# R&D IN FUNCTION OF DIRECT PUBLIC SUPPORTS TO SMEs: AN EXPLORATORY STUDY IN TURKEY

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**ABSTRACT**

The globalization has increased the importance of research and development (R&D) activity and of technological advancements, especially in information and communication technologies. This case is valid for small and medium-sized enterprises (SMEs) which have taken a crucial place in all economies. Since R&D activities have high costs and public features, these activities cannot be carried out by firm, especially SMEs' fiscal sources.

Direct supports play a key-role in most countries. In related literature, many researchers have stressed that direct public supports towards R&D activities are important for SMEs. Recently, the requirement of public support in R&D activities has been increased in Turkey, just as in most countries. The study investigated both the relationship between direct public supports and R&D in SMEs and the factors determining the using level of R&D supports with an empirical study for Turkey as a sample. A survey of 600 SMEs in Turkey was conducted by a research company on behalf of the authors. The survey data have been estimated by logistic regression analysis and allow us to indicate the factors which determine the using level of direct public supports of SMEs. According to the logistic regression model, the determiner factors are the information level of firms on R&D supports, available convenient support kind, the number of licenses and patents, supply of new product to market etc., in order to increase the possibility for benefit from supports. The most important factor is the fact that SMEs obtain licenses and patents. These results provide contribution to improving R&D activities in SMEs.

**Keywords:** R&D level, direct public supports, logistic regression.

**JEL:** C25, H2, H25, L60, O38, O31

## 1. INTRODUCTION

Economists think that R&D utilized to define the technological capacity of a country or firm is an important variable. R&D spending is used every step of technological activities such as to develop new product and process of production and to use efficiently available or imported technology (Cohenn and Levinthal, 1989).

The starting point for most theories of R&D is changed economic conditions during the 1980s. The globalization and technological revaluation have affected all firms from the point of innovation. The use of technology in production has been increased. In new economic generating innovative activity, knowledge as an input in a production function has taken a place as an addition to the traditional inputs of labor, capital and land in production process. However, knowledge is different than the traditional inputs (Audretsch, 2001). Knowledge and its organization have played an important role in the innovation progress of firm. While the management of knowledge is considered as a source of intellectual capital, R&D occur as sources for new knowledge (Thorpe, Ryan, Charles, 2009). Also, from the point of public finance, knowledge is a public good. Knowledge as public good is non-exclusive and non-rival. It has positive externalities. For this reason, public support for R&D is required to overcome market failure associated with the public good character of knowledge (Hussinger, 2008).

Rogers (2003) explained innovation as "new idea, implementation or an aim developed by individual or institution". It can be said that

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there is a relationship between R&D and innovation activity. R&D is an input which shows the level of innovation activity (Rogers, 2003).
Both institutions and economists defined R&D activities from many different points. For example, according to OECD, R&D is defined as creative work on a systematic basis in order to increase the store of knowledge (OECD, 1993).

The R&D term contains three activities: basic research, applied research and experimental development. Basic research depends on observable or not facts, towards acquiring new knowledge, experimental or theoretical. Applied research is based on investigation towards a specific practical aim. This kind of investigation aims to acquire new knowledge that may be useful in developing or improving products, processes or services. The knowledge derived from applied research is often patented but may also be kept secret. In other words, the results of these researches are subject to intellectual property rights. Experimental development is a systematic work, based on research or practical and existing knowledge. These works provide experience, directed to producing new materials, products or devices or installing new processes, systems and services (Economic Incentives to Business R&D).

Due to globalization and economy based on high knowledge, the cost of production in traditional production structure has been high. This case causes diminishing the competition advantage of large firms. In result, SMEs have become more important in knowledge-based economy system. SMEs are of overwhelming importance in most countries. The new information and communication technologies (ICTs) present an increase in production and elasticity in economic activities with rich opportunities. Therefore, the importance of R&D has been increased (Wattanapruttipaisan, 2002).
Despite all these developments, the impact of direct public supports to R&D has been examined empirically by only a few studies and comprehensive research is very limited in this area. The aim of this study is to fill this gap. In addition, most previous studies focus on this segment in developed countries. In this study, we examine Turkey, with the status of a developing country, as a sample country. Therefore, we can obtain an opportunity to compare results among countries.

