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R&D and Export Decision: Evidence from Turkey

Esra BALLI[1*] Çiler SİGEZE[2]
1.Çukurova University, FEAS, Department of Economics, Adana, Turkey
2.Çukurova University, FEAS, Department of Econometrics, Adana, Turkey

Abstract
This study analyzes the relationship between export and R&D expenditure using Probit and Tobit models for Turkish manufacturing industry. Besides testing the suggested relationships discussed in literature, we particularly focus on examination of the relationship between export and labor productivity, i.e. presence of self selection and learning by exporting effects for Turkish firms. To this end, we employ a regression setting estimated by seemingly unrelated regression (SURE) technique. The findings show that convincing signs of self selection effect are present in Turkey, while there is no evidence on the presence of learning by exporting effect.
Keywords: Research and Development, Export, Learning-by-Exporting, Self- Selection, Turkey.

1. Introduction

Most of the existing studies on export-oriented growth agree that an export-oriented policy is a successful strategy for developing economies, as it leads to higher output growth and allows exporters to learn advanced foreign technologies. Among these expected outcomes the latter is particularly important for developing countries because access to advanced foreign technologies in international markets encourages exporters to learn advanced knowledge and trigger higher productivity and, at the end of the day, to employ a strategy with higher level of innovation activities (Golovko and Valentini, 2011). Thus, through innovation, firms can enter new foreign markets across the world with new and competitive products. Turkish manufacturing industry is composed of mainly labor-intensive industries, which hardly allocate resources to R&D efforts. Considering the prospective effects and implications of innovative research this issue poses very important limitations for Turkey's economic growth in the long run. Export decision of Turkish firms also amount to the concerns on composition of growth of Turkey as the latest figures show that between 2003-2012, 140678 Turkish firms made export decision while only 8789 out of 140678 Turkish firms were continuous exporters (Akel, 2014).

Cohen and Levinthal (1989) argue that invest in R&D has outcomes in two directions: The first one is to direct productivity gains through innovation, and the second one is the learning by exporting. Despite possible promising outcomes, R&D expenditure and related export decisions are not always an easy choice for the firms. Wakelin (1998) argues that smaller firms may not opt for allocating resources to R&D and entering the export markets because of sinking costs risk and cost of searching out new markets. In this sense there are two hypothesis outlined in literature regarding productivity of exporting firms: The first is self-selection hypothesis that asserts that only more productive firms are more likely to enter into export markets, for engaging in foreign trade implies further costs related to operating in foreign countries. Secondly, learning by exporting hypothesis suggesting that exporting firms can have access to information set of their trade partners and competitors, causing further productivity gains for the exporting firm. Griffith (2003) concludes that R&D activities influence innovation and the ability of adapting newly introduced technologies of the companies in the same sector. Griffith et. al. (2006) find that the level of innovation activities determines productivity level. There are a variety of views in literature trying to explain firms' export decision. Cassiman and Golovko, (2011) show empirical evidence on positive association between successful product innovation and export decision for small and medium enterprises. In a further study, Golovko and Valentini (2011) indicate that innovation and export decisions are positively related for Spanish manufacturing firms. According to Melitz (2003) firms make a decision on export once firms achieve a productivity threshold. Hall and Mairesse (1995), on the other hand, indicate that a sustained R&D expenditures lead to productivity gains for French manufacturing firms. Crépon et. al. (1998) provides evidence on the presence the positive correlation between productivity and R&D for French manufacturing firms. Aw and Hwang (1995) point out that productivity differences have an important role for a firm to be exporter or non-exporter. Bernard and Jensen (1999) indicate that firms with higher productivity are tending to be exporter. Aw et al. (2007) find that firm productivity results in export decision. Lööf et al. (2015) found that persistent innovators and exporters can obtain higher productivity growth for Swedish manufacturing firm.

Considering studies focusing on R&D and export decision for Turkish firms, Aysan and Hacihasanoglu (2007) find that an increase in productivity leads to export decision in Turkey. Consistently, Aldan and Gunay (2008) find that larger and more productive firms self select into export market, along with the increasing effects of export on labor productivity for Turkey. Besides, Arvas and Uyar (2014) show that heterogeneous structure of productivity is present between net exporters and net-importers. Cebeci and Fernandes (2015) find that export growth is highly driven by continuous exporter firms. Focusing on the survival strategies of Turkish firms

Demirhan (2015) finds that Turkish manufacturing exports can be boosted by assisting efficient, but financially incapable firms and by promoting the importance of quality. Regarding the empirical evidence of the presence of learning by exporting and self-selection hypotheses in Turkey, Yasar and Rejesus (2005) find the symptoms of learning by exporting Turkey for the period of 1990–1996. Maggioni (2012) examine the relationship between exports and productivity for Turkey utilizing Yasar ve Rejesus (2005)'s methodology. He finds evidence in favor of both self-selection and learning by exporting hypothesis. Contrary to previous study, Kiliçaslan and Erdogan (2012) find no evidence of learning by exporting hypothesis in Turkey for the period of 1997- 2007.

