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FROM INNOVATION SYSTEM PERSPECTIVE: ENVIRONMENTALLY FRIENDLY TECHNICAL CHANGE AND SMALL-AND MEDIUM-SIZED ENTERPRISES

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Abstract

Small- and medium-sized enterprises (SMEs) impose a significant negative impact on the environment, as they play an important role in total production and economic growth in most economies. We analyze environmentally friendly technical change in SMEs where the research on the factors that affect environmentally friendly innovation and adoption of products and processes is limited. Using econometric analysis of original survey data of 1,141 SMEs from Turkish manufacturing industries, we measure not only intra-firm characteristics, roles of environmental regulations and enforcement, but also the roles of innovation partners, external environmental pressures and competition through business competences, network involvement, and environmental orientation.

ملخص

تفرض المشروعات الصغيرة والمتوسطة الحجم تأثيرا سلبيا كبيرا على البيئة ، كما أنها تلعب دورا هاما في الإنتاج الكلي والنمو الاقتصادي في معظم الاقتصادات. نحن نحلل تغيير التقنية الصديقة للبيئة في المشاريع الصغيرة والمتوسطة في الوقت الذى يقتصر فيه البحث على العوامل التي تؤثر على ابتكار واعتماد المنتجات والعمليات الصديقة للبيئة. باستخدام تحليل اقتصادي قياسي لبيانات المسح الأصلي من 1141 الشركات الصغيرة والمتوسطة من الصناعات التحويلية التركية، نقيس ليس فقط فيما بين الشركات الخصائص، ودور الأنظمة البيئية وإنفاذها، ولكن أيضا أدوار لشركاء الابتكار، والضغوط البيئية الخارجية والمنافسة من خلال الاختصاصات التجارية، وإشراك الشبكات ، والتوجه البيئي.

1. Introduction

The role of technical change in attaining dual goals of sustainable development, better environmental and higher economic performance, has been investigated in a considerable number of theoretical and empirical studies in environmental economics literature (Jung, Krutilla, and Boyd 1996; Montero 2002; Brunnermeier and Cohen 2003; Jimenez 2005; and Frondel et al. 2007). The studies focusing on environmental innovations and technical change, with the presumption of linear innovation processes, mostly rely on strategic interactions of enterprises, regulators and institutions in driving theoretical, empirical and policy related conclusions. On the other hand, the "systems of innovation" approach, by focusing on the nonlinear nature of the innovation processes, characterizes the technical change as a continuous complex learning process with social, cultural, and technical dimensions (Freeman 1986; Lundvall 1992; and Cooke 1992). Given the nonlinear and multifaceted nature of technical change, in this paper, we analyze the environmentally friendly innovations and adoptions of small- and medium-sized enterprises (SMEs) from the perspective of innovation systems. Such analyses have a potential to contribute to both lines of literature and environmental policy design of different regions at various scales.

As SMEs play an important role in total production in manufacturing, in economic growth and employment in most economies, they also have a significant negative impact on environment. For example, in European Union 90% of the businesses were SMEs in 1996. This percentage has increased to 99% in recent years and the SMEs are contributing up to 80% of employment in some industrial sectors, such as textiles, in the EU. Similarly, in the United Kingdom, 99% of the businesses were SMEs in 1998. It was estimated that SMEs, as a sector, contributed to 70% of industrial pollution, given the fact that the environmental impact of the SMEs is not know exactly at various geographic scales (Hillary 2004). Given their number and with the possibility that the SMEs are not subject to the same extent of regulatory control as large companies, it will not be unreasonable to assume that the SMEs are an important group from an environmental point of view (Ammenberg, Börjesson, and Hjelm 1999). There have been numbers of policy measures are introduced by the Commission to help the European SMEs in taking full advantage of business opportunities provided with a sound environmental management between 2005 and 2007. These policy measures are: Small, clean and competitive program which helps the SMEs comply with the environmental management, Think Small First - A "Small Business Act" for Europe and Enterprise Europe Network to increase awareness and disseminate knowhow gained by other EU programs on energy and the environment (European Commission, 2008).

Although, these facts on the SMEs and the assertions on their importance for the environment are recognized extensively, especially in EU, there are limited researches focusing on the SMEs impact on the environment. Due to globalization, industries and firms through trade and cross-border investments, firms are under tremendous pressures through competition, regulation, interested parties and consumers to use environmental friendly technologies and develop environmental friendly products, processes and practices. The major challenge for environmental policy makers is to find ways to support and encourage the development and the adoption of these technologies, products and practices among SMEs. This is even more challenging in developing countries, like Turkey. As Turkey adopts EU and world standards, successful environmental innovations play a key role for SMEs and policy makers.

To promote environmentally friendly innovations in SMEs, understanding the intra-firm characteristics taking place in a system of innovation is as important as understanding the roles of regulation and enforcement, external pressures, and competition within and across industries and economies. Moreover, a clear understanding of these factors further enhances the policy makers' and practitioners' effectiveness in their decisions. This has been

emphasized several times in the existing literature and constitutes our primary motivation in this research.

This research aims to analyze environmentally friendly technical change for SMEs from innovation system perspective. Promoting environmental friendly innovations in SMEs, requires understanding of not only intra-firm characteristics, roles of regulations and enforcement, but also the roles of innovation partners, external pressures and competition within and across industries and economies. Hence, this research maps the channels though which the SMEs work out to innovate and adopt environmentally friendly practices, products and processes. In addition to both government regulation and enforcement, the map includes business competences, network involvement, and environmental orientation. Theoretically, the map relies on studies in both environmental economics and innovation system literature, particularly the innovation triangle model (Dijken et. al. 1999) and its successors.

Furthermore, we complement the map with econometric analysis which investigates the effect of various factors on innovativeness and adoption of the SMEs. We estimate our econometric models using OLS and limited dependent variable regression techniques with the following exogenous variables; motivation, knowledge and power indexes comprised in business competences, environmental orientation, network index capturing the effects of innovation partners (suppliers, competitors, customers, consultants, financiers, employees, public authorities, environmental groups and organizations, and international agencies), barriers, environmental regulations and enforcement, and firm, sector and region specific control variables. This research focuses on innovativeness in the environment domain in general and does not aim to explore the differences in the firm's innovativeness across either sectors or regions.

This research fills the gap in the literature by analyzing the SMEs' environmentally friendly innovativeness and adoption from the innovation system perspective. The primary findings of the paper include SMEs' business competences on the environment, environmental orientation, environmental regulation expenditures, network involvement with innovation partners on environmental innovations and adoptions, and informal environmental enforcements which have significant impact on the environmentally friendly innovations and adoptions that SMEs have and do. We find not only the three main determinants of SMEs' innovativeness as described in the innovation triangle model with business competence, environmental innovation and network involvement, significant, but also the conventional variables such as environmental regulation expenditure that is a proxy for government regulation, which is significant for Turkish manufacturing SMEs. In general, our results emphasize the importance of environmental regulation expenses as well as the informal enforcement activities that SMEs are exposed to. The effect of informal enforcement through related parties is a particularly interesting finding in the context of developing countries. In the case of manufacturing SMEs in Turkey, this result may have some policy implications for government and enforcement authorities. To design clever enforcement strategies and to stimulate SMEs to develop and successfully adopt environmental innovations and behaviors, authorities should also consider and use informal channels.

