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Product Innovation Strategies: A Firm Level Analysis

Ürün Yenilik Stratejileri: Firma Düzeyi Analizi

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ABSTRACT

In this study, we examine the association between firms' innovation process and their product quality improvement and new product introduction strategies. Our focus is on the distinction between firms' product quality improvement and variety extension objectives. We use data from Turkish Statistical Institute (TURKSTAT) Innovation Survey between the years 2014 and 2016. According to the descriptive results, number of firms report that product quality as very important is greater than the firms report that product variety. Logit estimations results show that majority of the product variety objective and technology level indicators are significant and positively related with probability of product innovation. There is also a positive relationship between probability of product innovation and patent applications for small and medium sized firms. Moreover, probability of innovation is positively related with variety objective whereas quality objective indicators are insignificant.

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ÖZ

Bu çalışmada, firmaların yenilik süreci ile ürün kalite iyileştirme ve yeni ürün tanıtım stratejileri arasındaki ilişkiyi inceliyoruz. Odak noktamız, firmaların ürün kalitesini iyileştirme ve çeşitlerini genişletme hedefleri arasındaki ayrımdır. Türkiye İstatistik Kurumu (TÜİK) Yenilik Araştırması'nın 2014-2016 yılları arasındaki verilerini kullanıyoruz. Tanımlayıcı sonuçlara göre ürün kalitesinin önemli olduğunu bildiren firmarların sayısı ürün çeşitliliğinden daha fazladır. Logit tahmin sonuçları ise, ürün çeşitliliği hedef göstergelerinin çoğu ve teknoloji seviyesi, firma türleri için ürün yeniliği olasılığı ile anlamlı ve pozitif olarak ilişkilidir. Firmaların patent başvuruları ile küçük ve orta ölçekli firmalar için ürün yeniliği olasılığı arasında pozitif bir ilişki olduğunu göstermektedir. Ayrıca, Çeşitlilik hedefi ile yenilik olasılığı artarken, kalite hedefi ile ilgili göstergeler anlamsızdır.

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1. INTRODUCTION

Innovation efforts of firms have essential economic ramifications and important role in economic growth. Both exogenous and endogenous economic growth literature emphasize important connection between innovation and economic growth since 1950s (Solow, 1956; Romer,1990). Following endogenous growth literature, Grossman and Helpman (1991) and Aghion and Howitt (1992) adopt quality ladder approach which shows the improvement in a line of existing products. According to quality ladder approach firms are vertical innovators and new products replace old. Both horizontal (product variety) and vertical (quality ladder) innovations can be among strategic objectives of a firm in order to expand the market share or enter to new markets. On the other hand, Cozzi and Spinesi (2006) developed a theoretical model where horizontal and vertical innovation co-exist. According to their model, quality improvement of existing products is more profitable if new varieties cannot grow at a higher speed than the population growth. Besides empirical literature also focuses on the implications of vertical and horizontal innovation strategies. Klomp and Van Leeuwen (2001) conducts a sensitivity analysis for innovation process and sales of firms. According to the results, firm's focus on innovative strategies effects success of innovation. Lööf and Heshmati (2002) define an innovation equation and show that firm objectives such as product quality and variety are significant determinants of innovation.

Firm strategies and structural differences between firms and industries have significant roles to determine innovative performance for empirical studies. For instance, size (measured by number of workers) could be an important indicator for differences in innovation process at firm level. Roper (1997) applies comparative analysis for innovation objectives of small firms in UK, Ireland and Germany. According to his results, German firms are more risk averse, whereas firms in UK and Ireland are more market responsive. In a comprehensive study for European countries. So that, results represent the behavior of small firms in these economies where outcomes may differ for large firms which might be a different dynamic. By incorporating the effects of structural variables, Rogers (2004) investigates determinants of innovation process with respect to firm sizes i.e. small, medium and large firms. We construct our sample in line with the latter to implement closer representation to the population by including all firm sizes as an addition to Roper's work. Industry structure of an economy could be considered as another structural factor. Rather than using the firm size, Bogliacino and Pianta (2016) examine product innovative firms in science-based sectors. Furthermore, Kim and Lui (2015) emphasize the importance of controlling for sectoral heterogeneity. Therefore, it is crucial to consider structural heterogeneity in terms of technology differences for empirical studies which we also focus on firm level in this study.

In line with the literature mentioned above we emphasize the importance of structural heterogeneity and firm size in this study. First, we argue that both horizontal and vertical innovation strategies should be considered jointly to analyze firm's innovative performance. Second, these parameters would be considered alongside with firm structure where small-medium size firms could present a different result compared to large firms.