The support of government to R&D takes various forms as direct supports and indirect supports (tax incentives). The subject of this paper is direct public supports.
In this paper, we focus on both the relationship between direct public supports and R&D in SMEs and the factors determining the using level of R&D supports with an empirical study for Turkey as a sample. SMEs are the backbone of economic activities in Turkey like in other economies. The average density of Turkey SMEs is as much as EU average.

The remainder of this paper is organized as follows: Section 2 describes the direct public support towards R&D. Section 3 provides previous literature. Section 4 presents the empirical results and Section 5 brings conclusions.

## 2. R&D TOWARDS DIRECT PUBLIC SUPPORTS in SMEs

R&D contributes to economic growth, employment, innovation and the quality of products. R&D is crucial drivers of growth and productivity (European Policy Communities, 2002). The role of private R&D investment has been recognized as a fundamental engine for productivity growth at both the macro- and microeconomic levels (Baumol 2002; Jones 2002).

Today, at the macroeconomic level, R&D has been fostered to accelerate technological progress and to enhance national competitiveness and long-term economic growth (Faria, Martin, Brandao, 1995). Most countries have introduced or extended fiscal instruments to support to business to increase spending on R&D (European Commission, 2003). Both theoretical and empirical analysis stresses the important role of R&D in economic growth. Sylwester (2001) finds strong positive relationship between industry R&D expenditures and economic growth in G-7 countries (Sylwester, 2001).
Therefore, these countries obtain more advantages from cooperation with their competitors (OECD, 2011). Both market failures and the features of R&D require intervention of government to foster technological advancement (OECD, 2010).

In recent years, with changing patterns and importance of R&D, some factors begin to determine the form of public intervention in R&D. These are the transition to the knowledge-

based economy, restructuring business R&D as a result of increased competition and technological improvement and an enhanced role of SMEs. It is suggested that SMEs are increasingly active players in the R&D activities, thanks to the removal of some of the main obstacles to their financing (Economic Policy Committee, 2002).

The government support for R&D takes various forms as direct supports (subsidies) and indirect supports (tax incentives). Direct public supports in R&D have the greater transparency than tax incentives.

Direct public supports for R&D have been used for a long time from a historical perspective. Since the beginning of the 21st century they represent the major source of the allocation of public funds to private small firms in OECD countries. Direct supports for R&D will directly or indirectly promote innovation, which creates the production of new marketable products, processes or services. (Cunningham, Gök, Philippe, 2013). The direct funding of private R&D expenditures has the advantage of allowing governments to retain control over the nature of R&D (OECD, 2010). Direct public supporting through subsidies or grants reduces the private costs of investing in R&D. However, governments need high information to give these supports.

The firm demands support from government in direct supports. The government assesses the investment project of a firm from the point view of its aim. Then, the government decides whether to provide support to a firm or not (Busom, Corchuelo Martinez Ros, 2012). This instrument creates an opportunity to government to choose projects supported by government and the kind of research. So, the sources can be allocated to the projects which have more risk and problems related to application and the maximum private and social benefits (Economic Policy Committee, 2002).
There are various direct support instruments towards R&D. First is called grant. Grant as a support compensates the proportion of SME R&D costs. Grant is generally given to R&D activities realized for the first time or that are competitor-based. based on competitor.
Loans as another support instrument are provided either directly by a government agency or through commercial banks or other financial intermediaries. These supports are only given under specific conditions (for example, on the successful result of a product development project and generation of new sales), or may require repayment regardless of the supported outcomes.

There further direct funding in question are presented by government. These are government loan guarantees, business angels and venture capital (Cunningham, Gök, Philippe, 2013).

Government loan guarantees undertake all or part of private R&D investment risk and encourage potential investors to provide finance to R&D performers. Guarantee mechanism is a crucial method to abolish market failures in R&D field and to encourage private R&D investments. Especially, it is a very suitable instrument of support for SMEs (European Commission, 2003).

