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Research Article

The Relationship Between Logistics Performance and Innovation: An Empirical Study Of Turkish Firms

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ABSTRACT

The aim of the study is to explore whether logistics performance affects firms' innovation decisions. Using Turkey Regional Enterprise Survey conducted between August 2015 and June 2016, we measure logistics performance by transportation costs. We consider several aspects of innovation including process innovation, product innovation, organizational innovation and investments in Research & Development. We also analyze whether the impact of transportation costs on innovation activities varies across industries or regions. Our findings indicate that the impact of transportation costs on R&D activities is highest for firms in the construction sector, whereas for innovation outputs, the impact is greatest for the wholesale & retail sector. Moreover, our results also reveal three regions where transportation costs matter the most for innovation are Ankara, Bursa-Bilecik-Eskisehir and finally Diyarbakir-Sanliurfa.

Keywords: Innovation, Logistics, Turkey

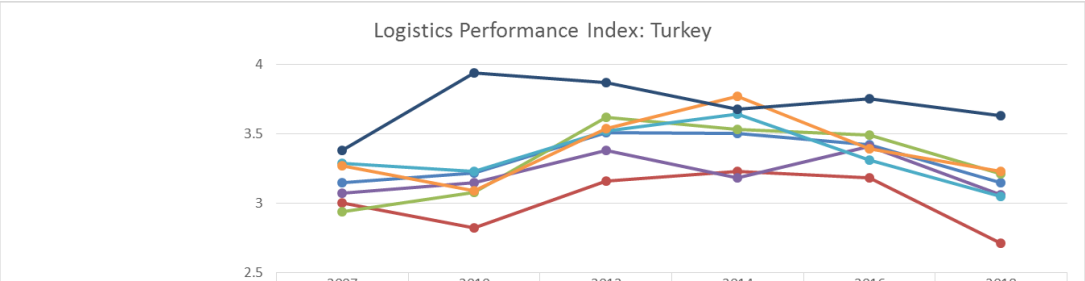
1. Introduction

This study contributes to two strands of literature on the determinants of firm performance. The first strand is that of innovation and performance relationship and its applications in analyzing the impact of various internal and external factors that affect innovation activities. As international competition is increasing, innovation is vital for the survival and maintaining competitive position of firms (Grossman & Helpman, 1993).

Innovation in OECD OSLO Manual (2005) is defined as: "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Our focus is on both inputs (R&D expenditures) and outputs (product, process, and organizational) of innovation activities of Turkish firms.

The second strand is the analysis of logistics-related problems that firms face such as costs, customs, and origin of inputs or supplies. Improvements in logistics services can minimize total delivery costs and customer satisfaction (Daugherty, Ellinger & Gustin, 1996), and thereby contribute to the overall competitive position of firms. Logistics performance has many dimensions such as sales growth, cost-efficiency, low loss and damage, on-time delivery, social responsibility, and product availability (Chow, Heaver & Henriksson, 1994). We focus on transportation costs (fuel and all other logistics costs).

To combine these two strands of literature, we analyze how logistics affects firm-level innovation efforts. We choose Turkey for our empirical analysis. Turkey has a strategic geographical location as it has the potential to act as a hub region that connects Eastern Europe, Central Asia, Middle East, and North Africa. As of 2018, logistics industry makes up 13% of Turkish national income. However, Turkey has yet to reach its full potential in terms of logistics capabilities as can be seen from Figure 1, which shows Logistics Performance Index (LPI) for Turkey.



	2007	2010	2012	2014	2016	2018
LPI	3.15	3.22	3.51	3.5	3.42	3.15
Customs	3	2.82	3.16	3.23	3.18	2.71
Infrastructure	2.94	3.08	3.62	3.53	3.49	3.21
International Shipments	3.07	3.15	3.38	3.18	3.41	3.06
Logistics quality and competence	3.29	3.23	3.52	3.64	3.31	3.05
Tracking and tracing	3.27	3.09	3.54	3.77	3.39	3.23
Timeliness	3.38	3.94	3.87	3.68	3.75	3.63

Figure 1. Logistics Performance Index for Turkey (LPI, World Bank)

LPI has six key dimensions:

1) Efficiency of the clearance process (i.e., speed, simplicity and predictability of formalities) by border control agencies, including customs;

2) Quality of trade and transport related infrastructure (e.g., ports, railroads, roads, information technology);

3) Ease of arranging competitively priced shipments;

4) Competence and quality of logistics services (e.g., transport operators, customs brokers);

5) Ability to track and trace consignments;

6) Timeliness of shipments in reaching destination within the scheduled or expected delivery time (Arvis, Saslavsky, Ojala, Shepherd, Busch & Raj, 2014).

As can be as seen from the figure, over the last years, Turkey's performance has deteriorated in all six components of the LPI. According to Transportation and Logistics Industry Report (2018), firms in Turkish logistics industry are worried about global economic recession as it affects the volume of trade and thus performance of the sector. Moreover, they also see technological advancement and improvement in infrastructure as the most important factors that can contribute to their competitive position.

Thus, a successful innovation system would contribute to national and sectoral performance. However, Turkey's 2017 R&D intensity rate of 0.961 is well below the OECD average of 2.368 and European Union (EU) average of 1.963 (OECD, 2019). Another innovation performance indicator; Global Innovation Index (2018), ranks Turkey 50 out of 126 countries in the overall index and 62 in the innovation input-index. One of the components of the innovation input-index is logistics infrastructure. Thus, logistics and innovation performance of countries are tied to each other.

Thus, the purpose of the study is to analyze whether logistics performance affect firms' innovation performance of Turkish firms. We have used data from the World Bank's Turkey Regional Enterprise Survey (R-ES) for the year 2015, which covers 6006 firms.

To the best of our knowledge, this is the first study that uses this survey. The data is unique for it is the only regional survey for Turkish firms, which covers 26 NUTS-2 regions of Turkey. World Bank states the objectives of this survey as follows:

- "To provide statistically significant business environment indicators that are comparable across regions in Turkey and across all of the world's economies";
- "To assess the constraints to private sector growth and enterprise performance at both the regional and national level";
- "To stimulate policy dialogue on the business environment in the different regions of Turkey and to help shape the agenda for reform."

