Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 195 (2015) 759 – 767

Procedia
Social and Behavioral Sciences

World Conference on Technology, Innovation and Entrepreneurship

Determinants of R&D Investment Decision in Turkey

Ömer Limanlı[a]*

[a]*Artvin Çoruh University, Artvin 08600, Turkey*

Abstract

In this study, we investigate the determinants of research and development (R&D) decision in Turkey for 2008 and 2013. For this purpose, World Bank Enterprise Survey data sets are used. This study is the first attempt to investigate the determinants of R&D decision made by a firms in micro-data level in Turkey. In the study, Generalized Linear Mixed Model for Complex Survey Design approach is used since this approach provides advantages of multilevel analysis and survey design. Estimation findings demonstrate us that sales, susidy, share of foreign ownership, competition incentive, scale of enterprise, domestic and foreign trade shares are very important factors to influence probability of invesment on R&D. Public policies which take into account these factors would be invaluable for growth and development of Turkish Economy.

Peer-review under responsibility of Istanbul Univeristy.

Keywords: Investment; R&D Decision; Turkey

1. Introduction

It is clear the importance of technical developments in world history. In addition to contributing to economic development and growth, the forming power of technical progress of market structure has given direction to the discussion of economic theory. At this point, Schumpeter (1950) has made very important contributions to the literature.

Schumpeter (1950) put technological change and innovation at the center of the capitalist market economy. Countries should invest in research and development (R&D) in order to ensure and sustain economic growth and

* Corresponding author. Tel.: +90-466-351-1203; fax: +90-466-351-1202.
E-mail address: omerlimanli@artvin.edu.tr

Peer-review under responsibility of Istanbul Univeristy.
doi:10.1016/j.sbspro.2015.06.471

development in this system. As stated above, the market structure will be affected during this process. Namely, the firms shaping technological developments, creating innovation and sustaining these developments will increase their market shares. Towards to imperfect competition from perfect competition in this process, Schumpeter (1950) and his followers argue that the monopoly market structure is the main source of economic growth. The monopoly firm can finance its capital investment with gained excessive profits. R&D investment will be included these investments. Thus, monopoly power will be continue and growth sustained. Schumpeter (1950) calls this process "creative destruction". Every innovation will demolish former one. The firms which want to increase or protect their market share will demolish current developments with newer innovations. The firms which do not refuse but adapt innovation will survive (Dosi, 1988). In this sense, Schumpeter (1950) has discussed economics from "evolutionary" point of view and has brought a new dimension to economics.

Countries make significant investments in R&D in order to survive in the creative destruction process. For example, as a ratio of GDP, Denmark %3, Finland %3.32, Israel %4.21, Japan %3.49, Korea %4.15 and Sweden %3.30 made R&D expenditure for 2013. These countries maintain their position in the global economy by investing in R&D. Same ratio for Turkey is very low and it cannot be compared to above countries' ratios. It is only %0.95for Turkey (OECD, 2015).[†]

The countries which have very low R&D expenditures, like Turkey, have to find the way to allocate more resources to R&D. This could be done directly by public support (subsidies). The other way is to influence the determinants of R&D expenditures of the firms. This option is only used for firms which make already R&D expenditures. These are important facts. Other very important fact is to encourage firms which have not made any investments in R&D. Encouraging the firms for their firs R&D investment provides more R&D activities. Thus, creating innovation probability will increase. Therefore, identifying the determinants of investment probability in R&D is very important.

The paper is organized as follows. Section 2 contains related literature. In Section 3, data, model and variables are presented. Estimation results are given in Section 4. Some concluding remarks are in Section 5.