Venture capital fund is provided by institutional and individual investments cush as person, company, bank, insurance company, retirement funds. The two most common tools of public support are direct funding through grants and loans (Busom, Corchuelo and Ros, 2012).
Business angel is the form of the informal venture capital (European Commission, 2009).

## 3. PREVIOUS LITERATURE

Lach (2002), in the study, measured the influence of R&D direct subsidies on firms in Israel during the period 1990-1995. In the analysis results, it is evidenced that the subsidies have more positive effects on SMEs than large firms. However, to measure the effects of subsidies on private R&D, we need to know whether firm can realize these expenditures without these supports. This study found evidence that SMEs generally perform their R&D activities thanks to these supports. For this reason, it is more important that SMEs facing constraints related to both capital and qualified workers must be supported by government (Lach, 2002).

Czarnatzki, Ebersberger and Fier (2007) focus on the impact of innovation policies and R&D collaboration in Germany and Finland. They reached different results in these two countries. In Germany, subsidies for individual research do not have a significant impact on R&D

and on patenting, but the innovative performance could be improved by additional incentives for collaboration. However, public funding is an important source of finance for R&D for Finnish firms (Czarnatzki, Ebersberger and Fier, 2007).

The research has been done into the impact of direct public supports on R&D performance in firms existing in the service sector in Germany. The supported firms are relatively more successful than other firms when it comes to innovation. Since innovative firms with more R&D employee and laboratory equipment are given priority, these firms show more willingness to apply for public subsidies. Empirically, they demonstrate that public grants rise the firms' privately financed innovative activities (Czarnatzki and Fier, 2001).

Wallsten (2000) searches whether there is a correlation between government R&D grants and the level of R&D, using a multi-equation model. He finds evidence that the grants crowd out firm-financed R&D spending.
Branstetter and Sakakibara (2002) evidenced the impact of Japanese government-sponsored research consortia on the research productivity. They found the relationship between consortium and R&D. While consortium has a positive impact on the level of potential R&D spillovers within the consortium, it is seen that there is a negative relationship with the degree of product market competition among consortium members.

Using a dataset of firms in Spain, Busom, Corchuelo and Ros (2011) reach the result that the firms with weak financial structure, especially new firms, prefere direct support in their R&D. However, SMEs generally prefer tax incentives for R&D (Busom, Corchuelo and Ros, 2011).

Hottenrott and Lopes-Bento (2012) analyze the impact of R&D supports on private R&D investments. They emphasize international corporations and the efficiency of public supports in SMEs for R&D activities. According to the results of the analysis, R&D supports increase private R&D expenditures. In addition, the study analyzes the effect of R&D investment on innovation performance. If the investment of R&D yields new and marketable products, it can be considered productive (Hottenrott and Lopes-Bento, 2012)

Sakakibara (2001) examines the contribution of diversity to firm government-sponsored R&D expenditure based on data of 213 Japanese firms. This article also indicates that government subsidies work as a substitute to firms' R&D (Sakakibara, 2001).
The study of Hussinger (2008) empirically analyzes the effect of public supports of R&D on firms' R&D investment per employee and new product sales in the German manufacturing sector, using parametric and semi parametric two-step selection models. The results indicate that R&D expenditures that are supported are as productive in generating new product sales as private R&D investment (Hussinger, 2008).

Prochazka (2011) focused on participation of Czech SMEs in various R&D supports programs in the survey. The results of the survey show that SMEs are strongly motivated to obtain funding in order to improve their competitive position. Also, according to the findings, intellectual property rights are showed to have low importance for SMEs (Prochazka 2011).

## 4. DATA AND EMPIRICAL RESULTS

### 4.1. Data

In testing the relationship between direct public supports and R&D in Turkey, the survey was conducted including 52 close-ended questions for SMEs in Bursa, Turkey. Suggestions based on findings of survey are presented. The face to face survey method has been chosen to collect the data. A five-point Likert scale that ranged from'1' "strongly agree" to '5' "strongly disagree" is used in the survey (1=strongly agree, 2=disagree, 3=neutral, 4=agree, 5=strongly disagree). The participants were asked to indicate the degree of their agreement or disagreement with each question. Also, some responses in the questionnaire submitted were deleted.

