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ARTICLE INFO	ABSTRACT
	Purpose The purpose of this paper is to present an investigation into the relationships between Research and Development (R&D) and export decisions in Turkey. We empirically test to what extent firms' R&D and export decisions are determined on the basis of firm-specific characteristics such as labour productivity, total sales, age, skill, capital intensity, foreign ownership and transfer of technology. **Design/methodology/approach:** Data used in this study was extracted from the World Bank's Turkey-Enterprise Survey conducted in 2013 and 2014 in a cross-section study undertaken in face-to-face interviews with the establishments. Bivariate Probit estimation is utilized. **Findings:** Our main findings show that learning by examining the export effect is invalid for Turkey. Additionally, as expected, government support and the transfer of technology increases the probability of a decision to export. Furthermore, both export and R&D decisions exhibits substantial differences on the basis of firm characteristics. **Research limitations/implications**: Our principle findings lead to the implication that Turkish government support for small firms can particularly be employed as a mechanism to cope against the obstacles posing limitations on small firms to make a decision to export. **Originality/value**: The novelty of this study is that it uses data extracted from one of the most recent and reliable surveys conducted by the World Bank on the behaviour of firms in Turkey.

1. Introduction

The relationship between Research and Development (R&D) and the decision to export has been of great interest in firm-level studies. An increase in a firm's R&D expenditure is regarded as one of the main strategies to deal with competition stemming from globalization. Theoretical and empirical studies show a positive relationship between a firms R&D ability and export capability. Most 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. Accordingly, access to advanced foreign technologies in international markets

encourages exporters to learn advanced knowledge, resulting in higher productivity. In particularly, Cohen and Levinthal (1989) argue that investment in R&D has outcomes in two directions: The first one is to direct productivity gains through innovation, and the second one is learning by exporting. Substantially, there are two hypotheses outlined regarding productivity of exporting firms: The first is the self-selection hypothesis that asserts that only the most productive firms are more likely to enter into export markets, since engaging in foreign trade implies greater costs related to operating in those foreign countries. Secondly, the learning by exporting hypothesis affirms that exporting firms can have access to their trade partners and competitors' information sets, engendering a further productivity gain for the exporting firm. This study aims to investigate the extent that the patterns observed in the behaviour of Turkish firms are in line with

the discussions in literature, using a dataset obtained from the World Bank's recent micro-level survey on Turkish firms. Our main motivation stems from the fact that a limited number of studies were undertaken on this in Turkey despite the fact that the issue poses important policy implications. In particular, we place a special emphasis on the relationship between R&D and export decisions in Turkey, as well as on the presence of self-selection and learning by the export hypothesis. This article is arranged as follows; the following section presents a literature review on the relationship between exports and R&D decisions. The third section briefly details developments in export and R&D expenditure in Turkey. The data and variables are presented in section four. We present the empirical strategy and empirical results in the fifth and sixth sections respectively. The conclusions are presented in the seventh section.

2. Literature Review

Most empirical studies have agreed that R&D plays a crucial role in a firm's export decision and its productivity. Yasar and Rejesus (2005) applied the Propensity Score Matching technique and Difference-In-Difference estimators to shed light upon the validity of self-selection and learning by exporting for Turkey during the period of 1990-1996. They found the symptoms of learning by exporting in Turkey. In a further study, Maggioni (2012) examines the relationship between exports and productivity for Turkey depending on Yasar ve Rejesus (2005)'s methodology for the period of 1990-2001. The author finds evidence in favour of both self-selection hypothesis and learning by exporting. Aldan and Gunay (2008) find that while larger and more productive firms self-select into export market, exporting increases labour productivity and employment for Turkey. Aw and Hwang (1995) point out that there are significant differences in productivity levels between exporters and non-exporters in their study. Hall and Mairesse (1995) report that a sustained R&D expenditure causes productivity gains. Crépon et al. (1998) also concludes that there is a positive correlation between productivity and R&D. Srithanpong (2016) finds that Thai firms' decision to participate in R&D activities is positively affected by their government's support. Golovko and Valentini (2011) find that firms that invest in innovation are considerably more likely to export. Van Beveren and Vandenbussche (2010) report that firms self-select R&D activities to enter into the export market. Ito and Pucik (1993) indicate that firms' export ratio is not related the firms' R&D activities. Bravo-Ortega et al. (2014) find that firms in Chile engaging in R&D activities have a higher tendency to export. R&D expenditure and related export decisions are not always an easy choice for 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. Yang and Chen (2012) find that R&D has a significant impact on both productivity