The paper is organized as follows. In the next section, we provide a brief review of literature. Then, we introduce the data, the econometric models and the methods of the estimation, as the results are reported in section 4. The final section offers some concluding comments. The construction of the model variables is described in the Appendix A and Tables and Results are presented in the Appendix B.

2. Literature Review

Although there are quite number of studies investigated the impact of firms and industries on the environment in the literature, the impact of SMEs on environment has been under-studied. The lack of resources to implement environmental strategies became the common assumption for the SMEs (Aragon et. al., 2008). On the other hand, from a resource-based view of the firm, it is shown that the SMEs have an important role to play in diminishing the negative impact of the businesses on the environment. Furthermore, Aragon et. al. (2008) shows that there is a positive and a significant relationship between firm performance and eco-efficient innovative-preventive environmental practices for the sample SMEs. Moreover, certain characteristics of the small firms may promote proactive environmental approaches, even though larger firms have shown to be environmentally more proactive. Smaller firms may be at a resource disadvantage but not a capability disadvantage in environmental advances. This is important for policy makers and practitioners. Therefore, more research attention should be given to the SMEs environmental practices, given their importance in global economies (Aragon et. al., 2008).

In addition to the research needed on SMEs' environmental performance, the need of research on environmentally friendly innovations in SMEs is even strikingly more apparent in the literature given the utmost importance of sustainable development. There are a large number of studies investigating the effect of environmental pressures stemming from environmental regulation of firms and their environmental performances. Magat (1978, 1979) and Downing and White (1986) analyze the effect of various types of environmental regulations on the firms' innovations. The comparative ability of several policy instruments to induce the development and adoption of pollution abatement technologies in a competitive industry is investigated by Milliman and Prince (1989) and Jung, Krutilla, and Boyd (1996). In addition to the studies that investigate the role of government regulation (monitoring and enforcement) as a key determinants of environmental performance (such as Dasgupta et al. 2001; Deily and Gray 1996; Magat and Viscusi 1990), some studies look at the impact of informal regulation emphasizing the role of communities and capital markets on firms' environmental performance (such as Mamingi et al. 2008; Foulon et al. 2002; Hamilton 1995). These studies investigate the impact of public disclosure programs (can be *structured* for example Toxics Release Inventory in the United States, or *unstructured* information that can be found in newspaper (Foulon et al. 2002) on firms' environmental performance. For example, Hamilton (1995) and Konar and Cohen (1996) show that capital markets react significantly to the release of information indicating that market shows an upward trend when the information reveals a good performance and downward trend when it reveals a poor performance. Therefore, evidence from these studies shows that public disclosure does improve the polluters' environmental performance. Mamingi et al. (2008) examine the impact of negative environmental news in the printed press on the environmental performance of Korean publicly traded firms in the context of a developing country. They show that news in the printed media (newspapers) and the firm's awareness of this news publication maybe important predictors of environmental performance, irrespective of the reaction of stock markets (Mamingi et al. 2008). Foulon et al. (2002) investigate the impact of both traditional enforcement and information strategies on pollution levels and rates of compliance within the context of a single program in the British Columbia pulp and paper industry. They present evidence that the public disclosure of environmental performance does create additional and strong incentives for pollution control. However, their analysis suggest that two approaches, traditional enforcement practices and information strategies should be used as complementary policy instruments to achieve improvements in firms' environmental performance. Evidence from OECD and developing countries indicate that firms' environmental reputation matters particularly for those whose profits are affected by the judgments of environmental performance by customers, suppliers and stockholders (Cohen 1998).

Lanjouw and Mody (1996) investigate the innovation and diffusion of environmentally responsive technology in various countries, specifically comparing US, Germany and Japan, and found the evidence of the environmental regulation and innovation connection at a global level. They show that over time across these countries innovation is responsive to pollution abatement expenditure, which is considered an indicator of the stringency of environmental regulations. Some of the other studies in this literature include, but not exhaustively, Biglaiser and Horowitz 1995; Ulph 1996; Hackett 1995; Scott 1996; and Montero 2002. We believe that a study investigating the SMEs' environmental innovativeness can substantially benefit from various types of work in this area and has a good potential to contribute to the literature with a good statistical analysis of appropriate data. The lack of work on SMEs in the literature is due to the difficulty in finding micro-level data. Illustratively, the Census Bureau's Pollution Abatement Cost and Expenditure survey contains information at the firm- and plant-level, however, only the aggregated data at the two-, three- and four-digit SIC level is publicly available (Brunnermeier and Cohen, 2003).

Brunnermeier and Cohen's (2003) work is one of the few empirical studies in the literature that studies environmental innovation in US by employing an econometric approach to the industry level data. They specifically investigate the effects of changes in pollution abatement expenditures and regulatory enforcement on environmental innovation in 146 US manufacturing industries between the years 1983 and 1992. They found that the effect of increasing pollution abatement expenditures on environmental innovation is statistically significant. On the other hand, the increase in monitoring effort is found to be ineffective in increasing innovation. Their study also shows empirical evidence that environmental innovation is more likely to occur in internationally competitive industries. The incentive to innovate is not only affected by regulatory pressures. There are some evidences that firms also respond to other external factors. But, these factors are not well-investigated in general industry level, not alone in SMEs. Along with their findings, Brunnermeier and Cohen (2003) emphasize that it would be useful to use more disaggregated plant-level data to study the determinants of environmental innovations.

Frondel et al. (2007) investigate the correlation between facilities' decisions on innovation activities and the adoption of environmental management systems (EMSs) in German manufacturing firms. They found that facility related internal factors as well as incentives explain the adoption of EMSs. Furthermore, their study shows that neither external groups nor single environmental policy is effective in encouraging adoption of EMSs. These factors do not play a significant role in innovation and abatement activities of the facilities. They conclude that environmental innovation decisions are not related to the adoption of EMSs, rather they seem to be correlated with stringency of environmental policies.

In another study, Jimenez (2005) looks at direct and indirect innovation-oriented environmental regulations in the case of SMEs in Chile. He argues that to foster innovation through regulation, instead of putting most of the effort on regulation-setting process, the focus should also include a cooperative style in the design and implementation of regulations, especially in SMEs. His empirical analysis shows that SMEs that are subject to indirect regulations (negotiated voluntary agreements) innovate significantly more than the ones that are subject to direct (command-and-control) regulations. Similarly, Blackman and Bannister (2006) investigate the clean technology adoption by small scale brick makers in Mexico through two alternative sources, clean technological change and informal regulations, to improve small firms' environmental management. They find that informal regulatory pressure through competing firms and private-sector local organizations, their education and their awareness of the health risks associated with dirty technologies was an effective means of promoting adoption.

Given the importance of the adoption in environmental friendly technical change, Dijken et. al. (1999) provides an innovation triangle model to explain the dynamics of adoption of environmental innovations in several European countries. The model is based on three dimensions, namely strategic orientation, competences and network relations. These dimensions are proposed to be the main determinants of the process of adoption and interrelate with each other. Their effect on the adoption, and thus innovativeness, are studied with simple statistical procedures. The sample of 527 firms from Denmark, Italy, Netherlands, Portugal and United Kingdom are interviewed by phone. The authors discuss the sector and country specific adoption behavior of the firms. Given the significant share of the adoption of environmental innovations in the overall innovativeness of the SMEs in developing countries, some of the observations in this study do bear significance for comparison purposes.