Our findings show that transportation costs (or investments) promote innovation activities more than other costs do (such as the cost of labor, cost of raw materials and intermediate goods used in production, cost of electricity, cost of sales). Therefore, regulations that improve the efficiency of logistics service providers could lead to reduced transportation costs and lead increased business volumes, which in turn will help boost national income. By showing whether the impact of transportation costs differ across regions and sectors, our results allow drawing

regional and sectoral policy conclusions. For example, we find that policymakers can target textile firms in Bursa and offer subsidies or R&D tax credits to firms engaged in new product development.

The rest of the paper is organized as follows: In the next section, we briefly discuss the literature for the relationship between logistics-related challenges and innovation. In section 3, we first describe the dataset and empirical methodology and then present our main findings. Finally, we conclude the discussion in Section 4 by highlighting some important policy implications.

2. Literature Review

Logistics management can be defined as: "...is the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfillment of orders" (Christopher, 1998, p. 103).

When we review the literature on the relationship between logistics performance and economic growth, we see that the relationship has been studied in several ways. First, investment in transport infrastructure is considered to be a prerequisite of economic development as it creates new markets for goods, links depressed industrial regions and other rural areas to the more prosperous regions and thereby increase overall economic activity (Banister & Berechman, 2003, p.24). Second, firms can reduce travel time and costs by a more efficient logistics system, which also helps to reach a wider area for inputs and stimulate production in peripheral regions (Gunasekera, Anderson & Lakshmanan, 2008; Lean, Huang & Hong, 2014). Third, the quality of transport infrastructure (such as roadway, railway, and waterway) affects the degree of foreign direct investment, which is one of the engines of growth (Hong, 2007). Lastly, lower transport costs and improvements in logistics (logistics innovation) can increase productivity and performance.

Due to its importance, the impact of logistics on innovation can be examined through several channels. One channel is the effects of transportation costs on location choice. Firms may concentrate in certain regions because of proximity to skilled-labor force or non-tradable inputs. Proximity contributes to knowledge spillovers and firms have better production technologies compared to isolated ones. In his well-known work of economic geography, Krugman (1991) argues that transportation costs determine the location of production and the extent to which they are geographically concentrated. That is, if transport costs are low, economies of scale facilitate spatial concentration. In addition, the location would be even more concentrated where knowledge externalities matter more, such as R&D intensive industries. Moreover, greater geographic concentration of production leads to more dispersion of innovative activity. Positive agglomeration effects, which promote innovative activities, are particularly important for the early stages of the industry life cycle. As the industry goes through maturity and decline stages of its life cycle, production will be more concentrated ın peripheral areas within the same region, leading to the dispersion of innovation as well (Audretsch & Feldman, 1996, p. 271). Thus, the literature on economic geography suggests that transport costs affect geographic knowledge spillovers, and thus innovation creation.

This effect of transportation costs on knowledge-spillovers is further studied in innovation-led regional development models in the literature. Tödtling and Trippl (2005, p. 1210) argue one of the important regional barriers to innovation is the presence of old industrial regions where inter-firm networks are too rigid because of strong clustering and overspecialization. Another barrier is the lack of dynamic clusters. Especially in peripheral areas, innovation efforts are weak and interregional knowledge spillovers are low, as small and medium-sized firms dominate them. Both barriers stress the need for the development of linkages to external clusters and knowledge providers. Development of transport technologies and infrastructures and thus the relative decline in transport costs facilitate such linkages (Torre, 2008).

Another channel is through the relationship between logistics services and overall firm performance, which would indirectly affect how much firms invest in innovation activities. For example, problems in transportation (such as theft, breakage or spoilage, and delays in customs) increase lead times in the supply chain. This increases costs for the firms and reduces customer satisfaction (Hertz, Johansson, & de Jager, 2001; Droge, Jayaram & Vickery, 2004). Therefore, improvements in logistics-related services reduce transportation costs which in turn enable firms to serve more markets (Grawe, 2009, p. 361), increase customer satisfaction and firm performance (O'Cass, Song & Yuan, 2013, p. 1061), and thereby provide competitive advantage for firms (Lindberg & Götberg, 2016). Using logistics performance index of 133 countries, Erkan (2014) shows that countries which improve their logistics performance have a more developed technological infrastructure and thus can enlarge their markets. The authors also argue that logistics is one of the key strategic sectors of Turkey and policies should be developed in order to increase the performance of the sector to gain competitive advantages. Another study by Sarıdogan (2013) points out the high costs of logistics sector in Turkey and suggests using emerging strategic cost management approaches to improve performance. Capabilities including innovativeness, flexibility, and knowledge integration in maritime logistics can also promote firms' financial performance (Yorulmaz & Birgun, 2016).

This last channel of improvements in logistics services have gained much attention in literature in recent years and many papers have been published in logistics (and supply chain) innovation and firm performance. Firms' successful innovation investments affect their performance (profitability, growth) positively and provide sustainable competitive advantages. However, to succeed in innovation, they need an effective logistics and supply chain management. Two recent systematic literature reviews are by Gao, Xu, Ruan and Lu (2017) and Tebaldi, Bigliardi and Bottani (2018) stress the need of empirical works in this area. Both works consider the role of logistics innovation in sustainable development, which has three dimensions: economic, social and environmental performance.

While a number of studies have been done in the literature, there is no study that explicitly attempts to measure the impact of transport costs on firms' innovation activities. Second, the geographical location of Turkey makes logistics sector particularly important for its economic development. Therefore, it is important to quantify the contributive role of the sector on innovation, which is the engine of economic growth. Moreover, to determine priority areas for policy development, it is import to find out the relative importance of logistics across regions and industries.

3. Data and Methodology

We use data from Turkey Regional Enterprise Survey (R-ES) 2015. The survey uses stratified random sampling and includes establishments from all different sectors and regions. The survey comprises of the following sectors: all manufacturing sectors according to the group classification of NACE Revision 2.0: (group C), construction sector (group F), services sector (groups G and I), and transport, storage, and communications sector (group H and J). Regional stratification for the Turkey RICA ES was done including eighty-one NUTS 3 regions. All firms had January 2014 to December 2014 as their last complete fiscal year. For questions pertaining to monetary amounts, the unit is the New Turkish Lira.