and exports.[*] In particular, Özler, Taymaz and Yilmaz (2009) present evidence that Turkish firms are highly constrained by these costs of entry to export markets. Basile (2001) tests the relationship between innovation and export behaviour of Italian manufacturing firms using the Tobit model. In the study, export behaviour is used as a probability of a firm to export and as the propensity to export for the exporting firms. The results indicate that innovation activities measured by R&D expenditure are important and make an explanation of heterogeneity in export behaviour of Italian firms.

Griffith et al. (2006) investigate the importance of innovation in productivity using R&D expenditure, innovation output, and productivity for four European countries and found that the level of innovation activities determines productivity level. Bernard and Jensen (1999) find that firms with higher productivity are inclined to export and that plant size is positively associated with the decision to export, despite the gains of exporting for the firms being ambiguous in terms of productivity and wage -growth. Aw et al. (2007) find that firm productivity leads to export decision and there is an evidence of a positive, statistically significant and robust relationship between export participation and future productivity. Girma et al. (2008) examine the two-way relationship between R&D and export activity using a Bivariate Probit estimation technique for firm level databases for Great Britain and the Republic of Ireland. They find that previous exporting experience increase the innovative capability of Irish firms. Caldera (2010) analyses the relationship between innovation and the export behaviour of firms applying random effects of the probit model using firm-level survey data for the period 1990–2002 for Spanish firms over the period 1991–2002. R&D intensity is used as one of the innovation inputs in this study. The empirical results show that innovation has a positive effect on the export decision.

Aw et al. (2011) undertook an analysis, using a dynamic structural model, of a producer's decision to invest in R&D and export for the Taiwanese electronics industry for the period of 2000-2004. The results show that export decisions and invest in R&D or technology are inter-correlated and affect future profitability. Braymen et al. (2011) test the factors that affect new firms exporting within the first four years of operation, for the period of 2004-2007 in the United States, utilizing Bivariate Probit model. The results show that there is a positive relationship between a new firm's R&D decision and its export decision. Yang and Chen (2012) investigate the relation between productivity and exports and in addition, the determinants of R&D activity in Indonesian manufacturing firms, and find that R&D has a significant impact on both productivity and exports. Esteve-Pérez and Rodríguez (2013) investigate exports and R&D using Bivariate Probit model for small and medium-sized enterprises in Spanish manufacturing for, the period of 1990–2006. The results show a clear interdependence between export and R&D activities. Lööf et al. (2015) test

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[*] For more discussion on exporting, and productivity see Wagner (2007) and the references cited therein.

joint effect of exports, innovation and external knowledge on total factor productivity growth for Swedish manufacturing firms and find that persistent innovators and persistent exporters can achieve higher productivity growth through learning, by exporting relative to temporary innovators and exporters.

Becker and Egger (2013) find that firms that innovate are more likely to engage in export activities than firms that do not innovate. Damijan et al. (2008) provided no evidence for the hypothesis that innovation increases the chance of becoming a first-time exporter. Çetin and Cincera (2015) find that firms engaging in R&D activities and firms' exports decisions are correlated for EU countries. Neves et al. (2016) assert that export activities lead to an increase in R&D investment in Portugal. Lechevalier and Ito (2010) find that firms investing in R&D and export tend to maintain R&D or export.

This paper focuses on two types of relationships depicted in the literature. In the first place, we attempt to investigate how the firms' export decision and R&D decision are determined based on the firm's specific characteristics, including, total sales, foreign ownership of the company, government support, labour productivity, age, skill, capital intensity. Secondly, we take into account the interaction between export and R&D decisions for Turkish manufacturing firms. Therefore, examining the factors determining R&D decision for companies informs well-targeted government policies.

3. Developments in export and R&D expenditure in Turkey

Starting from the 1980s, replacing the import-substituting strategy, Turkey has implemented an export-led growth policy, raising the importance of the interaction among export, research and development (R&D) expenditures, and ultimately, the country's economic growth. Table 1 shows exports and R&D expenditures in Turkey between 1996 and 2013.