From the innovation system perspective, the country specific experiences unearth the idiosyncratic characteristics of regulations and enforcements as well as small firm responses. Blackman (2006) gathers several academic studies on small firms and the environment in various developing countries in a book. The studies together investigate the following questions: 1. How important is small firm pollution? 2. Will forcing small firms to comply with environmental regulations exacerbate unemployment and poverty? and 3. What policy options are available to control small firms' pollution? Among these studies, Blackman and Bannister (2006) found community pressure is very effective in promoting adoption. Furthermore, competition among the firms in the informal sector is one of the factors which increases the effects of the community pressure.

Moreover, as per country specific analysis, there is no study capturing the environmentally friendly innovation dynamics of SMEs in Turkey. The literature is seriously under-provided in this field. In the recent study, Müftüoglu et al. (2009) determines whether there is a regional and sectoral innovation systems in Turkey. The study covers ten manufacturing sectors and twelve cities from highly developed regions of the country. It is found that when compared with the European Union, firms in Turkey focus more on process innovations and benefit from information flows from public institutions as well as the private ones. Moreover, it is observed that firms learn more by following and imitating other firms. The factors affecting the learning processes of the firms and the scales of the effects are analyzed in the research. The differences between the innovativeness of the firms in metropolitan cities and that of the firms in non-metropolitan cities are also noted.

This work will contribute to the existing literature in several ways. First, to date, there are a limited number of empirical analyses on SMEs and environmental innovations. It will extend the literature by employing an econometric approach at firm level data on SMEs. Second, it will enrich the literature by explicitly looking at the SMEs' specific characteristics from both economic and management perspectives in their ability to induce and adopt environmentally friendly innovations. Finally, the observations and conclusions can contribute to discussions on environmental policy design.

3. Data and Methodology

3.1. Data

The paper uses unique firm-level manufacturing dataset for the empirical analysis. The dataset is constructed by surveying the randomly sampled 1,141 SMEs with less than 250 employees from ten different manufacturing sectors from 49 organized industrial zones in eight NUTS level 1 (Nomenclature of Territorial Units for Statistics) regions in 2009. These regions are Istanbul, Eastern Marmara, Western Marmara, Western Anatolia, Central Anatolia, Aegean, Mediterranean and Southeastern Anatolia. These eight NUTS level 1

regions include 38 cities as NUTS level 3 regions shown in light color (Figure 1). In parallel to Müftüoğlu et al. (2009) the sample of cities in the data set is a good representation of the regions in terms of their level of socio-economic development. Furthermore, as stated in Müftüoğlu et al. (2009), the selected manufacturing sectors in this study are the leading industries in terms of their labor intensity, export share, the number of firms in each sector, and the technological classification, these manufacturing sectors are the important ones for the country (Table 1 in the Appendix B).

The survey of 23 questions[1] is conducted by computer assisted telephone interviewing method[2]. The questionnaire was tested through a pilot study. Given the feedback from the pilot study, the survey was put into its final form. Out of 2,904, the total of 1,200 surveys were completed successfully. The paper, consistent with the OECD definition, relies on the number of employees to define SME and thus uses 1,141 of the SMEs in the sample[3]. The raw data collected for these SMEs in the survey is used to construct the secondary data to be used in econometric analysis.

In Turkey, as of 2007, there are 315,295 SMEs in all manufacturing sectors and 4.7% of them are located in Organized Industrial Zones (OIZ) (Ministry of Industry and Trade, 2008). Our study relies on the 1,141 SMEs operating in OIZ in the regions. Therefore, our sample represents 7.7% of the manufacturing SMEs in OIZ in Turkey. Additionally, our sample represents 11.4% and 7.8% of SMEs operating in OIZ in these ten leading manufacturing sectors and these eight regions, respectively.

3.2 Methodology

In the relevant literature there are various ways of investigating innovativeness of businesses. Some studies use continuous or count variables such as intellectual property rights (i.e. patents and patent applications) and R&D expenditures, some others employ categorical variables. In this study we investigate the innovativeness of the SMEs in two ways. The first way focuses on the degree of innovativeness measuring the level of innovative activities engaged by the SMEs by using the OLS regressions. In our OLS regressions, we test for the effects of variables of our interest on the 1) number of environmentally friendly *innovations and adoptions* that firm has and does; 2) number of environmentally friendly *practices* that firm applies and monitors in its operation, 3) number of environmentally friendly *behaviors* that firm engages in its operation, and 4) degree of innovativeness (as it is measured as the percentage of firm's turnover obtained from the sale of environmental friendly technologies, products, and environmentally friendly marketing strategies). The second way studies the chances that the SMEs would posses intellectual properties such as patent, utility model, registered trade mark, license agreements by employing logit regression. Any factor, such as stringency of environmental regulations, might increase the chance of a firm to be innovative as well as raises its level of innovativeness by making the firm engage in adoption and improvement in various activities, e.g. product, process, end-of-pipe technologies, organizational changes and marketing strategies. The logit regression tests the effects of

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1 The survey is available from the authors upon request.

2 The sampling and the survey are conducted by a professional survey company. The survey was put into the electronic from by entering the survey into Voxco program. The method used is computer assisted telephone interviewing (CATI) which is an interactive front-end computer system that aids interviewers to ask questions over the telephone. The answers are then keyed into the computer system immediately by the interviewer.

3 There are several definitions of SME based on the number of employees and/or the turnover in Europe and USA as well as for OECD.

variables of our interest on probability of the SMEs having at least one of the following intellectual properties: patent, utility model, registered trade mark, license agreements.

We characterize the firm's number of environmentally friendly innovations and adoptions, practices, behaviors, the firm's degree of innovativeness and the probability of the firm's environmental innovations and adoptions as a function of certain SMEs' characteristics such as size, motivation, knowledge and power indexes comprised in business competences, environmental orientation, network index capturing the effects of innovation partners, barriers, environmental regulations and enforcement, and sector and region specific control variables. The model equations estimated using OLS (equation 1) and logit regression (equation 2) techniques[4] are as follows:

$$Y_i = \beta_0 + \beta_{bc} Bcomp_i + \beta_{nt} Netwk_i + \beta_{ori} Ori_i + \beta_{bar} Bar_i + \beta_{reg} Eregexp + \beta_{regst} Eregst + \beta_{efi} Efi + \beta_{eff} Eff + \beta_s \ln size_i + \sum_{n=1}^{n=9} \beta_{sect_n} Sect_{n,i} + \sum_{n=1}^{n=7} \beta_{reg_n} Reg_{n,i} + \beta_p \ln pop_i + \varepsilon_i \quad (1)$$

$$IP_i = \beta_0 + \beta_{bc} Bcomp_i + + \beta_{nt} Netwk_i + \beta_{ori} Ori_i + \beta_{bar} Bar_i + \beta_{reg} Eregexp + \beta_{regst} Eregst + \beta_{efi} Efi + \beta_{eff} Eff + \beta_s \ln size_i + \sum_{n=1}^{n=9} \beta_{sect_n} Sect_{n,i} + \sum_{n=1}^{n=7} \beta_{reg_n} Reg_{n,i} + \beta_p \ln pop_i + \varepsilon_i \quad (2)$$

The subscript *i* denotes the observations, i.e. the SMEs, in the sample. *Y* represents the dependent variables (*Innm, Epra, Ebeh, and Turnover)* in equation (1), and *IP* represents the dependent variable in equation (2). Our exogenous variables are: the firms' business competences index (*Bcomp*), network index (*Netwk*), environmental orientation index (*Ori*), barrier index (*Bar*), environmental regulation expenditures (*Eregexp*), environmental regulation stringencies (*Eregst*), formal and informal environmental enforcements (*Eff* and *Efi*), the size of the firms (ln*size*) (the number of employees working at the firm)[5], the sets of sectoral (*sect1*,…,*sect9*) and the regional (reg*c1*,…,reg*c7*) dummies and the populations of the regions (*lnpop*) where firms are located. Dummy and population variables are added to the regressions to eliminate a possible heterogeneity bias. The variable descriptions and their descriptive statistics are presented in the Appendix A and Table 2 and 3 in the Appendix B.