This study aims to investigate to what extent the patterns observed in the behavior of Turkish firms are in line with the discussions in literature, by using a dataset obtained from the World Bank's recent micro level survey on Turkish firms. Our main motivation stems from the fact that there is limited number of studies on Turkey although the issue poses important policy implications. In particularly, we place a special emphasis on the relationship between R&D and export decisions, as well as on the presence of self-selection and learning by exporting hypothesis in Turkey. The reminder of this paper is as follows. The second section presents the empirical strategy. The third section summarizes the data used. The fourth section reports empirical results and the fifth section concludes.

2. Method

We investigate the relationship between export and R&D expenditure and the relationship between export and labor productivity in three steps. Firstly we consider the decision whether to invest in R&D or not. For this purpose, we utilize Probit model in which the dependent variable is binary variable that takes the value of 1 if a firm has a positive R&D expenditure. Probit model is especially useful for estimation with binary dependent variable as it allows us to estimate conditional probability that an event will occur under the condition of a given X. Following Greene (2003) terminology Probit model is defined as

$$P(Y=1\,|\,x)=\int_{-\infty}^{x'\beta}\phi(t)dt=\Phi(x'\beta)$$

where x and β denote the set of covariates and corresponding parameters, respectively while $\Phi(.)$ stands for cumulative normal distribution function. Secondly, to estimate the determinants of R&D expenditures, we employ Tobit model proposed by Tobin (1958). Tobit models are especially useful to treat datasets that involve zero responses to significant proportions. This nature of the Tobit model significantly coincides with the nature of R&D expenditures in Turkey where a big majority of the firms do not opt for spending on R&D.

Using Cameron and Trivedi's (2005) terminology, general form of Tobit model can be given as

$$y_i^*=x_i'\beta+\varepsilon_i, \qquad (1)$$

where the error term

$$\varepsilon\sim \mathrm{N}(0,\sigma^2)$$

has homoscedastic variance σ^2 across observations. This implies that the latent variable $y_i^*\sim \mathrm{N}(x_i'\beta,\sigma^2)$. The observed y is defined by

$$y_i = - \text{ if } y_i^*\le 0, \qquad (2)$$

$$y_i = y_i^* \text{ if } y_i^*>0, \qquad (3)$$

where – means that y is observed to be missing. No particular value of y is necessarily observed when $y^*\le 0$, though in some settings such as R&D expenditures we observe y = 0.

In general, we follow a model specification suggested by Yang and Chen (2012) to investigate the determinants of R&D, in both Probit and Tobit models. The independent variables used are Size, Skill, MNC, CR-4, capital intensity, export intensity, SCI, and year. Following Yang and Chen (2012), firm's foreign ownership (MNC) proxies firms' international ties by a categorical variable coded to indicate a given firm's foreign ownership (MNC). Capital intensity (KL) variable is computed as total sales per employee. Following Özler, Taymaz and Yilmaz (2009) and Yang and Chen (2012) we control for firms' size by including a variable (SIZE) indicating firm's total number of employees. The variable Skill represents the ratio of university graduates to total employees; CR-4 shows 4-digit industry concentration ratio as a percentage; export intensity (EXP) is measured the ratio of export expenditure to total sales as a percentage and finally SCI used as a science based industries. Chemical, fabricated metal products and textile are selected as science based industries. Table 1 presents descriptive statistics and definitions of the variables.

$$RD=\beta_0+\beta_1\ln SIZE+\beta_2 SKILL+\beta_3 MNC+\beta_4 CR4+\beta_5\ln KL + \beta_6 EXP+\beta_7 SCI+\beta_8 Year \qquad (4)$$

For a better evaluation of the presence of self-selection and learning by exporting hypothesis, as the second part of our empirical strategy, we apply seemingly unrelated regression estimation (SURE) method for it accounts for the causal relations in revealing the relationship between export and labor productivity that are defined as the ratio of export expenditure to total sales as a percentage and the ratio of total sales to working hours, respectively. In the SURE model it is possible to assume that the equations are associated via the correlations in errors and to obtain an estimation that gives estimators that are at least asymptotically more efficient than those provided by an equation-by-equation Ordinary Least Square (OLS) (Zellner, 1962). In the SURE model, apart from the variables included in Probit and Tobit specifications, we consider the effect of share of foreign ownership (MNC), the firm's export share in region's exports in sample as a percentage (DEXP) and forecasted instrumental variable RD_{exp} from the Tobit model in equation (1).