After, adjusted 600 responses are included in the analysis. The response rate is high, around

93%. The questionnaire consisted of three sections as follows: a) Demographic information, b) R&D case in SMEs, c) Direct public supports for R&D in SMEs.

### 4.2. The Reliability Analysis

A reliability test was performed to ensure the consistency of the items used. Cronbach's Alpha value is used, to determine the internal reliability of the questionnaire applied. The survey consists of two main parts. Examples of the first type are related to the case of R&D activities and the view to R&D of SMEs. Examples of the second type are related to the use level of R&D in SMEs and to assess the efficiency of public supports. For this reason, Cronbach's Alpha value is applied in all parts. Then, this value is reapplied with two parts that are joined.
The first part of the questionnaire aims to measure the case of R&D activities and the view to R&D of SMEs. In this way, 20 questions with a five-point Likert scale are used. Cronbach's Alpha value of this scale is 0.949. Namely, the scale has a high reliability rate of. The result of the reliability analysis is presented in Table 4.2.

Table 4.2. The Results of Reliability Analysis

| | Cronbach's Alpha | Research Question Number |
|---|---|---|
| Part 1 | 0.949 | 20 |
| Part 2 | 0.904 | 17 |

In the second part of the questionnaire, the aim was to measure the use level of R&D in SMEs, using a five-point Likert scale, with 17 suggestions as a part of the analysis. Cronbach's Alpha value of this scale is 0.904. It is showed that the responses have a high internal reliability level.

Similarly, when one of the questions was deleted, Cronbach's Alpha value is diminished. Finally, when two parts are joined, Cronbach's Alpha value is obtained as 0.964. This scale shows a pretty high reliability level.

### 4.3. Empirical Findings

#### 4.3.1. Demographics Profile

Table 2 reports the working areas of SMEs that participated in the survey. As seen in Table 2, 50 % of SMEs in Bursa consists of fabric and clothing, 15.3% accounts for the automotive industry with the metal industry that follows with 10.2 %.

Table 4.3.1. Sectorial Distribution

| | Frequency | Percentage |
|---|---|---|
| Construction | 30 | 5.0 |
| Fabric and clothing | 300 | 50.0 |
| Innovation | 14 | 2.3 |
| Manufacture of food products | 6 | 1.0 |
| Metal | 61 | 10.2 |
| Furniture | 46 | 7.7 |
| Automotive | 92 | 15.3 |
| Plastic and Rubber | 15 | 2.5 |
| Healthcare | 8 | 1.3 |
| Agriculture and Animal | 0 | 0.0 |
| Others | 28 | 4.7 |
| **Total** | **600** | **100.0** |

Regarding the number, frequency and percentage of employees in SMEs, the questionnaire responses are indicated in Table 3.

Table 4.3.2. The Number of Employee in SMEs

| | Frequency | Percentage |
|---|---|---|
| 1-5 | 72 | 12.0 |
| 6-10 | 182 | 30.3 |
| 11-20 | 232 | 38.7 |
| 21-30 | 28 | 4.7 |
| 31-50 | 38 | 6.3 |
| 51 and up | 48 | 8.0 |
| **Total** | **600** | **100.0** |

As it can be concluded from Table 4.3.2., 42.3 % of SMEs has between 1 and 10 employees. Some 49.7 % of SMEs has between 11 and 50 employees. Only 8 % of SMEs has between 51 and 250 employees.

In Table 4.3.3. SMEs are asked whether they

have a separate R&D department or not. Table 4 reports the answer given by the participants.

Table 4.3.3. Separate R&D Department Available in Firms

| | Frequency | Percentage |
|---|---|---|
| 1-3 | 36 | 6.0 |
| 4 and up | 26 | 4.4 |
| No | 535 | 89.6 |
| **Total** | **597** | **100.0** |

According to the results of the survey, 89.6 % SMEs do not have a separate R&D department. Moreover, SMEs which have a R&D department only employ between 1and 3 persons. It is seen that most SMEs do not have a R&D department. Despite of the fact that a few of SMEs have a separate R&D department, the number of their employees is generally four.
As shown in Table 4.3.4., the number of firms having patent, license and copy right is limited.