In order to see if we have multicollinearity problem in our regression variables, we use variance inflation factor analysis (VIF). The results of VIF analysis are reported in Table 4 in the Appendix B. For the models that are considered in the paper (equations 1 and 2), VIFs for the variables are very low (VIF values that are large (greater than 10) generally indicate the

[4] We also run various categorical data models for the regressions where the dependent variables are Innm, Turnover and Ipnum. For the Innm regression, we run multinomial logit model (MNLM) and negative binomial model (NBM). Due to the violation of independence of irrelevant alternatives, the MNLM cannot be used. For the Turnovern regression, we run ordered logit model (OLM) and generalized logit model (GoLogit). The parallel regression assumption does not hold for 3 variables, and thus OLM is not used. On the other hand GoLogit results are similar to the OLS ones. For the Ipnum regression, we run poison and NBM. There is an over dispersion problem in poison model. MNLM produces similar results with the OLS model. When the categories of the dependent variable are more than 5 and the categorical model results are similar to the OLS results, it is possible to employ OLS regression for categorical data (Demaris (1992)).

[5] In these regressions (Innm, Epra, Ebeh), we also use the total sales of firm as a size variable, however, the results from both measures are very similar so that we report the size as the number of employees working at the firm, which is the most commonly used size measure in the literature.

existence of multicollinearity problem) and therefore, the VIF analysis indicates that there is no multicollinearity issue in our regressions.

With business competences, we intend to measure internal competences of the SMEs. Business competence includes motivation, knowledge and power indexes. With motivation index, we measure environmental motivation of firms which can be presented as the number of organizational competences related with environmental products, processes, and strategies. With the knowledge index, we measure knowledge of firms; these are the number of technical competences that firm has. With power index, we measure SMEs power in environmental initiations such as the number of financial competences that firm has. Therefore business competence represents abilities and skills of the firms gained through planned activities in organizational, technical and financial areas. On the other hand, external competences, which we measure with Network index, represent firms' abilities and skills gained through voluntary interactions with innovation partners. Network index (the number of external competences that firm has) captures the effects of innovation partners, which SMEs may involve with, in their environmental innovation and adoption activities. These external partners are suppliers, competitors, customers, consultants, financiers, employees, public authorities, university and research institutions, industry and trade organizations, environmental groups and organizations, and international agencies.

Other than business competences (internal) and network index (external competences) which present various kinds of voluntary knowledge flows, environmental orientation of SMEs can play an important role for SMEs to adopt and innovate environmental friendly products, processes and practices. With environmental orientation index, we intend to assess whether SMEs have a well-defined environmental policy, and/or an EMS, and/or proactive policy which go beyond compliance with legislation. We also compute barriers index (mainly measures financial barriers) that SMEs face in the process of innovation and adoption.

Moreover, we also include conventional variables such as environmental regulation and enforcement measures where we investigate the effect of environmental pressures stemming from environmental regulations, formal (mandatory inspections) and informal (from network partners) enforcements on firms' environmental innovation and management activities. Environmental regulation expenditure (measures the costs of innovation and adoption of environmentally friendly processes, products and practices including pollution preventive and control expenditures, environmental management expenses, any other environment related costs) is a proxy to measure the regulation effect on firm's innovation and adoption. We further determine the effect of the stringencies of environmental regulation on the firm's performance. Formal enforcement measures the level and the types of enforcement of the environmental regulation, such as audits by municipalities, and informal enforcement measures the demands from firm's stakeholders.

4. The Results

We run four different regressions using *equation (1)* to investigate the factors which affect firms' environmentally friendly innovations and adoptions, practices, behaviors and turnover from the sales of environmentally friendly technologies, products and marketing strategies. These results are summarized in Table 4 in the Appendix B. The first regression results (column (1) in Table 4) show that SMEs' environment related business competences (organizational, technical and financial competences), environmental orientation, environmental regulation expenditures, network involvement representing firms' abilities and skills in interacting voluntarily with innovation partners and stakeholders and informal environmental enforcement have significant impact on the number of environmentally friendly innovations and adoptions that SMEs have and do.

With this analysis, we test the Innovation Triangle Model (ITM)[6], which defines the determinants of SMEs innovativeness in three major components, business competence, environmental innovation and network involvement, by using additional variables for Turkish manufacturing firms. Based on our empirical findings, the innovation triangle model holds for Turkish SMEs where these three major components play a very important role in their innovation process. Specifically, all three pillars of the ITM model turn out to be significant factors affecting the number of innovations as well as environmentally friendly behavior. Among the three, for a unit increase in these factors, environmental orientation, with 0.356, has the major influence on the number of innovations, while business competences, with 0.193, highest impact on the number of environmental friendly behavior. As far as environmental friendly practices concern, while two components of the ITM model, namely business competences and environmental orientation, significantly influencing, by 0.027 and 0.024 for unit changes, network effect is not significant. Except the network dimension, the other two dimensions of the ITM model do not seem to affect the commercialization of the innovations represented by the turnover variable. Interesting observation is that the network involvement does seem to play an important role in raising revenue from environmentally friendly innovations, by 0.028 for an additional involvement. All in all, it might be concluded that ITM holds almost completely for the innovation and adoption of environmental friendly technologies and practices, while it partially explain the commercialization of these innovations.

Different than the ITM, we also test the role of government regulation and enforcement in SMEs' innovation and adoption behavior and find that environmental regulation expenditure, which is a proxy variable for government regulation, turns out to be a significant factor. An increase in expenditures increases environmentally friendly innovations, practices, behavior and the turnover from these innovations by 0.366, 0.024, 0.101 and 0.408. Previous research (Dijken et. al.1999) shows that technologies such as end-of-pipe equipments (i.e., filters and sinks), regulatory requirements and costs play an important role in SMEs' innovativeness, and in general, larger and financially viable companies tend to lead in purchasing these equipments. However, there are other types of environmentally friendly technologies such as recycling and prevention and their adoption requires SMEs' innovative and organizational capabilities (Dijken et. al. 1999). Environmentally friendly technological innovations can be considered in three types: abatement for pollution cleaning, information based technologies for measuring environmental impacts (such as sensors, monitoring devices, equipments and software), and technologies for cleaner production (Dijken et. al. 1999). We particularly concentrate on the two types in this case, the first type is the abetement type of technologies for cleaning pollution (can be end-of-pipe or after the damage) and the second type is the technologies for cleaner production such as new processes, adopted products, new systems for reducing energy and material usage. Christie et. al. (1995) indicates that in adopting cleaner production rather than clear cut technical capabilities, the managerial capabilities of firms plays a crucial role, such as cleaner production can be described as a way of looking at products and production process to reduce their environmental impacts. These production techniques include systems to reduce consumption of energy and improve energy usage; new process technologies or redesign of existing processes for waste minimization, recycling and pollution product substitution; new products that can minimize consumption and waste and maximize scope for recycling and reuse (Christie et. al., 2005).