2. Literature Review

There is vast empirical literature on R&D. These studies are substantially interested in the determinants of R&D expenditures. As far as we know, there is less study which based on R&D investment decision than R&D expenditures. There is a big difference between these approaches. In the expenditure approach, firms already invest in R&D. In the investment decision, firms do not invest in R&D. We are here interested in the latter case. Therefore, we just present only the literature that interested in determinants of R&D investment decision.[‡]

The first attempt to investigate the determinants of the probability of R&D investment decision could be found in Cohen et al. (1987). Actually, Cohen et al. (1987) used the R&D expenditures from 2,494 business units in 244 manufacturing lines of business operated by 345 firms in USA. Their estimation procedure includes Tobit regression. Thus, sample is separated two sub-samples. One contains only positive R&D expenditure and other contains all (zero plus non-zero). This technique provides the probability of moving from zero expenditure to positive expenditure. They are primarily interested in two variable; business unit sales and other sales. Other sales are difference between firm sales and business unit sales. They took sales as an indicator of firm size. Control variables are also used. This indicator is used so much in literature. They found that other sales have positive significant effect on probability of positive R&D investment. When other control variables are included in model,

[†] Here, we just present indicators about R&D expenditures. For detailed information for OECD countries see OECD (2015), for Turkey see Tezcan and Yanıktepe (2006), Demir and Geyik (2014), Soybilen (2013), and for selected countries see Piekut (2013).
[‡] For detailed literature review, please see Kamien and Schwartz (1975), Cohen and Levin (1989), Hall (2002), and Becker (2013).

business sale turns significant and positive while other sales turn insignificant but still positive. They conclude that there is a little evidence for Schumpeterian hypothesis and industry characters are very important factors.

Braga and Willmore (1991), as far as we know, modeled R&D investment decision using discrete dependent variable first time. They used data comes from 4,342 firms in Brazil for 1981. The dependent variable is binary (1/0) which indicates that firm whether invest (1) in R&D or not (0). They used logistic regression. They found that size (mean value added), export (1/0), technology import (1/0) and diversification have positive and significant on the probability of R&D investment. Their other independent variables are profitability, public ownership, foreign ownership. They are all insignificant.

Siddhartan and Agarwal (1992) studied similar model with Braga and Willmore (1991). But, Siddhartan and Agarwal (1992) used probit regression. Their data comes from 384 firms for 1981-1984 operate in India. They used various independent variables which include size (total sale), industry types, skill, capital intensity, advertisement. We will just state significant variables. Siddhartan and Agarwal (1992) estimate two equations. Model 1 includes linear scale of size variable (total sale). Model 2 includes logarithm scale of size variable. Chemical, engineering and process industries have positive and significant effect. Size variable have negative and significant effect for both models. While capital intensity have positive significant effect for model 1, profit/sale ratio have positive and significant effect for both model.

Kumar and Saqib (1994) have also estimated a model for India. Their data comes from 291 firms for 1977-1981. Their study is different from previous studies in terms of independent variables. They included square of size (sales) and concentration index in the model. These variables were used so much before Kumar and Saqib (1994). But, in the modeling investment decision, these variables were used first time. Square of size is important variable. This variable indicates a nonlinear relationship between size and R&D investment decision and R&D expenditures intensity. Similarly, same nonlinear relationship could be found between R&D dependent variable and market concentration index. Nonlinearity means a threshold effect. This is very important for policy analysis. Kumar and Saqib (1994) found that size have positive significant effect while size square have negative significant effect. This means that there is a threshold for positive probability. After some size scale, the probability of R&D investment starts to decline. Export as a value of production, value added in sales, profit ratio to production value, machine industry, electrical industry and chemical industry variables have positive and significant effects.

Urem (1999) investigated chemical and machinery industry in Czech Republic and Hungary in 1991 and 1994 for 204 firms. Urem (1999) used similar variables following the literature. Urem (1999) found that size (log of average number of employees), foreign ownership share, share of export in sales and investment activities have positive and significant effect on the probability of R&D investment. Urem (1999) did not include square of size.

