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Intra-OIZ and Intra-Industry Knowledge Spillovers in Ankara: A Spatial Econometric Analysis*

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Abstract

Network between the firms reveal the knowledge spillovers which is inevitable for economic growth of a country for neoclassical economists. In this study, existence of intra-OIZ and intra-industry knowledge spillovers in Ankara is tested by the help of an export decision function. As it considers the spatial dependence between the regional units, the spatial econometric method is preferred. The data set is taken from the "Field Research Survey" of SMEDO. The spatial effect is one third of the total effect for intra-OIZ relations while it is one fourth of the total effect for intra-industry relation for Ankara.

Keywords: *Geographical Agglomerations (Clusters), Organized Industrial Zone (OIZ), Spatial Econometrics, Knowledge Spillovers, Export*

JEL Classification: *C21, C25, O12, O24, R15*

Ankara'da OSB-İçi ve Endüstri-İçi Bilgi Sıçramaları: Mekânsal Ekonometrik Bir Analiz

Özet

Firmalar arasındaki ağ yapısı, neoklasik iktisatçılar için bir ülkenin büyümesinde kaçınılmaz olan bilgi sıçramalarını ortaya çıkarmaktadır. Bu çalışmada, Ankara'da OSB-içi, endüstri-içi bilgi sıçramalarının varlığı ihracat karar fonksiyonun yardımıyla test edilecektir. Bölgesel birimler arasındaki mekânsal bağımlılık dikkate alındığından mekânsal ekonometrik metot tercih edilmiştir. Veri seti, KOSGEB'in "Saha Araştırma Anketi"nden alınmıştır. Ankara'da OSB-içi ilişkiler için mekânsal etkiler toplam etkinin üçte biri iken endüstri-içi ilişkiler için bu etki dörde bir oranındadır.

Anahtar Kelimeler: *Coğrafi Yığılmalar (Kümeler), Organize Sanayi Bölgesi (OSB), Mekânsal Ekonometri, Bilgi Sıçramaları, İhracat*

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1. Introduction

One of the main industry policies in Turkey is establishing Organized Industrial Zones (OIZs), Technology Development Zones (TDZs) and Industrial Zones (IZs)[1]. First OIZ in Turkey was established in Bursa 1969. Till 2007, there have been 70 active OIZs. In 2012, this number is 263 OIZs with 148 active ones and 115 planned ones. The expectation of being in geographically agglomerated firms is not only to interact with each other but also to transfer knowledge among them. As far as we know, the interaction between the firms is tested not yet in Turkey. This is mainly due to the lack of appropriate data and analysis (econometric) tools.

The OIZs are from the cluster (geographical agglomeration) idea which is first suggested by Marshall (1920) and have got stronger support by Porter in 2000's. In geographical agglomerations (clusters), firms are benefitting from the (positive) "externalities" (knowledge spillovers) that other firms produce. Neo-classical economists and the endogenous growth theoreticians emphasize the importance of knowledge and knowledge spillovers in their theories and models.

Clusters are always known to be encouraged because of the knowledge spillovers but the main question arises whether there is "knowledge spillovers" exist in clusters. Our starting point is to analyze the knowledge spillovers in clusters with a Turkish OIZ application. The question is stronger when the analyzing unit is clusters. The ambiguity depends on whether or not OIZs are considered as "clusters". Due to this ambiguity, the hypothesis of this study is changed to investigate if OIZs can be considered as clusters by analyzing the existence of (spatial) knowledge spillovers. As far as we know, the econometric method at least spatial econometric method is not used yet for analyzing the efficiency of OIZs.

1 In Turkey, two laws on OIZs and TDZs, and one act on IZs are effective.

2. Literature Review

Knowledge spillovers, which are crucial to the economic growth of a nation, were first introduced into economic literature by the neo-classical economists especially with Marshall (1890). As Porter (1990, 1996, 2000) emphasized, knowledge is better spilled in geographically nearby firms. Clusters (geographical agglomerations) are the best way to increase knowledge spillovers.

Knowledge spillovers which serve as the engine of endogenous economic growth can be defined as a benefit of innovation (knowledge) accumulates not only to the innovator benefits, but also "spills over" to other firms (Branstetter, 2001). Zucker et al. (1998, 65) defines this terminology as "positive externalities of scientific discoveries on the productivity of firms which neither made the discovery themselves nor licensed its use from the holder of intellectual property right-lay a central role in the literature as causes of both economic growth and geographic agglomeration". According to Mare (2004, 8), the condition for spillover to occur is "accumulation of an input has an unintended (and unrewarded) positive effect on productivity". Based on the spillover, the firm, the province or the country benefits from increase in productivity, decrease in costs or competitive advantage from nearby firms, provinces or countries without any payment.