In Turkish SMEs, we observe both innovations and adoptions of abatement technologies such as end-of-pipe technologies due to regulatory requirements, costs (through environmental regulation expenditure variable), and technologies for cleaner production due to SMEs'

[6] Dijken et. al. (1999) applied this model to specific sectors in Denmark, Italy, UK, the Netherlands, and Portugal.

innovative and organizational capabilities (through business competences and environmental orientation variables). For example, the impact of firms' environmental regulation expenditure, business competences and environmental orientation, measured by a unit increase in these factors, on the number of environmentally friendly innovations and adoptions, are 0.366, 0.17, and 0.356, respectively.

We also intend to measure the success of SMEs innovativeness through measuring the percentage of turnover from the sales of environmental friendly technologies, products, marketing strategies. The results from this regression are presented in Table 4 column (4) in the Appendix B. Similarly, we find that network involvement, environmental regulation expenditures and informal enforcements are important variables in the success of these innovations.

More interestingly, rather than formal enforcement activities, informal enforcement channels through related parties seem to be more effective in SMEs innovation and adoption activities. Although these relationships might be important factors for the SMEs in developed economies, in a developing country context, they bear special importance due to fact that they can play critical role by providing support to enforcement efforts of regulatory bodies. Informal enforcement through related parties such as suppliers, competitors, customers, consultants, financiers, employees, public authorities, university and research institutions, industry and trade organizations, environmental groups and organizations, and international agencies found to be significant in innovation and turnover regressions (columns (1) and (4) in Table 4 in the Appendix B). An increase in perceived pressure form an additional partner, leads to an increase in innovativeness and the revenue gained from the innovations by 0.023 and 0.042. Additionally, in the survey, SMEs indicate that among the network channels that they are involved with, other than public authorities, employees, customers and industry and trade organizations are the most powerful partners that they feel the pressure from to be environmentally friendly (see Figure 2 below).

This may have some policy implications for government and enforcement authorities, particularly in the case of SMEs in Turkey. To design clever enforcement strategies and to stimulate SMEs to develop and successfully adopt environmental innovations and behaviors, authorities should also consider and use informal channels. Similar evidence is found by Jimenez (2005) using Chilean firms. He shows that indirect regulations (cleaner production agreements) rather than direct command and control techniques stimulate innovation in Chilean SMEs. He indicates that even though well-defined regulations can stimulate SMEs innovation, however, the implementation of regulations plays an important role in SMEs innovation behaviors in Chile.

In addition to straight forward innovation and adoption activities, for the SMEs in developing countries, environmentally friendly practices and behaviors are equally important initial steps towards sustainable industrial production. As promoted by Aragon-Corre et. al. (2008), these practices are the first steps towards proactive environmental practices, as they specifically applicable to SMEs. The difference between the SMEs' environmental friendly practices and behaviors is that while environmental practices include performance measures that firms regularly monitor, environmental behaviors show the activates that SMEs engage in their operation. Based on the regression results related to the number of environmentally friendly practices that SMEs involve in their operation (column (2) in Table 4 in the Appendix B), we find business competence, environmental orientation and environmental regulation expenditures play an important role in monitoring SMEs' certain performance measures. The practices that SMEs regularly monitor can be due to regulation pressures (through environmental regulation expenditures), and managerial capabilities (through business competence and environmental orientation).

More interestingly, in addition to the business competences, environmental orientation index, network involvement, and environmental regulation expenditures, we find that stringencies of environmental regulations strongly affect the number of environmentally friendly behaviors that SMEs engage in their operations (0.298, column (3) in Table 4 in the Appendix B). This shows that current regulation regime that the SMEs are subject to affect firm's managerial and technological responses to the regulations through influences in their decision-making on their production process and taking the so called first steps towards environmental friendly practices.

Lastly, we test for the effects of interest variables on the probability of the SMEs having at least one of the following innovations: patent, utility model, registered trade mark, license agreements (using *equation (2)*). The results are more in line with the findings of studies in economics literature where the environmental regulation expenditures, formal and informal enforcements, particularly the formal enforcement mechanisms, are found to affect the probability of innovation in SMEs (Table 5 in the Appendix B). However, we also find that larger firms and firms that have better environmental orientation such as well-defined environmental policy, and/or an EMS, or may have proactive policies which go beyond compliance with legislation have higher probability to innovate in Turkey.

5. Conclusions

A considerable number of studies in environmental economics literature investigate the role of technical change in attaining the dual goals of sustainable development, better environmental and higher economic performance with the presumption of linear innovation processes. However, the literature on "systems of innovation" by focusing nonlinear nature of the innovation processes, characterizes the technical change as an ongoing complex learning process. The research on factors that affect environmental friendly technical change in SMEs, that play an important role in economic growth in most economies, is limited in these literatures, although SMEs impose significant negative impact on the environment. Hence, given the nonlinear and multifaceted nature of technical change, in this paper, we analyze the environmentally friendly innovations and adoptions of SMEs from the perspective of innovation systems. Such analyses have a potential to contribute to aforementioned literatures and environmental policy design and compliance effort at various scales and regions. Using econometric analysis of original survey data of 1,141 Turkish manufacturing SMEs, we measure not only intra-firm characteristics, roles of regulations and enforcement, but also the roles of innovation partners, external pressures and competition through business competences, network involvement, and environmental orientation. In this paper, we are not particularly focused on sectoral or regional analysis of firm innovativeness; instead, we are mostly concern on factors which that play a crucial role on firm's environmentally friendly innovations, adoptions, practices, behaviors and strategies, in general in Turkey.

We find that SMEs' business competences (organizational, technical and financial competences), environmental orientation, environmental regulation expenditures, network involvement representing firms' abilities and skills gained through voluntary interactions with innovation partners and informal environmental enforcement have significant impact on the environmentally friendly innovations and adoptions that SMEs have and do. Most importantly, we find not only the three main determinants of SMEs' innovativeness as described in innovation triangle model with business competence, environmental innovation and network involvement significant, but also the conventional variables such as environmental regulation expenditures that is a proxy for government regulations significant in Turkish manufacturing SMEs.