Bhattacharya and Bloch (2004) investigated 1,213 firms which operate in Australia by using panel data for 1994-1995 and 1997-1998. Unlike other studies which we presented, Bhattacharya and Bloch (2004) studied on innovation. Although innovation and R&D should be thought separate things, they are highly related concepts. They used probit model and specifically interested in SMEs which are categorized as high-tech and low-tech. Their dependent variable is dummy variable that indicates that whether firms work on innovation or not. They found that size (total sale) has positive and significant, size square has negative and significant effect in all estimations (full, high-tech and low-tech). Profit has positive and significant effect in low-tech firms. Concentration ratio and share of export in total sale have positive and significant effect for full and high-tech sample firms. Import share in total sale have positive and significant effect in all estimations.

Griffith et al. (2006) analyzed firms' R&D investment continuity with dummy dependent variable for 1998-2000 using unbalanced panel data in France, Germany, Spain and United Kingdom. They used probit estimation method. Their independent variables are international competition pressure, funding and firms sizes (based on employee numbers and categorical variables). They separated funding in terms of fund source. Funds may come from local,

national or European Union. All variables have positive and significant effect except European Union and local fund sources for United Kingdom. These variables, respectively, have negative and positive but insignificant effect.

Hall et al. (2009) studied on SMEs which operates in Italy. They used panel data that collected in 1998, 2001 and 2004, and contains information about 7,375 firms. Their dependent variable is dummy variable which indicates that whether firms have positive R&D expenditure or not. They used several competition pressure variables. Competition pressure from large, regional, European or international firms have positive and significant effect. Firm size indicator (based on employee numbers) and public subsidy for innovation activity also have positive and significant effect.

Seerge-Blasco (2010) investigated 1,130 firms that operate in Catalonia region between 2001 and 2004. Firms are divided two sub-samples in terms of their technology level. Dependent variable was a dummy variable which indicates that whether firms invest in R&D or not. Study results shows that size (log employees) and size square have, respectively, positive and negative significant effect. Receiving subsidy, exporting, market share, and new firms founded in last three year (only for high-tech firms) have positive and significant effect. Being a part of other company group have negative and significant effect only for high-tech firm.

Costa-Campi et al. (2014) used panel data covers 2006-2010 for estimating R&D intensity and R&D decision for Spain. They used two estimation techniques. One is Tobit regression other is probit regression. They found from probit regression that size (number of employees) and one year lagged public fund variable have positive and significant effect. Firm age has negative and significant effect. When they remove public found variable, foreign capital variable turned to positive and significant while age turned to insignificant but it was still negative.

3. Model, Data and Variables

3.1. Data and Variables

Our data comes from World Bank Enterprise Survey. This survey was conducted a joint initiative of the European Bank for Reconstruction and Development and the World Bank in Turkey. This survey began in 2002. Data was collected for 2002, 2005, 2008 and 2013. We just used 2008 and 2013. The data for 2002 and 2005 have less observation than 2008 and 2013. We have 765 observations for 2008 and 734 observations for 2013 after dropping non-response observation for important variables. The sampling strategy for the survey is based on stratified random sampling methodology. There are three strata; region, size and sector. Agricultural sector was excluded. Remaining rectors constitute whole population[§].

The dependent variable is binary variable. It equals to 1 if firm invest in R&D and 0 if firm does not invest in R&D. We follow the literature in order to select independent variables. Our first independent variable is SIZE. We use total sales in last fiscal year as an indicator for size. We include also square of size, $SIZE^2$, in order to investigate nonlinearity. It measured with local currency unit. We expect that the probability of investing in R&D increase with respect to size and decrease after a threshold. Other two important variables that we use are total export share, EXSHARE, and total national share, NASHARE, in total sales. Especially, share of export might give information us about foreign competition pressure. Similarly, share of total national share in total sale might give us information about domestic competition and foreign competition. If firms only sale only domestic market, they will want to protect their domestic market share against foreign firms. We expect that EXSHARE must have positive sign and NASHARE must have negative sign. There are also two related variables. One is the total foreign ownership share, FOROW, other is whether firm is a part of other bigger firm, POBIG, or not. POBIG is dummy variable that equals 1 if firm is a part of other bigger firm and 0, otherwise. We expect that FOROW and POBIG