3.1. Dependent variables

We construct our dependent variables using the following questions in the survey:

- **R&D:** During the last three years, did this establishment spend on formal research and development activities, either in-house or contracted with other companies, excluding market research surveys? (yes/no),
- **New Product:** During the last three years, has this establishment introduced new or significantly improved products or services? (yes/no),
- **New Process:** During the last three years, has this establishment introduced any new or significantly improved methods of manufacturing products or offering services? (yes/no),
- **New Organization:** During the last three years, has this establishment introduced any new or significantly improved organizational structures or management practices? (yes/no).

Out of these, R&D is a measure of innovation inputs (or efforts) while the others are innovation outputs. Table 1 shows the distribution of innovators across industries[1]. Machinery & Vehicles sector has the highest number of innovators for all innovation types except New Organization. Regional distribution in Table 2 shows that Istanbul is the leader region in all innovation types.

	RD=1		New Process=1		New Product=1		New Organization=1	
Sector	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**	**Freq**	**%**
Food	65	17.96	78	13.85	100	13.64	51	14.29
Textiles and apparel	40	11.05	65	11.55	96	13.10	38	10.64
Fabricated metal, machinery, vehicles	66	18.23	98	17.41	134	18.28	58	16.25
Other manufacturing	47	12.98	80	14.21	108	14.73	40	11.20
Construction	63	17.40	77	13.68	105	14.32	67	18.77
Wholesale and retail	25	6.91	83	14.74	104	14.19	41	11.48
Transport	24	6.63	36	6.39	39	5.32	30	8.40
Other services	32	8.84	46	8.17	47	6.41	32	8.96

Table 1. Innovators by Sector (Turkey R-ES, 2015).

[1] Innovators are defined as firms that report "yes" to an innovation activity

	RD=1		New Process=1		New Product=1		New Organization=1	
Region	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Istanbul	77	21.27	93	16.52	131	17.87	50	14.01
Izmir	9	2.49	11	1.95	15	2.05	7	1.96
Bursa, Eskisehir, Bilecik	25	6.91	38	6.75	34	4.64	23	6.44
Kocaeli, Sakarya, Duzce, Bolu, Yalova	20	5.52	22	3.91	31	4.23	18	5.04
Ankara	13	3.59	14	2.49	21	2.86	8	2.24
Antalya, Isparta, Burdur	16	4.42	13	2.31	19	2.59	10	2.80
Tekirdag, Edirne, Kirklareli	12	3.31	15	2.66	16	2.18	12	3.36
Balikesir, Canakkale			3	0.53	5	0.68	2	0.56
Aydin, Denizli, Mugla	26	7.18	35	6.22	55	7.50	18	5.04
Manisa, Afyon, Kutahya, Usak	23	6.35	32	5.68	41	5.59	12	3.36
Konya, Karaman	11	3.04	12	2.13	14	1.91	8	2.24
Adana, Mersin	5	1.38	4	0.71	11	1.50	7	1.96
Kayseri, Sivas, Yozgat	15	4.14	25	4.44	34	4.64	19	5.32
Zonguldak, Karabuk, Bartin	8	2.21	14	2.49	11	1.50	9	2.52
Samsun, Tokat, Corum, Amasya	2	0.55	7	1.24	15	2.05	7	1.96
Hatay, Kahramanmaras, Osmaniye	8	2.21	35	6.22	33	4.50	17	4.76
Kirikkale, Aksaray, Nigde, Nevsehir	5	1.38	22	3.91	22	3.00	18	5.04
Kastamonu, Cankiri, Sinop	6	1.66	18	3.20	35	4.77	9	2.52
Trabzon, Ordu, Giresun, Rize, Artvin	19	5.25	29	5.15	26	3.55	24	6.72
Erzurum, Erzincan, Bayburt	7	1.93	9	1.60	18	2.46	6	1.68
Malatya, Elazig, Bingol, Tunceli	15	4.14	17	3.02	23	3.14	15	4.20
Gaziantep, Adiyaman, Kilis	5	1.38	13	2.31	17	2.32	5	1.40
Agri, Kars, Igdir, Ardahan	1	0.28	5	0.89	5	0.68	1	0.28
Van, Mus, Bitlis, Hakkari	5	1.38	14	2.49	18	2.46	11	3.08
Sanliurfa, Diyarbakir	22	6.08	58	10.30	75	10.23	37	10.36
Mardin, Batman, Sirnak, Siirt	7	1.93	5	0.89	8	1.09	4	1.12
Total	362	100	563	100	733	100	357	100

Table 2. Innovators by Region (Turkey R-ES, 2015).

3.2. Independent variables

3.2.1. Transportation costs

Logistics services include delivery or distribution methods for this establishment's inputs and products. Firms report the biggest obstacle that affects their operations. 3.50% of firms report that transportation is the biggest obstacle. Firms also report total annual cost of logistics and transportation including fuel. Highest average cost is reported by firms located in Kocaeli & Sakarya (Table 3). If we look at industrial classification, food sector reports the highest average costs (Table 4). Table 5 shows that for innovators, transportation costs are higher. This is expected as innovators are more successful firms and thereby they can bear such high costs.