In general, our results emphasize the importance of environmental regulation expenses and informal enforcement activities on the number of environmentally friendly innovations and

adoptions that Turkish SMEs have and do; the probability of them to innovate environmentally friendly technologies, products, and marketing strategies and the success of SMEs innovativeness through measuring the percentage of turnover from the sales of these activities. The effect of informal enforcement through related parties (such as suppliers, competitors, customers, consultants, financiers, employees, public authorities, university and research institutions, industry and trade organizations, environmental groups and organizations, and international agencies) is particularly interesting finding for the developing country context. In the case of manufacturing SMEs in Turkey, this result may have some policy implications for government officials and enforcement authorities. If policy makers and enforcement authorities want to design more comprehensive and long-run effective environmental policy tools and enforcement strategies, and stimulate SMEs to develop and successfully adopt environmental innovations, practices and behaviors, they need to consider the importance of informal channels and use those channels to create and improve strategies. For example, as the OECD (2009) policy brief suggests government can play a key role in disseminating information on environmental technologies. Regulators can collaborate with the partners who are supportive to the environmental friendly innovation process of SMEs and who are effective in pressuring the SMEs to be environmental friendly. Therefore, in addition to disseminating the information as a public authority, the government can work also with; for example, industry and trade organizations to disseminate information on environmentally friendly innovations to the SMEs. As our findings point that industry and trade organizations are one of the partners whom the Turkish SMEs are feeling the pressure to be environmentally friendly. Moreover, government can also work with the other effective partner, i.e. employees, where industry and trade organizations can provide government supported training opportunities to the employees of the firms. For example, the Ministry of Environment and Forestry of the Turkish Republic is exploring the possibilitiy of providing training and consultancy services to the SMEs on EMAS. Moreover, not only already effective partners can be channels to approach SMEs, but other partners, such as NGOs, university and research institutions, and financiers can also bring to be effective in providing the right amount and type of pressure to be environmentally friendly. Banks can be asked to check certain environmental criterion before providing loans or ask to ask SME employees to attend training and certification before providing energy efficiency loans. Additionally, findings from recent studies (i.e., Foulon et al. 2002; and Mamingi et al. 2008) which investigate the informal and formal pressures on environmental performance of firms suggests that in addition to the formal regulators (or in the case of absent and/or ineffective formal regulations) informal regulation should be implemented through community groups or NGOs. Therefore, regulators can gain leverage through non-traditional programs which utilize the power of communities, markets, and related parties wth whom the SMEs do collaborate and feel the pressure to be environmentally friendly.

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Appendix A: Construction of the Model Variables

ENDOGENOUS VARIABLES

IP: A dummy variable which takes the value of 1 if a firm has at least one of the four intellectual properties (trade mark, patent, utility model, and license agreement) and 0 otherwise. Having at least one of the four IP means that answering "yes" for at least for one of the IP categories in the survey question.

Innm: A continuous variable representing the number of "yes" responses to the survey question asking whether a company has developed or adopted the following innovations over the last three years: new environmental friendly products, improvement in existing environmental products, new environmental friendly production processes, improvement in existing environmental friendly production processes, environmental friendly end-of-pipe technologies, environmental friendly marketing strategies such as use of natural environment arguments, and environmental friendly organizational structure, culture incorporating environmental friendly policies and procedures. There are similar questions in both OECD (2003) survey and in the study by Müftüoglu et al. (2009).

Turnover: A categorical variable indicating the category that best captures the company's percentage of sales coming from the sales of environmentally friendly technologies, products and marketing strategies. No revenue, less that 1%, 1%-4.99%, 5%-9.99%, and more than 10% correspond to the categories of 1 to 5, respectively.

Ebeh: A continuous variable representing the number of the following activities that a firm engages in: always switching off lights and machines which are in use, perfectly closing all the water taps when they are not in use, using recycled water to save water when possible, systematically separating dangerous wastes from the rest, actively participating in buying and selling in waste markets, always avoiding wasting the chemical products that are used in the garage, storing boxes and papers to use again or recycling them, sponsoring natural environmental events, and having purchasing criteria including ecological requirements. Aragon et. al. (2008) classifies above activities as eco-efficient or innovative preventive activities.

Epra: A continuous variable indicating the level of regularly monitored performance measures. The regularly monitored performance measures are: the use of natural resources (energy, water, etc), wastewater effluent, solid waste generation, emissions, global pollutants (e.g. greenhouse gases), noise, smell, landscape protection, soil contamination, and risk of severe accidents. Some of these performance measures might not be applicable to some of the firms in the sample due to their inherited production technologies. Therefore, this variable is constructed as follows: first, the number of appropriate categories of each firm is calculated by subtracting the "not appropriate for the firm" responses from the total of ten categories, second, the number of "yes" responses are counted, and then the number of "yes" responses are divided by the number of appropriate categories. These environmental practices are inquired in OECD (2003) survey on environmental policy tools.

EXOGENOUS VARIABLES

Business Competence (Bcomp): A continuous variable measuring the motivation, power and knowledge of firms related to environmental capabilities. It is constructed by counting how many "yes" responses that a firm has to all of the following statements: Today our business is experiencing serious environmental pressure which needs a lot of attention by the management, we are keen to make new environmentally friendly investments which are subsidized by the government, whether we adopt environmentally friendly technologies

strongly depends on what our customers demand from us, if needed to improve our business, our financial position is strong enough to invest in new equipment, if compared to our direct competitors our market share is high, our employees are skilled enough to cope with environmental problems, and in general, we have no difficulties in finding adequate information when deciding in new investments. Dijken et. al. (1999) employs the aforementioned statements in constructing business competences index in the ITM model.

Environmental Orientation (Ori): A continuous variable measuring the level of environmental orientation of the firms. It is computed by adding up the "yes" responses of the firms to following statements and questions: We have a clearly stated environmental policy, we can see that environmental matters are becoming more and more important in our business, we have started to integrate environmental aspects of our business to our decision making process or to our business strategies, does your firm have an environmental affairs department or any equivalent department such as environmental, health and safety? does any of your employee(s) work on the environmental matters related to your business and company? and did any of your employees take any environmental training? Dijken et. al. (1999) employs the aforementioned statements in constructing environmental orientation index in the ITM model.

Network (Netwk): A continuous variable measuring the level of network involvement of the firms with various partners in regard to receiving useful advice and other kinds of support in the case of adoption, invention or innovation of new environmentally relevant technologies, products or approaches. The partners are suppliers, competitors, customers, consultancy companies, industry and trade organizations, public authorities (government and municipal, OIZ management), financiers, universities and research institutions, employees, environmental groups and organizations, and international organizations (EU, World Bank, European Institutions, United Nations). A firm is considered to have a relationship with a partner if it interacts with the partner time to time or always. The number of relationships with the partners defines the level of network involvement of the firms. Dijken et. al. (1999) employs some of the partner profiles above in constructing the network index in the ITM model. Moreover, Aragon et. al. (2008), under stakeholder management, considers some of these partners that firms pay attention in managing their enterprises.

Barrier (Bar): A continuous variable measuring the barriers that firms faces in being environmentally friendly. It is constructed by counting the number of responses of agree or fully agree to the following statements: financial constraints restrict our company to be environmentally friendly, the company's policy does not care about the environment, and in our company we would like to be environmentally friendly but it is hard to gather information about how can we be.

Environmental Regulation Expenses (Eregexp): A categorical variable representing the percentages of the firms' expenditures that are due to environmental related activities. The company has not been incurred any environment related expenditures, incurs less than 1%, 1%-4.9%, 5%-9.9% and more than 5% corresponds to the categories of 1-5, respectively.

Environmental Regulation Stringency (Eregst): A categorical variable measuring how firms perceive the environmental policy regime that their facilities are subject to. If the regime is very stringent influencing the decision-making within the facility, the firm falls into the category of 2, if it is moderate stringency it requires some managerial and technological responses, the firm falls into the category of 1 and if it is not particularly stringent where the obligations can be met with relative ease, the firm falls into the category 1, otherwise to 0. The stringency categories are determined based on the responses of "agreement" and "absolute agreement." These stringency criteria are employed in OECD (2003) survey on environmental policy tools.