[§] Please visit for detailed information for sampling and survey methodology to www.enterprisesurveys.org (15.04.2015).

must have positive sing. As Schumpeter stated, bigger firms will have finance for R&D. Literature shows us that public support, particularly in the early stages of industrializing, is very important. We include public subsidy, PUSUB, variable that is dummy variable equals 1 if firm received subsidy from government or European Union funds and 0, otherwise. We expect that PUSUB must have positive sing. We added one extra variable one is only for 2008. We added importance of costumers to affect to develop new products of services, COSTUMER. This is question was only asked for 2008. It is ordered categorical variable. 1 means costumers are not at all important, 4 means costumers are very important. We recoded this variable as dummy variable. Now, it equals 1 if costumers are not very important at all and it equals 0 if costumers are important. We expect COSTUMER must have negative sign because if firms do not value their costumers, they will not seek innovative activities for them. We also use for number of employment indicator as size indicator instead of total sale. SMEs indicator is ordered variable. It equals 0 if firm has less than 5 employees (micro), 1 if firm have more or equal then 5 and less or equal 19 employees (small), 2 if firm has more than or equal to 20 or less or equal to 99 employees (medium), and 3 if firm have more than or equal to 100 employees (lareg). For 2013, we combine SMEs indicator and creat a dummy variable. It equals to 1 if firm micro (<5) or small (≥5 or ≤19), 0 otherwise. There is no micro firm recorded in 2008. We used separated SMEs indicator and take small firm category as base category. We expect that bigger firm indicators must have positive sign. Descriptive statistics for variables are given in Table 1 for 2008 and Table 2 for 2013.

Table 1. Descriptive Statistics for 2008.

Dependent Variable	**N**	**Mean**	**Std. Dev.**	**Min**	**Max**
R&D	765	.27	.45	0	1
Independent Variables					
SALE	765	2.44e+07	6.50e+07	12,000	8.68e+08
$SALE^2$	765	4.81e+15	3.71e+16	1.44e+08	7.53e17
EXSHARE	765	16.44	29.06	0	100
NASHARE	765	75	37.71	0	100
FOROW	765	2.24	12.92	0	100
POBIG	765	.11	.31	0	1
COSTUMER	765	.10	.30	0	1
PUSUB	765	.10	.30	0	1
SMEs	765	2.01	.79	1	3

When we look at the Table 2, there is a strange minimum value for SIZE variable. SIZE variable is total sales in last fiscal year. Our SIZE variable for 2013 equals "1" for minimum value. There are also other strange values for this variable but there is no method to cut off this variable. We deleted the observations below the 2008 minimum value and estimated all equations again. There is no difference between two approaches. That's why we take SIZE variable as it is and used SMEs variable as alternative indicator variable instead of sale.

Table 2. Descriptive Statistics for 2013.

Dependent Variable	**N**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
R&D	734	.14	.35	0	1
Independent Variables					
SALE	734	3.04e+07	2.00e+08	1	4.35e+09

$SALE^2$	734	4.07e+16	7.19e+17	1	1.89e+19
EXSHARE	734	16.46	27.16	0	100
NASHARE	734	71.35	35.75	0	100
FOROW	734	2.38	11.92	0	100
POBIG	734	.21	.41	0	1
PUSUB	734	.11	.32	0	1
SMEs	734	1.19	1.06	0	3

3.2. Model

In complex sampling design methodology, there is correlation within clusters. If this correlation is not taken into account, there will be bias in the estimation. That is why we used two level logistic random intercept model. We treat the sector is level 2 and firms are level 1. Firms are nested within the sector. We use Rabe-Hesketh and Skrondal (2006)'s presentation in order to give formal presentation. Two level generalized linear mixed model could be written as in equation (1).

$$y_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta} + \mathbf{z}_{ij}^{(2)\prime}\boldsymbol{\zeta}_j^{(2)} \tag{1}$$