**Table 1: Turkish exports and R&D expenditures during 1996-2013**

Year	Exports (% of GDP)	Exports (current million US$)	R&D (% of GDP)	Patent applications, residents
1996	21,54	39094,66	0,45	189
1997	24,58	46664,62	0,49	203
1998	21,34	57459,51	0,37	207
1999	19,44	48551,40	0,47	276
2000	20,10	53574,40	0,48	277
2001	27,44	53785,58	0,54	337
2002	25,22	58638,96	0,53	414
2003	22,99	69674,96	0,48	489
2004	23,55	92361,27	0,52	682
2005	21,86	105557,06	0,59	928
2006	22,67	120354,56	0,58	1072
2007	22,32	144466,00	0,72	1810
2008	23,91	174608,49	0,73	2221
2009	23,32	143292,03	0,85	2555
2010	21,21	155074,47	0,84	3180
2011	23,98	185760,02	0,86	3885
2012	26,30	207440,37	0,92	4434
2013	25,65	210846,32	0,94	4392

Source: World Development Indicators

It can be argued that import-led growth policy is determinedly implemented in Turkey. Turkish exports increased during the last two decades except during 2008-2009 global financial crises. The momentum loss suffered during the 2008-2009 financial crisis was quickly overcome in 2011 for a steady increase in exports. Turkey exhibits quite poor performance in terms of R&D share in GDP and patent applications by % of population, relative to OECD countries, although it does shows signs of gaining momentum in the last number of years.

Figure 1. Import and Export Composition of Turkey in 2014
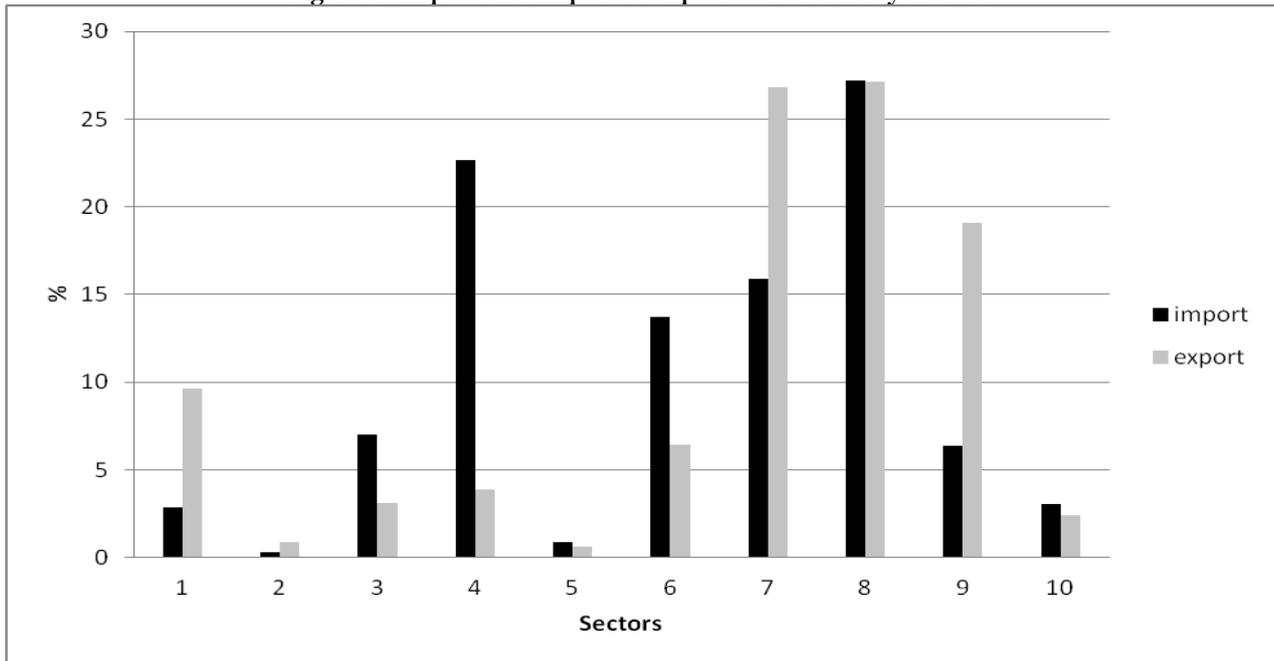
Source: TURKSTAT, 2014