This paper is a case study for Turkish firms, and it differs from previous work by focusing on the dichotomy between horizontal and vertical innovation perspectives. Thus, studies regarding Turkey are limited. Karabulut (2015) examine the effectiveness of innovation types on firm performance by implementing factor analysis. According to his results, product innovation has significant impact on firm's financial, customer, internal business processes, learning and growth performance. Gunday et al., (2011) also investigate main types of innovative efforts and their impact on firm enforcement. They suggest that Turkish firms' focus on innovation strategies have significant and positive effect on their overall performance in manufacturing sectors.

In this study, we aim to understand how product quality improvement and new product introduction strategies (both vertical and horizontal) differ in terms of their associations with innovation performance of Turkish firms. We also use structural differences such as firm size, competition and technological discrepancies between sectors as control variables. To our knowledge, this is the first study that incorporates horizontal and vertical innovation perspectives in Turkey. With the analysis conducted here, we try to understand how firm and industry characteristics are correlated with innovation efforts. We believe that revealing this relationship would shed light into quality and quantity approaches in Turkey. Furthermore, results of the study would provide important implications in sectoral and economic growth along with labor market outcomes.

The outline of the study is as follows; second section describes data and methodology. Third section present results. Fourth section concludes.

2. DATA AND METHODOLOGY

We use Innovation Survey for the years 2014-2016 prepared by Turkish Statistical Institute (TURKSTAT). TURKSTAT prepares the survey in accordance with Community Innovation Survey (CIS). Sectoral coverage is based on NACE Rev. 2. Survey includes firms with 10 or more employee and manager of the firm fills the information at the headquarters. The survey covers the information of all affiliated units, provincial and district centers. After excluding firms with missing data, we have 3027 firms in 23 manufacturing sectors in our sample.

We form product innovation variable by using the yes/no question of "During the three years 2014 to 2016, did your enterprise introduce new or significantly improved goods?" We exclude sample related to simple resale of new goods. Our dependent variable is innovation which is an indicator of achieved product innovations by firms. Most importantly, we distinguish between entirely new and improved product strategies of firms. In order to implement this differentiation, we use the following question "During the three years 2014 to 2016, how important were each of the following strategies to your enterprise?" The answers to this question are i) focus on improving your existing goods or services and ii) focus on introducing entirely new goods or services. The answer ranges from 1 (not important) to 4 (very important). We should note that these two indicators are not realized, but they are firm objectives. Thus, we can consider importance attained to variety and quality objectives as strategy variables.

We also create two structural determinants to control for industry profiles. First, we consider market structure to control degree of competition and technological heterogeneity of sectors. We construct 4-firm concentration ratios using firm turnovers in 2016 for each market to measure the strength of competition in equation (1). We calculate 4-firm concentration ratios as the share of the largest four firms' turnover values to the sum the turnover in that industry.

$$\text{Market Concentration} = \frac{\sum_{i}^{\max 4} \text{Turnover}}{\sum_{i}^{\text{industry}} \text{Turnover}} \quad (1)$$

Second, we create a dummy variable for high, medium-high technology sectors in accordance with 2-digit NACE Rev 2 by using OECD Science and Technology Glossary classifications. Technology level variable takes the value of 1 if a firm operates in a medium-high or high technology sector and value of 0 if it operates in a medium-low and low technology industries. Additionally, we also use two innovative capability variables. First variable is the importance of firm's in-house information, which ranges from 1 to 4. Second variable is the patent applications. Patent application is a binary variable, taking the value of 1 if the firm filled patent application(s) during the period and 0 otherwise.

As mentioned above, we use binary product innovation as a dependent variable in the estimation. In this respect, we use logistic regression as our estimation methodology. We apply sampling weights and use robust standard errors to control for heteroscedasticity. We estimate logistic regression as the following:

$$\Pr(N_i) = F(\alpha_0 + \alpha_1 I_i + \alpha_2 Q_i + \alpha_3 S_i + e_i) \quad (2)$$

In eq. 2 N_i is the binary variable of product innovation. I_i is firm's innovative capabilities such as in-house information and patent applications, Q_i represents strategy variables such as variety and quality objectives of firms and S_i shows structural determinants such as market concentration and technology level variables. Therefore, we analyze firm's own innovative efforts and industry environment along with innovation strategies.