In equation (1), y_{ij} is dependent variable for unit i in cluster j. $\mathbf{x}'_{ij}$ and $\mathbf{z}_{ij}^{(2)\prime}$ vector of independent variables, $\boldsymbol{\beta}$ is fixed effect coefficient and $\boldsymbol{\zeta}_j^{(2)}$ is random effect coefficient. Random effects at each level are multivariate normal with zero means and are uncorrelated with the random effects at the other levels. The power in equation (1) indicates the level of sampling. Here, it means sector. The expectation of y_{ij}, μ_{ij}, is linked to the linear prediction of y_{ij} via a link function and its conditional distribution is a member of exponential function family. Here, we use logistic distribution. We rewrite equation (1) as two level logistic regression in equation (2).

$$\log\big(\Pr(y_{ij}=1|\mathrm{x}'_{ij},\zeta_j^{(2)})/\Pr(y_{ij}=0|\mathrm{x}'_{ij},\zeta_j^{(2)})\big) = \mu_{ij} = \mathbf{x}'_{ij}\boldsymbol{\beta} + \boldsymbol{\zeta}_j^{(2)}, \qquad \zeta_j^{(2)} \sim N(0,\psi) \tag{2}$$

We choose logit link function because it does not require normality of error terms. In this model, error term distribute logistically. In terms of distributional patterns, logistic regression is more flexibly than its alternative probit regression. We used *gllamm* command in Stata. This command was written by Sophia Rabe-Hesketh[**] In the next section, we will present our estimation results. We followed the model building strategy of Hosmer et al. (2013).

4. Results

Estimation results are presented in Table 3 for 2008 and Table 4 for 2013. We estimated separate equations in each year because of correlation between independent variables.

Estimation results verify Schumpeterian hypotheses for Turkey, at least for 2008. Bigger size increases the probability of investment in R&D. After a point, it decreases. This shows us a nonlinear relationship between size and R&D probability for Turkey in 2008. As we expected, export share, subsidy, being part of bigger firm and other size indicator, SME have positive and significant effects on probability of investment in R&D. The share of foreign owners has negative and significant effect. Foreign owners might invest in R&D only in host country.

[**] For more information, please visit www.gllamm.org (17.04.2015).

Table 3. Estimation Results for 2008.

	(1)	(2)	(3)	(4)	(5)	(6)
SIZE	9.01e-09***	9.10e-09***	8.09e-09**			5.82e-09*
	(3.72)	(3.49)	(3.06)			(2.07)
$SIZE^2$	-8.89e-18*	-8.84e-18*	-7.56e-18			-4.64e-18
	(-2.27)	(-2.34)	(-1.95)			(-1.57)
EXSHARE	0.007***		0.008***	0.007***	0.006***	0.006***
	(6.90)		(7.53)	(6.35)	(25.99)	(22.20)
FOROW	-0.013***	-0.014**	-0.014***	-0.010*	-0.011*	-0.013***
	(-3.45)	(-3.24)	(-4.61)	(-2.15)	(-2.45)	(-5.49)
PUSUB	1.588*	1.578*	1.637*	1.512*	1.582*	1.602*
	(2.49)	(2.31)	(2.42)	(2.21)	(2.22)	(2.15)
COSTUMER	-1.192***	-1.167***	-1.170***	-1.201***	-1.188***	-1.169***
	(-7.85)	(-8.11)	(-6.87)	(-12.37)	(-10.28)	(-9.32)
NASHARE		-0.007***				
		(-4.76)				
POBIG			0.544***	0.400***	0.567***	0.507***
			(12.66)	(274.67)	(14.36)	(7.02)
SME (1 if ≥20 and ≤99)				0.531***		
				(3.32)		
SME (1 if ≥100)				0.871***		
				(4.93)		
SME (1 if ≥20)					0.514***	0.391
					(3.84)	(1.84)
Constant	-1.561***	-0.900***	-1.620***	-1.389***	-1.599***	-1.722***
	(-12.10)	(-3.69)	(-10.78)	(-9.49)	(-23.88)	(-19.77)
Sector						
Constant	0.455***	0.443***	0.485***	0.562***	0.198***	0.424***
	(8.15)	(9.67)	(6.60)	(3.54)	(6.67)	(4.80)
N	765	765	765	765	765	765