The corresponding sectors in Figure 1 respectively are (1) food and live animals; (2) beverages and tobacco; (3) crude materials, inedible, except fuels; (4) mineral fuels, lubricants and related materials; (5) animal and vegetable oils, fats and waxes; (6) chemicals and related products; (7) manufactured goods classified chiefly by material; (8) machinery and transport equipment; (9) miscellaneous manufactured articles and (10) commodities and transactions not classified elsewhere in the SITC. According to the Figure 1 Turkey has net exports in food and livestock and manufactured goods classified chiefly by material, whereas a high dependency on imports exists in mineral fuels, lubricants and related materials, chemicals and related products and crude materials. Needless to say, the Turkish economy depends heavily on imports of natural resources to manufacture not only domestic goods, but also exports goods, rendering Turkey vulnerable to external shocks such as increases in oil and natural gas price, and, at the end of the day, weakening Turkish exporters' competitiveness. Besides, machinery and transport equipment sector gives an important clue about import-export nexus in Turkey, as it exhibits a dramatic dependence on imported intermediate goods. Inancli and Konak (2011) show that the Turkish automotive industry and its sub-sectors have external dependency on export.

4. Data and Variables

The data used in this study is extracted from the World Bank's Turkey-Enterprise Survey conducted in 2013 and 2014, arising from a cross-section study done through face-to-face interviews with the establishments. In this survey, the total number of selected samples, based on
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industry, establishment size and region stratification, is 1344. However, after omitting observations with missing and outlier responses on the variables involved in the empirical model, we end up with a sample size of 694. The advantage of the data used in this study lies in that it constitutes the most recent sample set available, reflecting the behaviours of firms from different dimensions such as industry, establishment size and regions in Turkey. In addition, this data gives information on export and R&D activities of firms and other firm characteristics.

Following Yang and Chen (2012), we proxy the characteristic of the firms in terms of international ties by a dummy variable structured to indicate a given firm's foreign ownership (MNC). In this point, it should be noted that empirical studies on the effect of foreign ownership on firm's R&D decisions show conflicting and ambiguous results. Lall (1983), for example, found that foreign ownership is a catalyst for a firm to initiate higher R&D activity. On the contrary, Lundin et al. (2007) showed that domestic firms are more inclined to spend more on R&D. In addition to foreign ownership variable, we include capital intensity in our empirical specification. To this end, as suggested by Yang and Chen (2012), capital intensity variable is calculated by the authors as total sales per employee. Last but not least, following Özler, Taymaz and Yilmaz (2009), we include variable transfer of technology from overseas through know-how and license agreements as a proxy for a firm's technology transfer. Table 2 presents descriptive statistics and definitions of the variables.

Table 2. Variable definitions and summary statistics

Variable	Definitions	mean	Std. Dev.
R&D	Dummy R&D: Dummy variable equals 1 if firm has performed export	0.063	0.243
	Dummy Export: Dummy variable equals 1 if firm has performed export		
EXPORT		0.546	0.498
lnkl	Capital intensity: total sales per employee	4.840	0.836
dtech	Dummy Technology Transfer: Dummy variable equals 1 if firm has performed transfer of technology.	0.272	0.016
sales	Total sales of the firm	119	384
skill	Ratio of university graduates to total employees	10.5	14.713
mnc	Firm's Foreign ownership	0.051	0.221
lpr	Labour productivity: as a ratio of total sales to working hours	14436.49	237686.4
govsup	If the firm has received any supports from the national, regional or local governments or European Union sources within last three years	0.110	0.314
age	Age of the firm	19	13

5. Empirical Strategy

In this paper, we investigate the possible relationship between export decision and R&D decision in Turkey. Given that both export decision and R&D decision are correlated and interdependent, the error terms of these equations are highly likely to be correlated. To handle this, we simultaneously model export and R&D decisions, utilizing a recursive Bivariate Probit model. Bivariate Probit estimates a maximum likelihood of two-equation probit models in obtaining parameters of the two simultaneous equations. On the other hand, in the recursive Bivariate Probit model, the endogenous variable R&D appears on the right-hand side of the first equation for export (Greene, 2003, s. 715). Following