$$LnLP = \alpha_0 + \alpha_1 RD_{\exp} + \alpha_2 \ln KL + \alpha_3 EXP + \alpha_4 MNC + \alpha_5 Year \qquad (5)$$

$$EXP = \gamma_0 + \gamma_1 RD_{\exp} + \gamma_2 \ln KL + \gamma_3 DEXP + \gamma_4 MNC + \gamma_5 LnLP + \gamma_6 Year \qquad (6)$$

3. Data

This study uses data extracted from the World Bank's Turkey-Enterprise Survey conducted in 2013 and 2014 in a cross-section study through face-to-face interviews with the establishments. The World Bank's motivation to collect and form such data set is to provide researchers a well grounded information on Turkish firms, which may be useful in understanding of firms' behavior in Turkey. This dataset is particularly useful as it provides important information on some vital aspects such as obstacles in enterprise growth, the constraints on creating employment and increasing productivity, the firms' ability to deal with international competition, and the response of the firms to domestic structural reforms. Additionally, because this survey studies were conducted in world wide scale, it is possible to compare and distinguish differences in business climates of the countries for which the survey study was carried out. The survey includes 1344 total number of Turkish firms selected based on industry, establishment size and region stratification. However, after omitting observations with missing and outlier responses on the variables involved in the empirical models, we end up with the sample size of 576. The advantage of the dataset in this study lies in that it constitutes the most recent sample set available, reflecting the behaviors of firms from different dimensions such as industry, establishment size and regions in Turkey. Therefore, authors of this paper believe that the paper improves upon the existing studies both in terms of use of a new dataset.

Table 1. Variable definitions and summary statistics

Variable	Definitions	Mean	Std. Dev.
LP	Labor productivity: as a ratio of total sales to working hours	78.81	273.73
KL	Capital intensity: total sales per employee	209749.52	733786.4
SIZE	Firm's total number of employees	32679929.77	20881327 2.6
SKILL	Ratio of university graduates to total employees	10.81	14.60
RD	Dummy variable equals 1 if R&D expenditure is positive	0.07	0.25
RDI	R&D intensity: the ratio of R&D expenditure to total sales (%)	0.14	0.94
EXP	Export intensity: the ratio of export expenditure to total sales (%)	32.21	36.02
MNC	Foreign ownership: share of foreign ownership (%)	2.8	13.58
CR4	4-digit industry concentration ratio (%)	2274.63	629.56
SCI	Dummy variable for science based industries: Fabricated metal products, Chemical and Textile	0.42	0.49
DEXP	Firm's export share in region's exports in the sample(%)	75.1	425.89
Year	Dummy equals 1 if firm was interviewed in 2014	0.58	0.49

Table 2 represents that R&D intensity is varying from industry to industry. The general tendency indicates that R&D expenditure in Turkey exhibits quite low levels, ranging from 0.001% to 0.455%. However, chemical and fabricated metal products industries invest in R&D more relative to all other industries including, food, textile and garments. On the other hand, garments, chemical, textile and non-metal products industries have the highest export intensity levels with 44.5%, 34.3%, 33% and 30% , respectively. Besides, the highest labor productivity level is in chemical industry with the value of 177.73, whereas the lowest is in garment industry with 30.868, reflecting a significant level of heterogeneity in terms of labor productivity in Turkey.

Table 2. Industry distribution and the corresponding R&D intensity, export intensity and labor productivity levels in Turkey

Industry	Number of observation	R&D intensity (%)	Export intensity (%)	Labor Productivity
Food	68	0.137	24.529	79.172
Textile	97	0.078	33.051	57.359
Chemical	93	0.202	34.354	177.733
Non-metal products	86	0.102	30.43	52.053
Fabricated metal products	67	0.455	24.656	92.245
Garments	92	0.001	44.489	30.868
Other manufacturing	73	0.083	29.041	60.611

4. Results

Table 3 depicts the determinants of R&D activity for Turkish manufacturing firms. Estimated parameters of the Probit and Tobit models display similarities from different aspects such as sign, magnitude and significance levels. Firm size and science based industries are positively and significantly associated with both participation and expenditure decision of R&D as expected initially. Among these, the former finding supports that higher scale companies are more likely to devote resources to R&D in Turkey, confirming the hypothesis, whereas the latter shows that science based firms have a tendency towards a higher R&D propensity and intensity. According to the models, skilled labor presence is found to be a significant determinant of R&D activity. However, the firms with higher capital intensity are expected to carry out less R&D activity. Surprisingly, models estimated show that exporting firms are less likely to engage in R&D activity. This finding is consistent with Akel (2014) suggesting that exporter Turkish firms enter the same markets with the same products. In addition, multinational partnership and CR-4 do not affect participation and expenditure decision of R&D. Finally, the variable year indicates that in 2013 firms participated and allocated more resources to R&D compared to 2014.