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

National sale share in total sale have also negative and significant effect. This sign of foreign competition have really important effect on R&D investment. Export share variable's sign also confirm this. Other negative and significant effect comes from costumer variables. The firms that ignore their costumer tend to less likely invest in R&D. When we look at the estimation results for 2013, so many variables are insignificant. There are only two variables that constantly significant. One is share of foreign owners and other is being a part of bigger firm. This time, foreign share variable have positive and is significant. For 2013, this variable meets our expectation. This might be a result of sampling probability. Being a part of bigger firm is again positive and significant. There are also two variables that negative and significant. National share have negative and significant as we expected. Second size variable, SME, have also negative and significant only one equation. Smaller firm size indicates decreasing probability of investment in R&D.

Table 4. Estimation Results for 2013.

	(1)	(2)	(3)	(4)	(5)
SIZE	-1.45e-08	-1.29e-08			-1.51e-08
	(-0.90)	(-0.77)			(-0.89)
$SIZE^2$	3.23e-18	2.88e-18			3.36e-18
	(0.86)	(0.74)			(0.86)
EXSHARE	0.020		0.018	0.020	0.020
	(1.71)		(1.65)	(1.61)	(1.70)
FOROW	0.038***	0.030***	0.036***	0.036***	0.038***
	(4.01)	(3.43)	(3.98)	(3.89)	(4.00)
PUSUB	-0.185	-0.499	-0.070	-0.281	-0.194
	(-0.30)	(-0.45)	(-0.11)	(-0.43)	(-0.31)
NASHARE		-0.016*			
		(-1.98)			
POBIG	1.943*	1.858*		1.896*	1.915*
	(2.19)	(2.02)		(2.02)	(2.20)

SME (1 if ≤19)			-0.518*	0.157	-0.102
			(-2.39)	(0.94)	(-0.89)
Constant	-3.108***	-1.494**	-2.461***	-3.317***	-3.014***
	(-10.21)	(-2.80)	(-23.99)	(-5.96)	(-14.14)
Sector					
Constant	0.653	0.729	0.607	0.649	0.677
	(1.62)	(1.74)	(1.95)	(1.52)	(1.58)
N	734	734	734	734	734

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5. Conclusion

Importance of technology in countries' development process is undeniable fact. Technological developments are derived from research and development activities. That is why countries have to figure out the determinants of R&D investment drivers. In this study, we tried to exposure these drivers in Turkey for 2008 and 2013. According to the estimation results, we found that Schumpeterian hypothesis is valid in Turkey, at least for 2008. Probability of R&D investment increases with firm size. This increment is not linear to size. After some point, if firm size continues to increase, the probability of R&D investment begin to decrease.

Export share in total sale and public support are other important and positive impact variables. Especially export share is important for developing countries like Turkey. Export is fundamental foreign currency source of developing countries. Export is also competition source in foreign markets. We confirm the export's competition impact by looking at national share in total sale. National share variable is negative and significant for two years. In this sense, export have very important variable that policy makers must take into account. As we stated, size is important for increment of probability of investment, at least at some point. R&D activities require big financial sources. Small firms do not have generally these sources. Public found supports are crucial in this situation.

Firms could be a part of other bigger firm or have foreign owners. These situations might be seen as financial support sources. For 2008, estimation results show that foreign ownership share is negatively associated with probability of investment. This might occur because of foreign owners only want to invest R&D in home country and transfer their innovations to foreign countries. But when we look at the estimation results for 2013, the sign of variables turns positive and again it is significant. Second variable that we consider in this paragraph has positive and significant effect for two years. This confirms our expectation. If firm is a part of other bigger firm, it might access finance easily.

Policy makers can take into account these variables in order to develop better economic policies.

References

Becker, B. (2013). The determinants of R&D investment: a survey of the empirical research. *Loughborough Universtiy Economics Discussion Paper Series, 2013-09*.