Aw et al. (2007), Girma et al. (2007) and Aristei et al. (2013) the empirical model takes the following form;

$$EXPORT_i = \begin{cases} 1 & if \quad EXPORT_i^* > 0 \\ 0 & if \quad EXPORT_i^* < 0 \end{cases}$$

$$R\&D_i = \begin{cases} 1 & if \quad R\&D_i^* > 0 \\ 0 & if \quad R\&D_i^* < 0 \end{cases}$$

$$\begin{cases} EXPORT = \gamma_0 + \gamma_1 R\&D + \gamma_2 dtech + \gamma_3 skill + \gamma_4 \ln age + \gamma_5 gov\sup + \gamma_6 lpr + \gamma_7 \ln sales \\ R\&D = \alpha_0 + \alpha_1 dtech + \alpha_2 \ln kl + \alpha_3 skill + \alpha_4 \ln age + \alpha_5 mnc + \alpha_6 gov\sup + \alpha_7 \ln sales \end{cases}$$

This strategy allows the correlation between the two dependent variables and the error terms with N (0, 1) nature. Here ρ denotes the covariance of the error terms in two simultaneous equations, taking the value of 0 if two decisions in the equations are taken separately. Hence ρ is defined as follows:

$$\begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2,} \end{pmatrix} \sim N \begin{bmatrix} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \end{bmatrix}$$

6. Empirical Results

Table 3 presents recursive Bivariate Probit regressions results. In this setting, we simultaneously estimate the determinants of the R&D and export decisions. The results show that there is no evidence of the presence of learning by exporting effect. Additionally, we can state that transfer of technology (dtech), and skill variables are positively associated with both export and R&D decisions. Furthermore, we cannot reject the null hypothesis that capital intensity (lnkl) has no impact on R&D decision. Besides, firms' age (lnage) and the total sales (lnsales) are positively and significantly associated with export decision. This finding implies that younger

firms are more inclined to initiate with export activities. On the other hand, given the data set and econometric techniques applied, there is evidence that Turkish government-support plays a stimulating role in both export and R&D decisions.

Considering the determinants of export decision of Turkish firms, our estimates indicate that government support increases export decision. In addition, skill measured as a ratio of university graduates to total employees and firm age have significantly positive effects on export decision. These findings show that the more experienced firm, in terms of year of establishment tend to export decision more relative to younger firms. Lastly, firms employing university graduates are more likely to engage in export decision. This may stem from the fact that exporting human capital is an important factor in reacting to international markets.

Table 3: Bivariate Probit Regressions Results

	R&D Decision	Export Decision
Constant	-2.972***	-2.591***
	(0.597)	(0.356)
R&D		-1.996***
		(0.279)
lnkl	0.156	
	(0.152)	
skill	0.016***	0.012***
	(0.004)	(0.003)
lnage	0.065	0.547***
	(0.240)	(0.155)
mnc	-0.012*	
	(0.007)	
govsup	0.413**	0.587***
	(0.203)	(0.173)
lpr		0.00002
		(0.00002)
lnsales	0.036	0.299***
	(0.129)	(0.052)
dtech	0.349**	0.244**
	(0.159)	(0.114)
Wald chi2	185.97***	
ρ	0.916**	
Number of observations	694	

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

7. Conclusion

In this work, we investigated the relationship between R&D decision and exporting activity by using data from the World Bank's Turkey-Enterprise Survey conducted in 2013 and 2014 in a cross-section study done through face-to-face interviews with the establishments, using Bivariate Probit estimation approach. In particular, we focus on the relationship between R&D and export decisions. Given the data set and econometric techniques applied, the empirical results show that the learning by export 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 potential of learning by exporting. In this sense, the importance of R&D must be understood by the government and firms to increase and sustain the benefits of international trade. Besides government subsidies and transfer of technology increases the probability of a firm's export decision, as expected. In other words, government support encourages firms to participate into export and R&D decision. Accordingly, this finding signals that government support for small firms can particularly be

employed as a mechanism to cope against the obstacles posing limitations on small Turkish firms to take export decisions. Our findings are in agreement with that of Esteve-Pérez et al. (2013) arguing that the interrelation between R&D and export should be considered by policy makers.

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