Table 4.3.4. The Case of Patent, License and Copy Right

| | Frequency | Percentage |
|---|---|---|
| 0 | 513 | 85.4 |
| 1 | 54 | 9.0 |
| 2 | 19 | 3.2 |
| 3 | 4 | 0.7 |
| 4 | 10 | 1.7 |
| 5 and up | 0 | 0.0 |
| **Total** | **600** | **100.0** |

While 85.4 % of firms do not have patent, license and copy right, the rest of the firms can obtain these intellectual rights.

Another question was related to the fact whether SMEs had the knowledge, enough information and equipment to establish an R&D department (Table 6).

Table 4.3.5. The Case of Enough Information and Equipment to Establish R&D Department for Firms

| | Frequency | Percentage |
|---|---|---|
| Strongly Agree | 75 | 12.5 |
| Agree | 269 | 44.9 |
| Neutral | 214 | 35.7 |
| Disagree | 41 | 6.8 |
| Strongly Disagree | 0 | 0.0 |
| **Total** | **599** | **100.0** |

Some 44.9 % of firms accept that they do not have enough information and equipment to establish R&D department. According to the result of frequency, only 6.8 % of the firms give a response “disagree”. Namely, they know how to establish R&D department.

### 4.3.2. Logistic Regression Analysis Results

The estimated results of the logistic regression are provided in Table 9, in order to see the use possibility of direct supports in SMEs. To determine the applicability of the model and having right classification rate, Hosmer and Lemeshow test (Table 4.3.2.) and classifications (Table 4.3.3.) are presented.

Table 4.3.2. Hosmer and Lemeshow Test

| Step | Chi-square | Df | Sig. |
|---|---|---|---|
| 1 | 10.509 | 8 | 0.231 |

As it can be seen in Table 7, Chi-square value is 10.509. Since this value is not statistically significant, null hypothesis will not be rejected.

Table 4.3.3. Classification Table

| | | | Observed | | Predicted |
|---|---|---|---|---|---|
| | | | Direct Public Supports | | Percentage Correct |
| | | | 0.00 | 1.00 | |
| Step 1 | Direct Public Supports | 0.00 | 344 | 33 | 91.2 |
| | | 1.00 | 68 | 144 | 67.9 |
| | Overall Percentage | | | | 82.9 |

Some 82.9% of the observed units 82.9 % are classified by the model in Table 8. The reliability of the model is increased due to the right classification rate of the model.

Table 4.3.4. Estimation Results

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1(a) | s4 | 0.469 | 0.099 | 22.614 | 1 | 0.000 | 1.599 |
| | s2 | | | 16.159 | 9 | 0.064 | |
| | s2(1) | 0.988 | 0.979 | 1.020 | 1 | 0.313 | 2.687 |
| | s2(2) | 2.094 | 0.852 | 6.041 | 1 | 0.014 | 8.118 |
| | s2(3) | 0.859 | 1.165 | 0.543 | 1 | 0.461 | 2.360 |
| | s2(4) | 2.641 | 1.327 | 3.958 | 1 | 0.047 | 14.025 |
| | s2(5) | 2.540 | 0.896 | 8.031 | 1 | 0.005 | 12.681 |
| | s2(6) | 2.093 | 0.938 | 4.976 | 1 | 0.026 | 8.112 |
| | s2(7) | 1.677 | 0.893 | 3.524 | 1 | 0.060 | 5.350 |
| | s2(8) | 2.004 | 1.173 | 2.918 | 1 | 0.088 | 7.422 |
| | s2(9) | 0.800 | 1.517 | 0.278 | 1 | 0.598 | 2.225 |
| | s13 | 1.772 | 0.180 | 97.202 | 1 | 0.000 | 5.883 |
| | s9 | -0.631 | 0.230 | 7.522 | 1 | 0.006 | 0.532 |
| | s16 | 0.473 | 0.167 | 8.054 | 1 | 0.005 | 1.604 |
| | S39 | -0.245 | 0.151 | 2.639 | 1 | 0.104 | 0.783 |
| | s40 | 0.308 | 0.163 | 3.583 | 1 | 0.058 | 1.360 |
| | s11 | 0.324 | 0.127 | 6.500 | 1 | 0.011 | 1.382 |
| | Constant | -5.432 | 1.166 | 21.692 | 1 | 0.000 | 0.004 |