Region	mean	sd	N
Istanbul	79247.57	475903.6	952
Izmir	187226.5	1684277	149
Bursa, Eskisehir, Bilecik	176059.8	1074523	202
Kocaeli, Sakarya, Duzce, Bolu, Yalova	217165.8	2316243	255
Ankara	27236.02	239564.4	161
Antalya, Isparta, Burdur	24154.88	164893.9	205
Tekirdag, Edirne, Kirklareli	48960.83	117188.4	120
Balikesir, Canakkale	106524.3	264069.3	115
Aydin, Denizli, Mugla	58070.42	184769.1	240
Manisa, Afyon, Kutahya, Usak	145946.8	713072.6	244
Konya, Karaman	82239.75	190821.6	161
Adana, Mersin	59478.98	150586.1	157
Kayseri, Sivas, Yozgat	73408.39	136511.9	155
Zonguldak, Karabuk, Bartin	125091.5	410985.2	117
Samsun, Tokat, Corum, Amasya	79656.87	161591.2	211
Hatay, Kahramanmaras, Osmaniye	124821.6	519850.5	299
Kirikkale, Aksaray, Nigde, Nevsehir	43916.92	181534.6	191
Kastamonu, Cankiri, Sinop	139217.3	590564.6	127
Trabzon, Ordu, Giresun, Rize, Artvin	131546.5	820418.5	390
Erzurum, Erzincan, Bayburt	18083.6	72139.42	125
Malatya, Elazig, Bingol, Tunceli	32872.84	126521.2	232
Gaziantep, Adiyaman, Kilis	55095.04	319961.8	241
Agri, Kars, Igdir, Ardahan	9240.645	30968.89	155
Van, Mus, Bitlis, Hakkari	117589.8	898208	240
Sanliurfa, Diyarbakir	45452.53	300252.4	336
Mardin, Batman, Sirnak, Siirt	26570.35	89957.25	226
Total	87492.78	716903.3	6006

Table 3. Transportation Costs by Region (Turkey R-ES, 2015; Authors' own calculations).

Sector	mean	sd	N
Food	195004.6	867707.8	732
Textiles and apparel	98923.02	470237.7	757
Fabricated metal, machinery, vehicles	93492.42	409951.8	720
Other manufacturing	231933.5	1708616	673
Construction	74405.08	467753.3	714
Wholesale and retail	11224.46	70102.37	959
Transport	3542.877	38135.89	709
Other services	24321.36	344703.1	742
Total	87492.78	716903.3	6006

Table 4. Transportation Costs by Sector (Turkey R-ES, 2015; Authors' own calculations).

	mean	p50	sd	N		mean	p50	sd	N
R&D					*New Product*				
No	16,5620.3	30000	729385.8	2123	No	160,547.4	30000	638868.7	1954
Yes	855,582.8	109500	2990142	202	Yes	547,332.1	62000	2376750	385
Total	225,565.4	31000	1138788	2325	*Total*	224,212.2	30020	1135483	2339
New Process					*New Organization*				
No	152,569	30000	579768.3	2035	No	198,637.3	30000	1111975	2142
Yes	731,874.5	80000	2782007	291	Yes	542,126.1	90000	1387611	181
Total	225,044.5	31500	1138496	2326	*Total*	225,400.7	31000	1139230	2323

Table 5. Transportation Costs by Innovators vs Non-innovators (Turkey R-ES, 2015; Authors' own calculations).

3.2.2. Control variables

We use the following control variables that are common in innovation studies.

Age: We calculate firm age as (Year of the survey- Year establishment began operations). The oldest firms belong to food and the youngest firms belong to other services, where mean ages are 31 and 12 respectively.

Size: We have four size categories as micro, small, medium, and large. 48% of firms in our sample are micro sized firms, followed by small-sized firms (26%).

Exporter: Exporter is a dummy variable, which gets the value 1 if firms export either directly or indirectly.

Other costs: Other costs include:

- Total annual cost of labor including wages, salaries, bonuses, social security payments,
- Total annual cost of raw materials and intermediate goods used in production,
- Total annual cost of electricity,
- Total cost of sales,
- Total annual cost of finished goods and materials purchased to resell.

3.3. Methodology

To estimate the relationship between transportation costs and innovation activities by Turkish firms we estimate the following model:

$$\begin{aligned} Innovation_{ijk} = \alpha + \beta_1 \text{age}_{ijk} + \beta_2 \log size_{ijk} \\ + \beta_3 Exporter_{ijk} + \beta_4 \log(Transport\ costs)_{ijk} \\ + \beta_5 \log(Other\ costs)_{ijk} + \varepsilon_{ijk} \end{aligned} \quad (1)$$

where *i* denotes firm, *j* denotes industry, *k* denotes region, and $Innovation_{ijk}$ is any of the four types of innovation- *R&D, New Process*, *New Production*, *New Organization.* Since innovation indicators are measured as binary variables, we use a Probit probability model. We expect transportation costs to have a positive effect on the probability of innovation as such costs indicate a larger market size and perhaps a greater variety of goods supplied. Therefore, such costs could promote innovation and technological spillovers.

Probit models are widely used to explain binary dependent variables and takes the following general form:

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

where *Y* is the discrete dependent variable, *x* is a vector of control variables, and $\Phi(.)$ is the cumulative standard normal distribution function. The set of parameters β reflects the impact of changes in *x* on the probability (Greene, 2008).

A regression with a binary dependent variable *Y* models the probability that *Y=1*. If the Probit coefficient β is positive, an increase in x increases the probability that *Y=1;* if the Probit coefficient β is negative, an increase in x decreases the probability that *Y=1.*

The marginal effects can be calculated by:

$$\frac{\partial E[y|x]}{\partial x} = \emptyset(x'\beta)\beta,$$

where $\emptyset(.)$ is the standard normal density (Greene, 2008). For interpreting the marginal effects, one can evaluate the expressions at the sample means.

Table 6 shows the coefficients of our Probit estimations. In all models, we control for sectoral and regional heterogeneities. Panel A reports the results for model (1) where transportation costs are distinguished from other costs, and Panel (B) reports the results when we control for total cost (to increase the sample size).

Results in Table 6, Panel A indicate that greater firm size increases the probability that firms will engage in R&D, product innovation, and new organization innovation. Larger firms can benefit from economies of scale and it is easier for them to finance their innovation investments. However, for process innovation, we do not find any evidence for the impact of size on innovation. Only in Panel B, where we control for total costs, size becomes an important firm characteristic that affects firms' innovation activities in new production methods. One explanation is that in Panel A, transportation costs capture size effect as well as costs. Larger firms can serve a greater geographical area so they will incur higher transportation costs. In addition, we do not find any significant effect of firm age on any type of innovation activities. However, the sign of the coefficient suggests a negative relationship; i.e., older firms are less likely to innovate. Younger firms face more competition in the market and thus they may be more willing to invest in research to gain competitive advantages. Being an exporter significantly increases the likelihood of innovation as these firms can take advantage of technology transfers.