3. RESULTS

Figure 1 shows share firms that considers quality and variety objectives as very important. Vertical axis shows the firm size and horizontal axis shows share of important objectives. Darker bars display importance of product quality and lighter bars show importance of product vari-

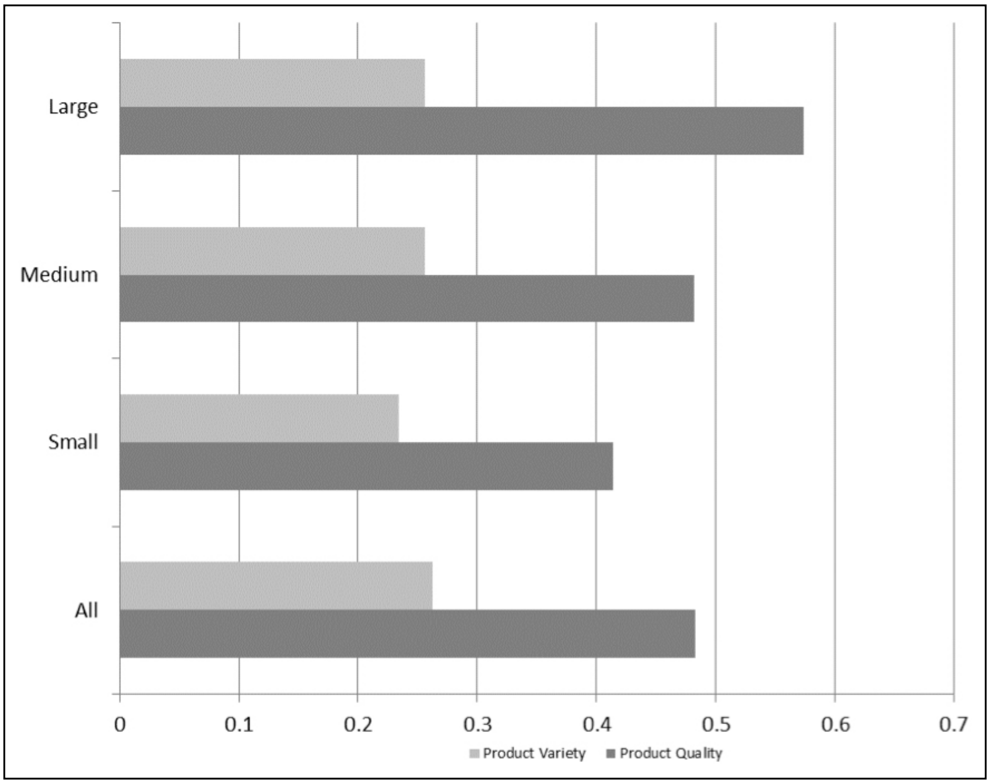

Figure 1. Share of Firms According to Quality and Variety Objectives.

ety. We observe that product variety is more important for large firms. On the other hand, shares on the importance of product quality are very similar for all types of firms.

Figure 2 represents sector compositions and market concentration indices in Turkey. Right axis shows innovation index and left axis shows market concentration index. We observe that high technology sectors such as computer and pharmaceuticals have market concentration ratios around 50 percent. On the other hand, we observe that tobacco industry is the most concentrated sector and food products is the least concentrated sector in Turkey.

Next, we estimate the association between firm's innovative efforts and industry environment. Table 1 shows coefficients from logit estimation results with robust standard

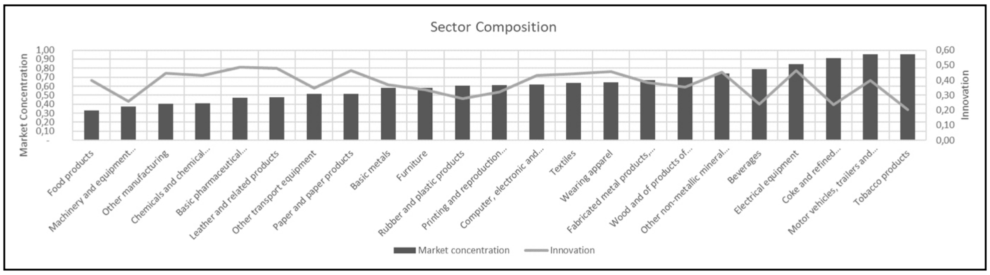

Figure 2. Sector Composition: Innovation and Market Concentration.