Environmental Formal Enforcement (Eff): A dummy variable indicating whether the firms have been audited or fined. The variable takes the value of 1 if they get mandatory inspections or if they had warning or if they paid fine based on their last mandatory audit, and zero otherwise. A simpler version of the relevant survey question exists in the OECD (2003) survey.

Environmental Informal Enforcement (Efi): A continuous variable indicating the level of pressure that firms feel from various partners to be environmentally friendly. The partners are suppliers, competitors, customers, consultancy companies, industry and trade organizations, financiers, universities and research institutions, employees, environmental groups and organizations, and international organizations (EU, World Bank, European Institutions, United Nations). The pressure from the public authorities (government and municipal, OIZ management) is not counted in constructing this variable, since the pressure from the public authorities are captured in the variable of environmental regulation. A firm is considered to have pressure from a partner if it "sometimes" or "always" feels the pressure from the partner. The level of pressure is measured by the number of pressuring partners to be environmentally friendly. Frondel et al. (2007) defines a set of above partners as pressure groups who might affect the changes in production processes as well as EMS implementation.

Regions (region1-region7): There are 8 NUTS level 1 regions (İstanbul, Eastern Marmara, Western Marmara, Western Anatolia, Central Anatolia, Aegean, Mediterranean and Southeastern Anatolia) in the study. Therefore, there are seven dummies with the base category of region 2, i.e. Istanbul. The base category is the region with the closest frequency of firms to the average of the whole sample.

Sector: There are ten manufacturing sectors. Therefore there are nine sector dummies with the base category of sector 1, i.e. food products and beverages. The base sector is the one which has the nearest frequency of firms to the average of the whole sample.

Size: A continuous variable indicating the number of full time employee working for the firm in 2009.

Population of province (lnpop): A continuous variable indicating the 2009 population of the provinces in which the firms are located. In estimations, the natural log of it (**lnpop**) is used. The population data source is Address Based Population Registration System from TURKSTAT, www.tuik.gov.tr.

Appendix B: Tables and Results

Figure 1: Survey Regions (NUTS Level 3)

Figure 2: Pressure from the Partners to be environmentally Friendly

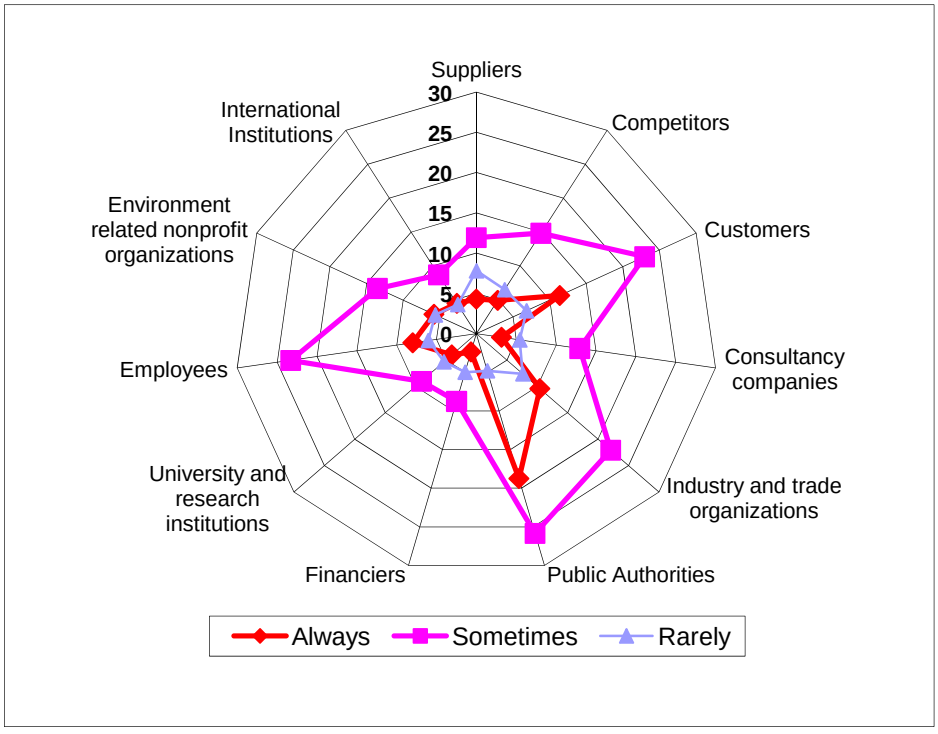

Table 1: Manufacturing Sectors in the Dataset

Sectors	Sector Codes (NACE)	Firms Main Activity Areas
Sector 1	15 (Low Tech)	Manufacture of food products and beverages
Sector 2	17 (Low Tech)	Manufacture of textiles
Sector 3	18 (Low Tech)	Manufacture of wearing apparel; dressing and dyeing of fur
Sector 4	24 (Medium High Tech)	Manufacture of chemicals and chemical products
Sector 5	25 (Medium Low Tech)	Manufacture of rubber and plastics products
Sector 6	26 (Medium Low Tech)	Manufacture of other non-metallic mineral products
Sector 7	27 (Medium Low Tech)	Manufacture of basic metals
Sector 8	28 (Medium Low Tech)	Manufacture of fabricated metal products, except machinery and equipment
Sector 9	29 (Medium High Tech)	Manufacture of machinery and equipment n.e.c
Sector 10	34 (Medium High Tech)	Manufacture of motor vehicles, trailers and semi-trailers

Table 2: Model variables and descriptions

Variables	Definitions
Innm	The number of environmentally friendly innovations and adoptions that firm has
Epra	Normalized variable indicating the level of environmentally friendly practices that firm conducts and monitors in its operations
Ebeh	The number of environmentally friendly behaviors that firm engages in their operations.
IP	A dummy indicating if firm has at least one of the following innovations: patent, utility model, registered trade mark, license agreement
Turnover	Categorical variable for the percentage of the turnover obtained from sale of environmental friendly technologies, products, and marketing strategies
Bcomp	The number of environment related business competences that firm has. Includes indices of motivation, knowledge and power composed of organizational, technical and financial competences
Ori	Environmental Orientation Index: The number of environmental competencies that firm has
Netwk	Network Index: The number of external competences that firm has (these competencies are related with external parties that firms may involve in environmental innovations/adoptions)
Bar	Barrier Index: The number of existing barriers that firm has
Eregexp	Categorical variable for the percentage of expenses related to the environmental regulation activities
Eregst	Categorical variable that indicates environmental regulation stringency
Efi	Informal environmental enforcement measured by the number of parties that pressure firms to be environmental friendly
Eff	A dummy indicating if firm gets mandatory inspections by government or municipal agency
Size	The number of employees working at firm
Pop	Turkish Statistical Institute 2009 population estimate of the city where firm locates
Sector	Sector specific dummies (9 sector dummies in total)
Region	Region specific dummies (8 region dummies in total)