As for the impact of transportation costs on innovation performance, we find a positive and significant relationship when we measure innovation by R&D expenditures and investments in new methods of production. Other costs including labor and raw material costs does not seem to have the same extent of impact on innovation decisions. Figures 2-7 report average marginal effects of transportation costs and other costs by size, industry and region respectively.

Our results can be summarized as follows:

- For R&D and process innovation, the impact of transportation costs on innovation is higher than all other costs of production, including labor and materials costs. This impact is especially noticeable for firms' R&D activities (Figures 3-7).
- The impact of transportation costs on innovation increase by firm size (Figure 2).
- The impact of transportation costs on R&D activities is highest for firms in construction sector (Figure 3).
- The impact of transportation costs on process, product, and organizational innovation is highest for firms in wholesale & retail sector (Figure 3).
- For textiles and machinery and vehicles sectors, the impact of transportation costs is highest on new method development (Figure 3).

- For wholesale & retail sector, the impact of transportation costs is highest on process innovations (Figure 3).
- The impact of transportation costs on R&D activities is highest for firms in Ankara (Figure 4).
- The impact of transportation costs on process and organizational innovation is highest for firms in Bursa, Eskişehir, Bilecik, followed by Sanliurfa & Diyarbakir (Figure 5 and 7).
- The impact of transportation costs on product innovation is highest for firms in Ankara, and Sanliurfa & Diyarbakir regions (Figure 6).

PANEL A				
	(1)	(2)	(3)	(4)
Dependent variable	R&D	New Process	New Product	New Organization
Variables				
Small	0.2498*	0.1186	0.2799***	0.3193**
	(0.1315)	(0.1014)	(0.0935)	(0.1291)
Medium	0.4192***	0.0872	0.2307*	0.3977***
	(0.1553)	(0.1294)	(0.1215)	(0.1532)
Large	0.5010***	0.2161	0.5064***	0.4039**
	(0.1887)	(0.1588)	(0.1488)	(0.1860)
Age	-0.0007	-0.0001	-0.0007	-0.0007
	(0.0008)	(0.0002)	(0.0005)	(0.0007)
Exporter	0.6956***	0.5284***	0.6386***	0.6088***
	(0.1064)	(0.0954)	(0.0894)	(0.1057)
Log (transport costs)	0.0878**	0.0697**	0.0166	0.0402
	(0.0375)	(0.0324)	(0.0300)	(0.0372)
Log (other costs)	0.0563	0.0667*	0.0566*	0.0786*
	(0.0406)	(0.0354)	(0.0329)	(0.0412)
Constant	-3.2647***	-3.1235***	-2.3152***	-3.7238***
	(0.4800)	(0.4093)	(0.3760)	(0.4934)
Sector dummies	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes
Observations	2,196	2,324	2,337	2,265
Pseudo R-squared	0.215	0.140	0.150	0.158
PANEL B				
	(1)	(2)	(3)	(4)
Dependent variable	R&D	New Process	New Product	New Organization
Variables				
Small	0.3220***	0.2135***	0.2777***	0.2724***
	(0.0902)	(0.0710)	(0.0650)	(0.0848)
Medium	0.5039***	0.2482***	0.2431***	0.3885***
	(0.1010)	(0.0850)	(0.0801)	(0.0964)
Large	0.5986***	0.4095***	0.4649***	0.4790***
	(0.1223)	(0.1024)	(0.0965)	(0.1156)
Age	-0.0000	-0.0000	-0.0008	-0.0001
	(0.0002)	(0.0002)	(0.0005)	(0.0002)
Exporter	0.6715***	0.5408***	0.6086***	0.5334***
	(0.0827)	(0.0747)	(0.0709)	(0.0818)
Log (total cost)	0.1013***	0.0914***	0.0783***	0.0958***
	(0.0219)	(0.0184)	(0.0172)	(0.0209)
Constant	-3.0615***	-2.7987***	-2.4610***	-3.3116***
	(0.2978)	(0.2482)	(0.2305)	(0.2874)
Sector dummies	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes
Observations	5,338	5,447	5,488	5,455
Pseudo R-squared	0.206	0.136	0.147	0.143

Table 6. Determinants of Innovation

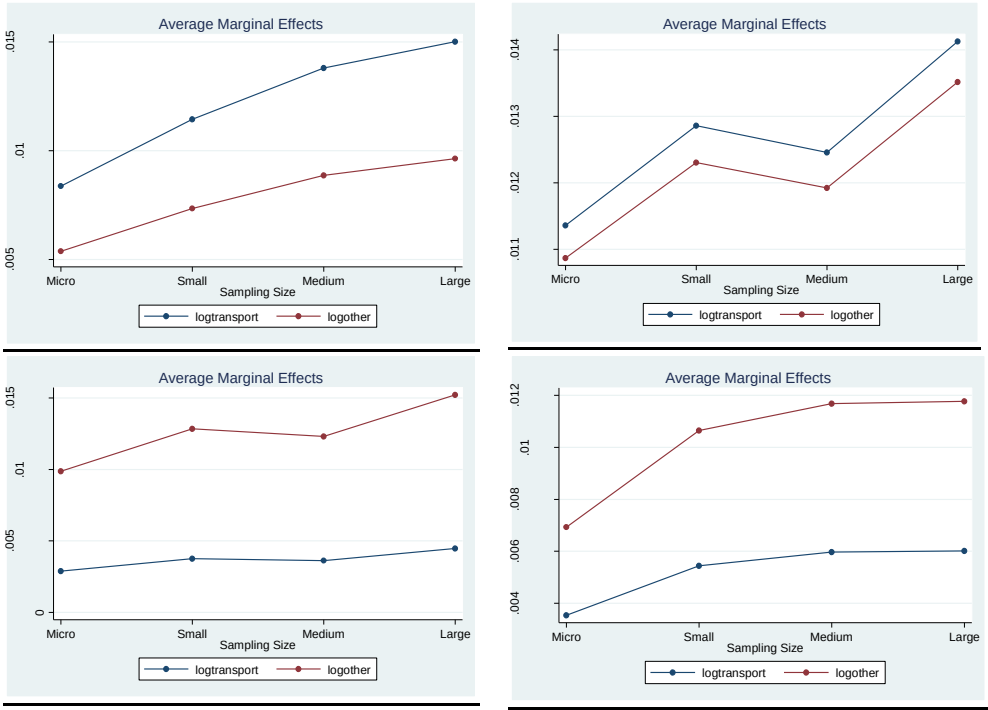


Figure 2. Average Marginal Effects by Firm Size (Turkey R-ES 2015, Authors' own calculations)