Bhattacharya, M. & Bloch, H. (2004). Determinants of innovation. *Small Business Economics*, *22*, 155-162.

Braga, H. & Willmore, L. (1991). Technological imports and technological effort : an analysis of their determinants in Brazilian firms. *Journal of Industrial Economics, 39(4)*, 421-432.

Cohen, W. M. & Levin, R. C. (1989). Empirical studies of innovation and market structure. In R. Schmalensee & R. Willig (Eds.), *Handbook of Industrial Organizatio, 2*, (pp. 1059-1107). The Netherlands: Elsevier.

Cohen, W. M., Levin, R. C., & Mowery, D. C. (1987). Firm size and R&D intensity: a re-examination. *Journal of Industrial Economics, 35(4)*, 543-565.

Costa-Campi, M. T., Duch-Brown, N. & Garcia-Quevedo, J. (2014). R&D drivers and obstacles to innovation in the energy industry. *Energy Economics, 46*, 20-30.

Demir, M. & Geyik, O. (2014).Development process of R&D and innovation expenditures in Turkey and its impact on economy. *Journal of Life Economics, 2* (in Turkish).

Dosi, G. (1988). Sources, procedures, and microeconomic effects of innovation. *Journal of Economic Literature, 26(3)*, 1120-1171.

Griffith, R., Huergo, E., Mairesse, J. & Peters, B. (2006). Innovation and productivity across four European countries. *Oxford Review of Economic Policy*, *22(4)*, 483-498.

Hall, B. H. (2002). The financing of research and development. *Oxford Review of Economic Policy, 18(1)*, 35-51.

Hall, B. H., Lotti, F. & Mairesse, J. (2009). Innovation and productivity in SMEs: empirical evidence for Italy. *Small Business Economics, 33*, 13-33.

Hoshmer, D. W., Lemeshow, S. & Sturdivant, R. X. (2013). *Applied Logistics Regression* (3rd ed.). USA: Wiley.

Kaimen, M. I. & Schwartz, N. L. (1975). Market structure and innovation: a survey. *Journal of Economic Literature, 13(1)*, 1-37.

Kumar, N. & Saqib, M. (1994). Firm size, opportunities for adaptation, and in-house R&D activity in developing countries: the case of Indian manufacturing. *UNU/INTECH Working Paper No. 13.*

OECD (2015). Main science and technology indicators. 2014(2), http://dx.doi.org/10.1787/msti-v2014-2-en.

Piekut, M. (2013). Comparison of R&D expenditures in selected countries. *Comparative Economic Research: Central and Eastern Europe, 16(3).*

Rabe-Hesketh, S. & Skrondal, A. (2006). Multilevel modeling of complex survey data. *Journal of the Royal Statistical Society: Series A (Statistics in Society), 169(4)*, 805-827.

Schumpeter, J. A. (1950). *Capitalism, socialism and democracy* (3rd ed.) New York: Hamper and Row.

Seerga-Blasco, A. (2010). Innovation and productivity in manufacturing and service firms in Catalonia: a regional approach, *Economics of Innovation and New Technology*, *19(3)*, 233-258.

Siddharthan, N. S. & Agarwal, R. N. (1992). Determinants of R&D decisions: a cross-section study of Indian private corporate firms. *Economics of Innovation and New Technology, 2(2)*, 103-110.

Soybilen, B. (2013). Türkiye'de inovasyon: nicelik var nitelik yok. *Betam Research Note*, *No. 13/158* (in Turkish).

Tezcan, K., & Yanıktepe, B. (2006). Current situation of R&D and tax incentives in Turkey. *Ç. Ü. Sosyal Bilimler Enstitüsü Dergisi, 15(2)*, 267-282.

Urem, B. (1999). R&D behavior of firms in transition economies: an analysis of the key determinants. In D. A. Dyker & S. Radosevic (Eds.), *Innovation and Structural Change in Post-Socialist Countries: A Quantitative Approach* (pp. 173-184). Kluwer Academic Publisher.