0.18	0.02	-0.01	0.04	0.03	0.00	-0.03
11	ln (*asset*)	0.38	0.04	0.03	0.02	0.02	0.03	0.00
12	*Debtr*	-0.13	-0.04	0.04	-0.02	0.00	-0.04	0.03

	Variables	8	9	10	11	12
8	ln (*ad*)	1				
9	ln (*rd*)	0.26	1			
10	ln (*intangible fixed asset*)	0.24	0.22	1		
11	ln (*asset*)	0.26	0.30	0.50	1	
12	*Debtr*	-0.01	-0.09	-0.11	-0.20	1