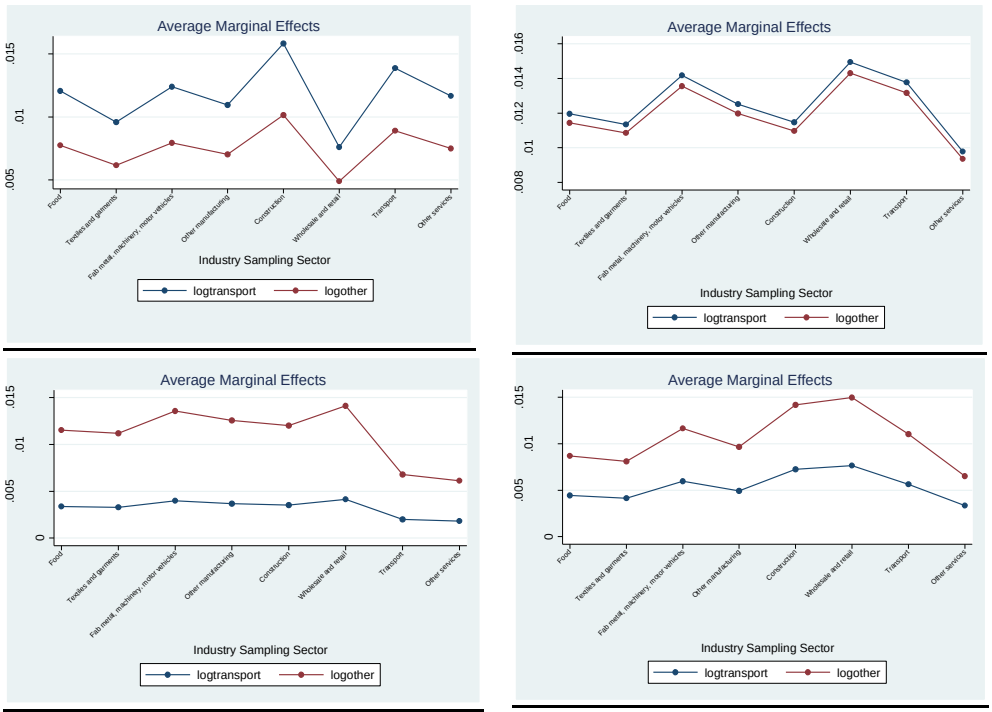


Figure 3. Average Marginal Effects by Industry (Turkey R-ES 2015, Authors' own calculations)