Table 1. Binary Logistic Estimation Results for Product Innovation: Coefficients

	(1) All	(2) Small	(3) Medium	(4) Large
VARIABLES				
Patent Application	0.864***	0.965***	0.740***	0.363
	(0.138)	(0.183)	(0.244)	(0.241)
2. In-House Information	0.299	0.364	0.146	-0.354
	(0.255)	(0.294)	(0.592)	(0.412)
3. In-House Information	0.995***	0.978***	1.286***	0.0851
	(0.183)	(0.214)	(0.420)	(0.342)
4. In-House Information	1.284***	1.277***	1.494***	0.495
	(0.182)	(0.220)	(0.411)	(0.305)
2. Variety Objective	0.293	0.353	0.218	0.108
	(0.272)	(0.327)	(0.567)	(0.395)
3. Variety Objective	1.019***	1.005***	1.059**	1.462***
	(0.250)	(0.300)	(0.520)	(0.365)
4. Variety Objective	1.442***	1.340***	1.757***	1.951***
	(0.256)	(0.306)	(0.529)	(0.408)
2. Quality Objective	0.247	0.147	1.175	-0.384
	(0.439)	(0.527)	(0.959)	(0.934)
3. Quality Objective	0.158	0.213	0.433	-1.345
	(0.384)	(0.481)	(0.697)	(0.860)
4. Quality Objective	0.362	0.400	0.745	-1.242
	(0.378)	(0.476)	(0.674)	(0.848)
Market Concentration	-0.326	-0.225	-0.636	-0.556
	(0.364)	(0.469)	(0.700)	(0.590)
Technology Level	0.472***	0.422**	0.650**	0.671***
	(0.142)	(0.181)	(0.272)	(0.233)
Constant	-1.927***	-1.994***	-2.460***	0.429
	(0.426)	(0.541)	(0.782)	(0.883)
R^2	0,1191	0.1126	0.1549	0.1172
Area Under ROC Curve	0.7273	0.7383	0.7367	0.7207
Observations	3027	1201	679	1147

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, ROC curves can be found in Figure 3. Source: Authors' own calculations and TURKSTAT Innovation Survey 2016.

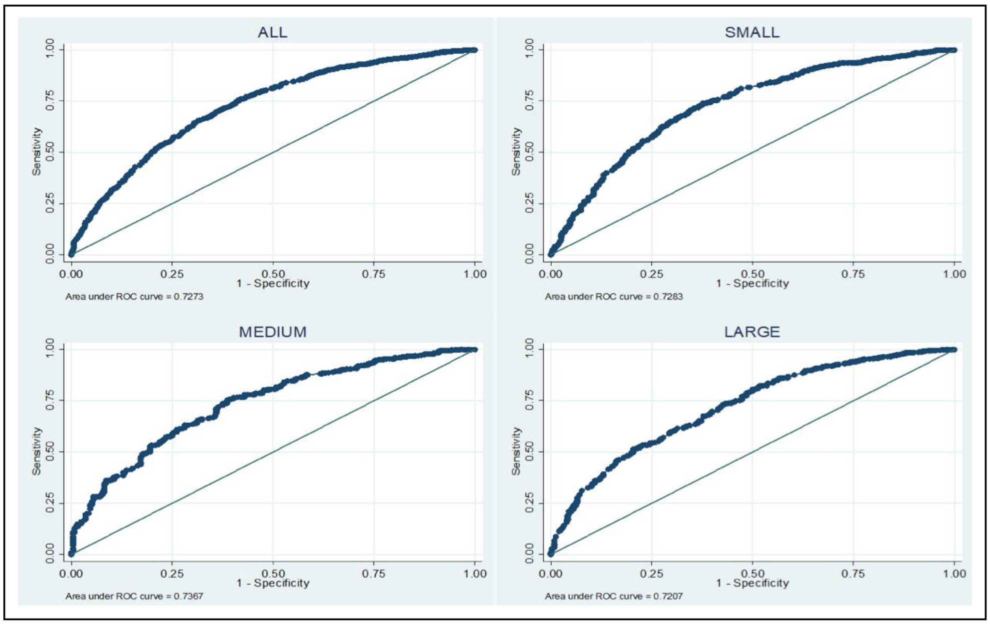

Figure 3. ROC Curves Source: Authors' own calculation based on data from TURKSTAT Innovation Survey 2016.