Table 3. Determinants of R&D activity for manufacturing firms in Turkey

	Probit Model	Tobit Model
Constant	-2.487***	-11.448**
	(0.68)	(3.666)
lnKL	-0.332*	-1.633*
	(0.182)	(0.921)
lnSIZE	0.365**	1.598**
	(0.144)	(0.742)
SKILL	0.013**	0.06**
	(0.004)	(0.024)
EXP	-0.007**	-0.029**
	(0.002)	(0.014)
MNC	-0,004	-0.027
	(0.006)	(0.036)
CR4	0.0001	0.0006
	(0.0001)	(0.0006)
SCI	0.4**	2.074**
	(0.169)	(0.878)
Year	-0.326*	-1.887**
	(0.175)	(0.892)
Sigma		5.084***
		(0.670)

Figures in the parentheses are standard deviations, ***,** and * denote coefficient are significant at 1%, 5%, and 10% statistical levels, respectively.

In the Table 4, SURE model estimates where finds regarding the presence of self-selection and learning by exporting effects in Turkey are presented can be found. The parameter of interest for self selection hypothesis is labor productivity in export equation (3). The value of relevant parameter is estimated to have positive and significant effect on exporting with the value of 21.368. This find reflects that self selection hypothesis is valid for Turkish manufacturing firms. On the other hand, in the productivity equation (2) export variable is insignificant, implying invalidity of learning by exporting in turkey within the given period.

Table 4. SURE estimates of interrelation of R&D, Labor productivity and Export intensity

	Productivity Equation	Export Equation
constant	-3.457***	47.145
	(0.047)	(33.814)
RD*	0.006*	-8.136***
	(0.003)	(0.692)
lnKL	1.008***	-21.719**
	(0.007)	(9.508)
EXP	0.0003	
	(0.0001)	
MNC	-0,0008**	0.223**
	(0.0004)	(0.098)
Year	0.056***	14,956*
	(0.012)	-2.835
LnLP		21.368**
		(9.223)
DEXP		1.473***
		(0.320)

Figures in the parentheses are standard deviations, ***,** and * denote coefficient are significant at 1%,5%, and 10% statistical levels, respectively

Apart from these main findings endogenous RD variable has been found to be significant at %10 and %1 statistical levels in productivity equation (2) and export equation (3), respectively. Surprisingly, capital intensity has negative and significant effect on export in Turkey. This find can also be attributed to composition of goods and services of Turkish firms' export. Besides, capital intensity has positive and significant effect in productivity equation, as can be expected.

5. Conclusion

This study investigates the determinants of R&D activities as well as mutual relationship among R&D, productivity and export in the Turkish economy using data from the World Bank's Turkey-Enterprise Survey conducted in 2013 and 2014 in a cross-section study through face-to-face interviews with the establishments. A more particular aim of this study is to test the presence of self selection hypothesis and learning by exporting effects for Turkey in the scope of the given period and sample.

Given the data set and econometric techniques employed it is evident that firm size and science based industries are positively and significantly associated with R&D activity as expected. Higher skilled employees play an important role to lead innovation outcomes in Turkey. Interestingly, our empirical findings signal that multinational foreign ownership does not put any positive contribution to R&D expenditures, ultimately innovative activities in Turkey. It can be interpreted that the Turkish Economy attracts multinational companies not with the motivation of improving R&D activities but thanks to its relatively cheap labor.

The results suggest that Turkish manufacturing firms exhibit the symptoms of self selection hypothesis as more productive firms tend to export more as compared to relatively less productive firms. However, learning by exporting effect is invalid for Turkey. Overall, Turkey lacks one of the most important pillars of international trade, learning by exporting, given the present structure and empirical results. This implies that fundamental transformation is needed to tackle the barriers limiting the potentials of learning by exporting. In this sense the importance of R&D must be understood by the government and firms to increase and sustain utilizing from the benefits of international trade. Besides, this study confirms the previously found evidence that Turkish firms are inclined to enter the same markets with the same products and far from diversification of both. This barrier can be abolished by creating incentives and providing assistance for market and product diversification.

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