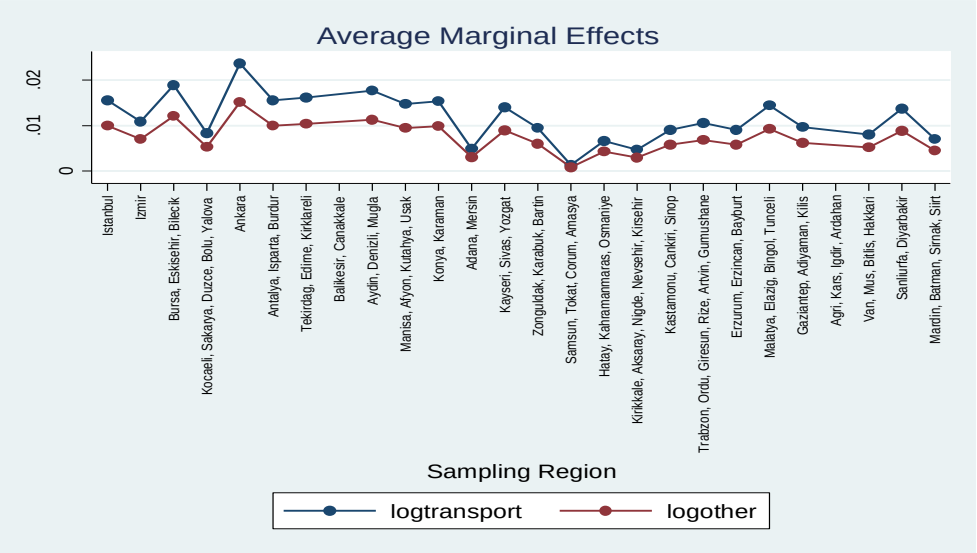


Figure 4. Average Marginal Effects by Region: R&D

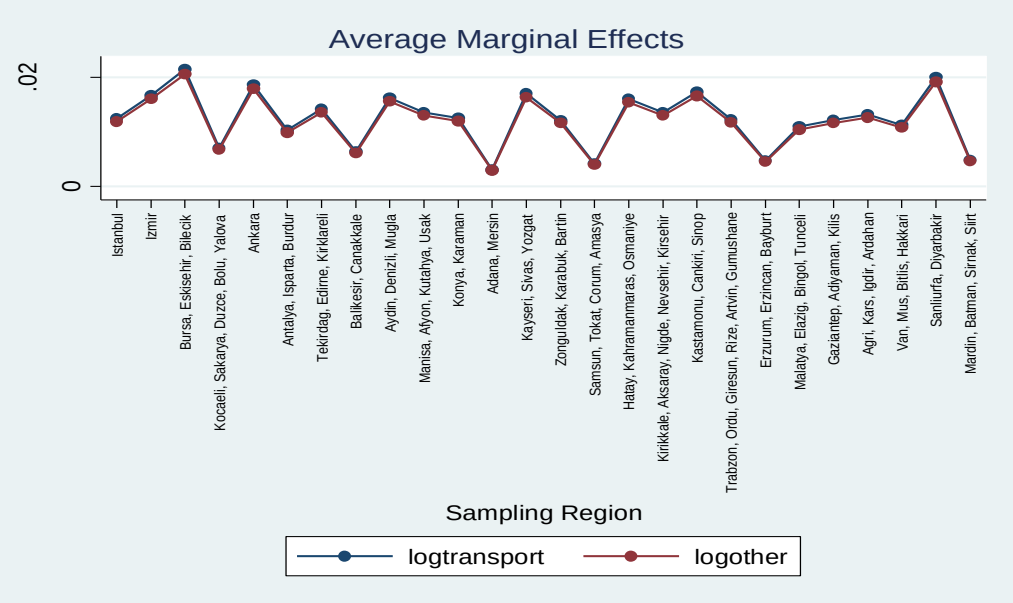


Figure 5. Average Marginal Effects by Region: New Process

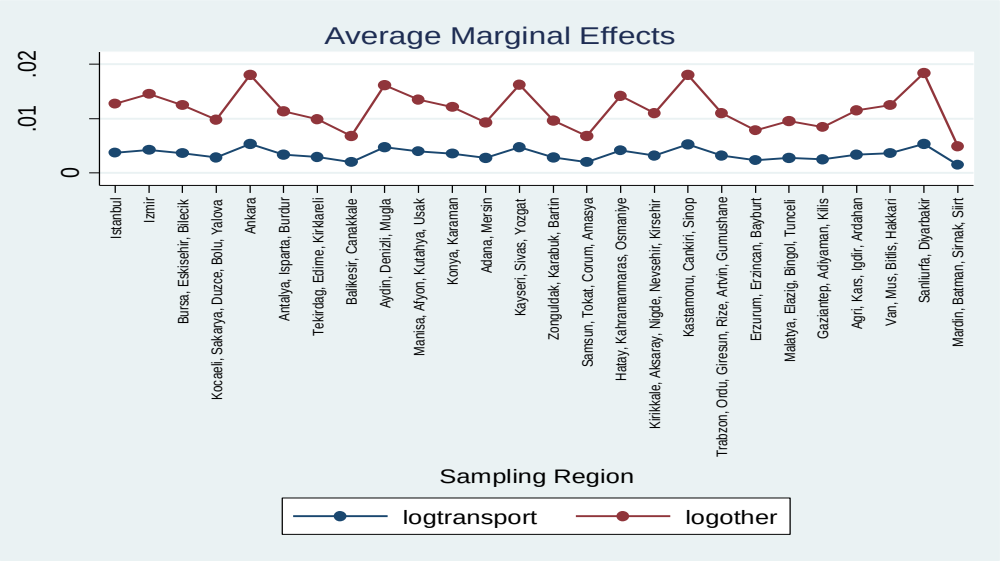


Figure 6. Average Marginal Effects by Region: New Product

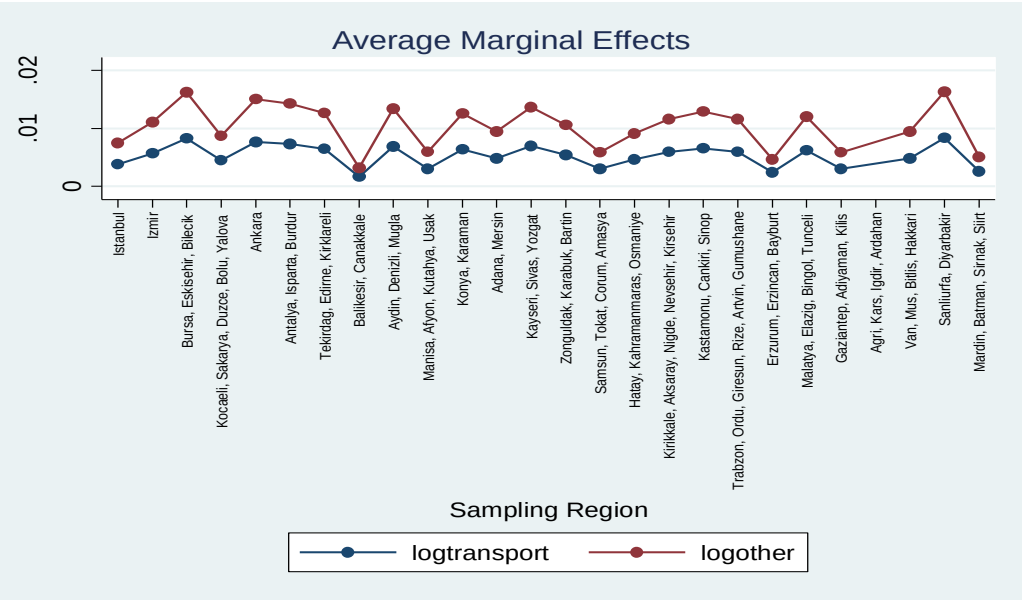


Figure 7. Average Marginal Effects by Region: New Organization (Turkey R-ES 2015, Authors' own calculations)

Conclusion

In order to become one of the leading economies of the world, Turkey needs to increase its competitiveness and invest more in innovation activities. This study takes logistics as a channel to promote innovation by Turkish firms as Turkey has logistical advantages compared to competitors and investments in logistics could help the country to position itself in global value chains. We find that larger firms and exporters have more advantages over small and local firms and thus are more likely to succeed in their innovation efforts. Moreover, the impact of transportation costs on innovation is greater than other costs (such as labor, raw materials, and electricity costs) for R&D activities and new process innovation. This suggests that increasing the level of efficiency in logistics (which is the primary aim of Turkey Logistics Master Plan) will be especially important for these innovation types.

Our results also reveal three regions where transportation costs matter the most for innovation. These are Ankara, Bursa-Bilecik-Eskisehir and finally Diyarbakir-Sanliurfa. Ankara Chamber of Industry reports 2015 classification of firms in manufacturing industry by technology levels as of 2015 are as follows: 26.1% low technology, 35.4% medium-low technology, 29.2% medium-high technology and 9.3% high technology. Investments in defense, furniture, medical, nuclear and plastics sectors by Ankara companies contribute to technology development.