Table 3: Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Min	Max
Innm	2.170	2.011	0	7
Epra	0.747	0.267	0	1
Ebeh	6.566	1.577	0	9
Turnover	1.843	1.191	1	5
IP	0.445	0.497	0	1
Bcomp	4.892	1.491	0	7
Netwk	4.178	2.994	0	11
Ori	3.242	1.543	0	6
Bar	0.755	0.766	0	3
Eregexp	2.298	1.132	1	5
Eregst	1.054	0.661	0	2
Efi	2.068	2.466	0	10
Eff	0.846	0.361	0	1
size	42.277	50.605	1	250
lnsize	3.113	1.177	0	5.521
pop	3391865	3648687	122104	12915158
lnpop	14.597	0.927	11.713	16.374

Table 4: Multicollinearity Test

Regression Models		
	VIF	1/VIF
Bcomp	1.32	0.757
Ori	1.61	0.621
Netwk	1.51	0.663
Bar	1.17	0.852
Eregexp	1.23	0.811
Eregst	1.08	0.922
Efi	1.32	0.755
Eff	1.16	0.860
lnsize	1.24	0.804
sector2	2.10	0.476
sector3	1.29	0.773
sector4	1.55	0.643
sector5	2.04	0.489
sector6	1.52	0.657
sector7	1.90	0.526
sector8	1.53	0.653
sector9	1.88	0.531
sector10	1.52	0.656
region1	1.85	0.540
region3	1.32	0.760
region4	2.33	0.428
region5	2.21	0.453
region6	2.17	0.460
region7	1.63	0.613
region8	1.77	0.566
Mean VIF	1.61	

Table 5: OLS Regression Results

Variables	Innm (1)	Epra (2)	Ebeh (3)	Turnover (4)
Bcomp	0.170 (0.036)***	0.027 (0.006)***	0.193 (0.034)***	0.020 (0.023)
Ori	0.356 (0.04)***	0.024 (0.006)***	0.130 (0.032)***	0.011 (0.026)
Netwk	0.096 (0.021)***	0.001 (0.003)	0.098 (0.019)***	0.028 (0.013)**
Bar	-0.102 (0.065)	-0.004 (0.011)	0.05 (0.065)	-0.039 (0.042)
Eregexp	0.366 (0.051)***	0.024 (0.007)***	0.101 (0.041)**	0.408 (0.040)***
Eregst	0.071 (0.075)	0.017 (0.013)	0.298 (0.069)***	0.057 (0.049)
Efi	0.061 (0.023)***	0.003 (0.003)	-0.016 (0.019)	0.042 (0.016)***
Eff	0.134 (0.148)	-0.011 (0.025)	0.127 (0.136)	-0.014 (0.094)
Lnsize	0.041 (0.043)	-0.008 (0.008)	0.01 (0.0390)	-0.090 (0.030)***
Lnpop	0.008 (0.094)	0.005 (0.014)	0.039 (0.079)	0.009 (0.062)
sector2	-0.2 (0.181)	0.065 (0.029)**	0.088 (0.158)	0.034 (0.122)
sector3	-0.014 (0.28)	0.091 (0.05)*	0.423 (0.261)	0.178 (0.227)
sector4	0.118 (0.238)	0.019 (0.035)	0.078 (0.181)	0.147 (0.167)
sector5	-0.171 (0.187)	0.021 (0.029)	-0.028 (0.165)	0.223 (0.127)*
sector6	-0.053 (0.247)	0.039 (0.036)	0.056 (0.196)	0.132 (0.158)
sector7	-0.247 (0.188)	0.019 (0.029)	-0.321 (0.169)*	0.159 (0.129)
sector8	0.028 (0.241)	0.004 (0.037)	-0.14 (0.2)	0.213 (0.158)
sector9	-0.087 (0.196)	0.02 (0.03)	-0.126 (0.166)	0.121 (0.126)
sector10	-0.294 (0.237)	-0.036 (0.04)	-0.141 (0.22)	0.333 (0.183)*
region1 (SE-Anatolia)	0.174 (0.294)	0.042 (0.049)	0.013 (0.264)	0.269 (0.205)
region3 (W-Marmara)	-0.087 (0.394)	0.015 (0.062)	-0.25 (0.385)	0.075 (0.287)
region4 (Aegean)	-0.103 (0.24)	0.055 (0.041)	0.129 (0.215)	0.137 (0.165)
region5 (E-Marmara)	-0.289 (0.284)	0.075 (0.044)*	0.309 (0.231)	-0.169 (0.188)
region6 (W-Anatolia)	-0.307 (0.223)	0.046 (0.037)	0.25 (0.193)	-0.009 (0.147)
region7(Mediterranean)	0.121 (0.292)	0.072 (0.048)	0.325 (0.255)	0.327 (0.197)*
region8 (Ctr-Anatolia)	-0.223 (0.329)	-0.011 (0.052)	0.279 (0.274)	-0.013 (0.208)
Constant	-1.297 (1.564)	0.355 (0.237)	3.412 (1.309)***	0.507 (1.016)
Observations	1141	1141	1141	1,141
R-squared	0.368	0.117	0.214	0.22

Notes: Robust Standard Errors are in parentheses; *,**, and *** denote significance at 10%, 5%, and 1%, respectively. Sector and Region dummies are included (sector 1 and region 2 are taken as a base).

Table 6: Logit Regression Results

Variables	Coefficients	Marginal Effects
Bcomp	-0.0146 (0.0494)	-0.00359 (0.0122)
Ori	0.0876 (0.0259)***	0.0216 (0.00637)***
Netwk	0.0190 (0.0529)	0.00468 (0.0130)
Bar	0.0502 (0.0880)	0.0124 (0.0217)
Eregexp	0.225 (0.0622)***	0.0554 (0.0153)***
Eregst	0.0621 (0.0975)	0.0153 (0.0240)
Efi	0.0601 (0.0292)**	0.0148 (0.00719)**
Eff	0.370 (0.193)**	0.0890 (0.0451)**
Lnsize	0.118 (0.0589)**	0.0290 (0.0145)**
Lnpop	0.0588 (0.120)	0.0145 (0.0296)
sector2	-0.834 (0.251)***	-0.193 (0.0528)***
sector3	-0.481 (0.419)	-0.113 (0.0929)
sector4	-0.893 (0.304)***	-0.200 (0.0592)***
sector5	-0.370 (0.249)	-0.0892 (0.0584)
sector6	-0.699 (0.320)**	-0.161 (0.0667)**
sector7	-0.727 (0.263)***	-0.169 (0.0561)***
sector8	-0.171 (0.308)	-0.0417 (0.0741)
sector9	-0.639 (0.266)**	-0.150 (0.0581)**
sector10	-0.714 (0.329)**	-0.164 (0.0681)**
region1(SE-Anatolia)	0.279 (0.380)	0.0694 (0.0949)
region3 (W-Marmara)	-0.320 (0.514)	-0.0769 (0.119)
region4 (Aegean)	0.178 (0.311)	0.0442 (0.0774)
region5(E-Marmara)	-0.387 (0.358)	-0.0933 (0.0839)
region6 (W-Anatolia)	-0.0426 (0.294)	-0.0105 (0.0721)
region7(Mediterranean)	0.223 (0.369)	0.0554 (0.0921)
region8(Ctr-Anatolia)	-0.788 (0.428)**	-0.180 (0.0876)**
Constant	-2.251 (1.993)	
Observations	1,141	1,141

Notes: Robust Standard Errors are in parentheses; *,**, and *** denote significance at 10%, 5%, and 1%, respectively. Sector 1 and Region 2 are taken as base. For dummy variables, marginal effect measures the effect of a discrete change from 0 to 1.