According to Table 9, it is seen that most of the estimated parameters are statistically significant, at least at 10 % significant level. Based on the results of the model estimate, the number of employees in firms and obtaining patent, license and copy right for firms are placed among the most important factors to use direct public supports of R&D in SMEs. According to the logistic regression model, other important factors which affect the use of direct supports of R&D of firms are the activity fields of firms and new product and/or service presented by the firms during last three years.

By using the logistic regression model, the use of direct supports for R&D can be determined. The possibility to use supports for R&D for the company with some of the following features: no R&D department, diminishing its profit for last three years, not having information on R&D supports, not considering any supports for R&D and not having any patent and copy right, not presenting new product and/or service during the last three years in the fabric and clothing sectors, no utilized direct R&D public supports, is accounted as follows:

$$Z_i = -5.432 + 0.469*6 + 0.988 - 0.631*3 + 0.473*5 - 0.245 + 0.308 + 0.324$$

$$P_i = \frac{1}{1+e^{-Z_i}} = \frac{1}{1+e^{0.7704}} = \frac{1}{1+2.1606} = 0.316 \quad (1)$$

In that case, the possibility to use support for R&D for the firm having such features is 32 %. According to this portion, it means that the firm in question cannot use R&D supports.

On the other hand, the possibility to use supports for R&D for the company with some of the following features: available R&D department, increasing its profit for the last three years, having information on R&D supports, considered supports for R&D and having a patent and copy right, presented new product and/or service during the last three years in the fabric and clothing sectors, not used direct public supports of R&D, is accounted like below:

$$Z_i = -5.432 + 0.469*6 + 0.988 + 1.772 - 0.631 + 0.473 - 0.245*5 + 0.308*5 + 0.324*5$$

$$P_i = \frac{1}{1+e^{-Z_i}} = \frac{1}{1+e^{-1.9183}} = \frac{1}{1+0.1468} = 0.8719 \quad (2)$$

The possibility to use supports for R&D of this kind of firm reaches around 87 %. This result shows that firm having such features has a high possibility to use direct public supports for R&D. The remarkable finding is that having a patent, license and copy right has a strong impact on the use level of R&D supports. While the possibility to use supports for a firm which does not have a patent, license and copy right is approximately 54 %, in contrast, the R&D use possibility of a firm taking these intellectual property rights reaches 87 %.

## 5. CONCLUSION

R&D has getting increased importance in nowadays economy, since a high level of R&D is a key factor to lead to technological improvement, competitiveness and economic and social welfare. R&D activities create an opportunity to diminish differences in the capabilities and competitiveness between large sized firms and SMEs. Many empirical studies show how R&D is a crucial driver of growth and productivity.

Due to the functions of R&D, government supports to R&D expenditures have various forms. Many governments are in favor of activities to promote more effective use of direct public supports. Direct public supports for R&D insure SMEs against the risk of failure of R&D projects. In this paper, we investigated both the relationship between direct public supports and R&D in SMEs and the factors determining the using level of R&D supports with an empirical study for Turkey as a sample. When the estimation results are investigated, it is seen that most parameters estimated (except activity area question) are statistically significant at 10 % level.

We find the following conclusions: direct public supports for R&D affect private R&D positively. The numbers of employees, patents, licenses and copy rights for firms have a strong impact on the use level of R&D supports in SMEs. Other important factors which affect the use of direct supports of firms are the activity fields of firms and new product and/or service presented by firms during the last three years. To conclude, future research should aim to find which kind of direct public supports can be more effective to increase R&D in SMEs.

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