Moreover, according to Industrial Capacity Statistics (TOBB 2015) the top five provinces in terms of the most capacity reports made as: İstanbul, Bursa, Ankara, İzmir and Konya. In addition, production in Bursa is dominated by textiles, furniture, and vehicles sectors; whereas in Bilecik and Eskisehir mining is the leading sector (these sectors file the highest capacity reports). In Diyarbakir, capacity reports were mostly made by food sector and in Sanliurfa by construction sector.

Considering the growth potential of these regions and sectors that are concentrated in these regions, we suggest the policymakers to develop regional policies accordingly in order to realize the goals of the 10th Development Plan in terms of sustainable growth. Future studies can analyze the strengths and weaknesses of these regions and sectors in more depth.

References

Ankara Chamber of Commerce (2016), "Statistics". Accessed from http://www.aso.org.tr/wp-content/uploads/2017/09/istatislikler-1.pdf, on 25 February 2019.

Arvis, J. F., Saslavsky, D., Ojala, L., Shepherd, B., Busch, C., & Raj, A. (2014). Connecting to Compete 2014: Trade Logistics in the Global Economy- The Logistics Performance Index and Its Indicators. World Bank. Accessed from https://openknowledge.worldbank.org/handle/10986/20399 on 1 March, 2019.

Audretsch, D. B., & Feldman, M. P. (1996). Innovative clusters and the industry life cycle. Review of Industrial Organization, 11(2), 253-273.

Chow, G., Heaver, T. D., & Henriksson, L. E. (1994). Logistics performance: definition and measurement. International journal of physical distribution & logistics management, 24(1), 17-28.

Christopher, M. (1998). Logistics and Supply Chain Management: Strategies for reducing cost and improving service, (2nd Ed.). New York: Prentice Hall.

Daugherty, P. J., Ellinger, A. E., & Gustin, C. M. (1996). Integrated logistics: achieving logistics performance improvements. Supply Chain Management: An International Journal, 1(3), 25-33.

Droge, C., Jayaram, J., & Vickery, S. K. (2004). The effects of internal versus external integration practices on time-based performance and overall firm performance. Journal of operations management, 22(6), 557-573.

Erkan, B. (2014). Türkiye'de lojistik sektörü ve rekabet gücü. ASSAM Uluslararası Hakemli Dergi, 1(1), 44-65.

Gao, D., Xu, Z., Ruan, Y. Z., & Lu, H. (2017). From a systematic literature review to integrated definition for sustainable supply chain innovation (SSCI). Journal of Cleaner Production, 142, 1518-1538.

Global Innovation Index (2018). Accessed from https://www.globalinnovationindex.org/Home on March 1, 2019.

Greene, W. H. (2008). Econometric analysis (6th ed). International edition, New Jersey: Prentice Hall.

Grossman, G. M., & Helpman, E. (1993). Innovation and growth in the global economy. MIT press.

Gunasekera, K., Anderson, W., & Lakshmanan, T. R. (2008). Highway-induced development: evidence from Sri Lanka. World Development, 36(11), 2371-2389.

Hertz, S., Johansson, J. K., & de Jager, F. (2001). Customer-oriented cost cutting: process management at Volvo. Supply Chain Management: An International Journal, 6(3), 128-142.

Hong, J. (2007). Transport and the location of foreign logistics firms: The Chinese experience. Transportation Research Part A: Policy and Practice, 41(6), 597-609.

Krugman, P. (1991). Increasing returns and economic geography. Journal of political economy, 99(3), 483-499.

Lean, H. H., Huang, W., & Hong, J. (2014). Logistics and economic development: Experience from China. Transport Policy, 32, 96-104.

Lindberg, A., & Götberg, A. (2016). Radical Supply Chain Innovation-Developing a Generic and Actionable Framework. M.Sc. Thesis, Department of Industrial Management and Logistics, Lund University.

O'Cass, A., Song, M., & Yuan, L. (2013). Anatomy of service innovation: Introduction to the special issue. Journal of Business Research, 66(8), 1060-1062.

OECD OSLO Manual (2005). Proposed guidelines for collecting and interpreting technological innovation data. OCDE: Statistical Office of the European Communities.

OECD (2019). Gross domestic spending on R&D (indicator). doi: 10.1787/d8b068b4-en. Accessed from https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm on 1 March 2019.

Sarıdoğan, A. A. (2013). Lojistik Sektörüne Rekabet Gücü Odaklı Stratejik Maliyet Yönetimi. Trakya Üniversitesi İktisadi ve İdari Bilimler Fakültesi E-Dergi, 2(2), 69-95.

Tebaldi, L., Bigliardi, B., & Bottani, E. (2018). Sustainable Supply Chain and Innovation: A Review of the Recent Literature. Sustainability, 10(11), 3946.

TOBB (2015) Industrial Capacity Report Statistics. Accessed from https://www.tobb.org.tr/BilgiErisimMudurlugu/Sayfalar/Eng/sanayi-kapasite-raporu-istatistikleri.php, on 20 February, 2019.

Torre, A. (2008). On the role played by temporary geographical proximity in knowledge transmission. Regional Studies, 42(6), 869-889.

Tödtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. Research policy, 34(8), 1203-1219.

Transportation and Logistics Industry Report (2018). Accessed from https://www.ulk.sakarya.edu.tr/wp-content/uploads/2018/05/Ula%C5%9Ft%C4%B1rma-ve-Lojistik-Sekt%C3%B6r-Raporu-2018.pdf on 20 February, 2019.

Yorulmaz, M., & Birgün, S. (2016). Deniz Ulaştırma Lojistiği Hizmet Yetenekleri İle Firma Performansı Arasındaki İlişkilerin İncelenmesi: Türkiye'de Faaliyet Gösteren Deniz Ulaştırma İşletmelerinde Bir Uygulama. Journal of Transportation and Logistics, 1(1), 59-82.