errors. We also form three sub-samples (small, medium, large) according to firm size. Column (1) presents the results for whole sample. Column (2), column (3) and column (4) show the results for small, medium, and large size firms respectively. Estimation results in column (1) to (3) show that there is a positive relationship between patent applications by firms and probability of product innovation. Moreover, most of the product variety objectives indicators and technology level are significant and positively related with probability of product innovation in all specifications. Thus, we can conclude that probability of innovation increases with variety objective and technology level of the industry. On the other hand, indicators related with quality objective and market concentration are insignificant in all specifications. Although firms' quality objective is positive in all columns, there is no evidence about its impact on innovation probability in our sample. Additionally, negative sign of market concentration indicates that as the industries are more competitive probability of achieving innovation for firm increases. However, its insignificance could be related to relatively small number of firms in some of the industries due to data limitations. Table 1 also presents area under ROC curves. ROC curve shows how strong our model in discriminating between positive and negative outcomes at all possible cutoffs. Thus, as the ROC curve is more concave and closer to the top left corner of the vertical axis, model demonstrates better goodness of fit. When ROC curve is a 45-degree line with an area of 0.5 value, it indicates that model has no explanatory power in classification of binary data. Table 1 indicates a fair value for goodness of fit of our model with larger than 70% area under ROC curves in all samples.

Table 2 presents marginal effects from the logit estimation in Table 1. We observe that coefficients of in-house information and variety objective increases with firm size. For example, Rise in "very important variety objective" increases the probability of achieving product innovation by 0.293 for small firms while this probability is 0.414 for large firms. Furthermore, marginal effect of dummy variable for industry technology level is the highest for medium size firms. Moreover, operating in a high technology market increases the probability to innovate for the medium and large firms more than small firms.

4. CONCLUSION

In this paper, we examine product innovation strategies and contribute to the literature by making a distinction between quality and variety objective of Turkish Firms. We use TURKSTAT Innovation Survey for the years 2014-2016. We observe that giving more importance to product variety extension is positively correlated to firms' innovation process. On the other hand, we observe that quality improvement objective on innovation process has no association with product innovation probability of firms. Moreover, results show that choice of introducing entirely new products as a strategy has significant association with firms' innovation performance. Further this relationship is stronger than the relationship between quality objective and innovation process. Therefore, number of new products (rather than presenting higher quality versions of the existing ones) in the market could increase

This study has some limitations. Firstly, the methodology adapted here is descriptive; the findings can only be interpreted as correlations. Secondly, due to data limitations,

Table 2. Binary Logistic Estimation Results for Product Innovation: Average Marginal Effects

VARIABLES	All	Small	Medium	Large
Patent Application	0.177***	0.202***	0.143***	0.069
	(0.027)	(0.036)	(0.046)	(0.044)
2.In-House Information	0.065	0.079	0.029	-0.074
	(0.056)	(0.064)	(0.121)	(0.087)
3. In-House Information	0.220***	0.217***	0.273***	0.017
	(0.039)	(0.046)	(0.085)	(0.069)
4. In-House Information	0.281***	0.281***	0.314***	0.094
	(0.039)	(0.046)	(0.084)	(0.060)
2.Variety Objective	0.063	0.076	0.045	0.024
	(0.058)	(0.070)	(0.117)	(0.089)
3.Variety Objective	0.225***	0.222***	0.228**	0.329***
	(0.053)	(0.064)	(0.108)	(0.079)
4.Variety Objective	0.313***	0.293***	0.365***	0.414***
	(0.054)	(0.065)	(0.108)	(0.082)
2.Quality Objective	0.052	0.031	0.228	-0.045
	(0.093)	(0.114)	(0.182)	(0.104)
3.Quality Objective	0.033	0.046	0.088	-0.199**
	(0.082)	(0.104)	(0.143)	(0.094)
4.Quality Objective	0.076	0.085	0.150	-0.180**
	(0.081)	(0.103)	(0.139)	(0.091)
Market Concentration	-0.067	-0.047	-0.123	-0.102
	(0.074)	(0.098)	(0.136)	(0.108)
Technology Level	0.097***	0.088**	0.125**	0.123***
	(0.288)	(0.037)	(0.051)	(0.045)
Observations	3027	1201	679	1147

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Source: Authors' own calculations and TURKSTAT Innovation Survey 2016.

time period in the analysis is relatively short for innovation process. Thirdly, macroeconomic environment and regional differences are excluded from the study which may be effective in innovation process as well.

Policy makers can evaluate private sector's innovation activities in accordance with enterprises' different innovative strategies. In this sense, policies directed at these issues could figure out how variety and quality objectives vary with firm size. Furthermore, the distinction suggested in this study would be also beneficial when the R&D subsidies are considered. Subsidies directed to influence private sector's activities would be beneficial in terms of innovation process.

Ethics: There are no ethical issues with the publication of this manuscript.

Peer-review: Externally peer-reviewed.

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