How the knowledge transfer occurs is not clearly stated (Jaffe, 1986: Jaffe, 1989: Jaffe et al., 1993). Romer (1986, 1990) emphasized the importance of these knowledge transfer mechanisms but he did not mention how this would happen or through which channel. If knowledge is conveyed through informal conversations, geographical proximity is important in spreading the knowledge. (Jaffe, 1986: Jaffe, 1989). For example, in Silicon Valley, according to Saxenian (1994) the most important knowledge transfer mechanism is informal conversation in an informal social network.

Arrow (1962) and Krugman (1991) emphasized in their studies that there is no direct measure to identify the existence of knowledge spillovers so they focused on the importance of new knowledge and they measured it with R&D intensity or R&D-sales ratio. Although it is more easily tested with the availability of the appropriate data and techniques, still some difficulties exist for analyzing the knowledge spillovers directly.

The main difficulty in testing spillovers is separating this effect from both "pre-existing pattern of geographic concentration of technologically-related activities" (Jaffe et al., 1993) and "natural (resource) advantage" (Ellison and Glaeser, 1997). As the intra-industry interaction becomes stronger, industrial density depends on other industries to locate geographically. When a firm uses natural resources as an input, since transportation costs are one of the main cost items, it prefers to produce near the natural resource. This is known as "natural advantage". Consequently, in the estimation of the existence of knowledge spillovers, these reasons result in overestimating the effects.

Technological improvements and knowledge spillovers always get the attention of both theoreticians and politicians because of their importance - they are always seen and believed to be the main engine of economic growth as proved in neoclassical growth theory[2] (Aghion and Howitt, 1998: Romer, 1994). Three theories and three types of knowledge spillovers exist in the literature: Marshall-Arrow-Romer (MAR), Jacobs and Porter.

MAR, Jacobs and Porter externalities are the three main approaches which have tried to explain technological externalities between the firms. As Glaeser et al. (1992, 1128) indicates, the main objective of the theories is "they try to explain simultaneously how cities are form and they grow". The two theories, MAR and Jacobs, were studied one versus another while Porter externalities is tested as a sub-hypothesis of MAR. One of theories stresses the importance of within(intra)-industry externalities, while the other one emphasizes the between(inter)-industry externalities. The researchers investigate the issue by testing the existence of intra (within) or inter (between) industry effects.

Marshall-Arrow-Romer (MAR) type of externalities are developed first by Marshall in 1890 and improved by Arrow and Romer in 1962, 1986, respectively. MAR externalities are basically higher concentrations of an industry which fosters knowledge to spill easier into the city and firms. Employment concentration ratios of an industry in a city, which is a proxy for MAR externalities, indicate the localization level of the industry. This is basically true for mature industries. Marshall (1920) emphasized the importance of a labor pool, specialized inputs and a flow of information for industry localization. For Arrow (1962), knowledge spillovers are more important for highly R&D-intensive industries.

Jacobs (1969) types of externalities are defined by the words diversification and urbanization. The bigger the city, the higher the knowledge transfers. The firm in an industry benefits most from the proximate industries nearby. Unlike MAR externalities, Jacobs (1969) is in favor of local competition which promotes growth and innovation. This idea emerges from industries which are newly established or high-tech industries.

Porter (1990) sticks into MAR externalities by extending it. In MAR externalities, local monopoly is the element which maximizes the spillovers while Porter (1990) emphasizes the importance of local competition rather than local monopoly. For Porter (1990), the firms benefit mainly from spillovers when they are geographically near to a competitive environment. This is also the basic argument for the geographical agglomerations (clusters) which is advocated as the best milieu for productive, competitive and innovative firms as the source of growth.

A forementinoned three theories have agreed with the idea on the advantage of geographical agglomerations but their main difference is on the industrial division in the city. According to MAR externalities, the specialization of one industry in a region is better than the mere of industries. Jacobs (1969) focused on the idea of interrelations of the industries and argues that a firm benefits more from a related industry which is not in the same industry as the firm but in a highly interacted industry. Porter sticks to the MAR's idea that localization of an industry is an advantage when there is competition in the industry. The differences and common points of these three theories are summarized at Table 1.

2 The importance of "invention" in economic growth is emphasized firstly with the work of Rae (1834).

Table 1: Basic Concepts of MAR, Jacobs and Porter Externalities[3]

MAR Externalities	Jacobs Externalities	Porter Externalities
Specialization	Diversification	Competition
Localization	Urbanization	Localization
Local Monopoly	Local Competition	Local Competition
Big industry advantage	Big city advantage	Clustering advantage
For mature industries	For new high-tech industries	

For the empirical literature on testing the hypothesis of specialization over diversification[4], the findings of Glaeser et al.(1992), Harrison et al. (1996) and de Lucio et al. (1996) support Jacobs externalities while Henderson et al. (1995) and Henderson (1997) found strong evidence for MAR externalities. Beaudry and Schiffauerova (2009) summarized the main findings of the 67 reviewed articles on this subject. 23 of them support MAR externalities while 26 side with Jacobs externalities. Nevertheless, nearly one third of the studies have found evidence for the existence of both externalities. The ambiguity in the results might depend on various reasons explained by Frenken et al. (2005) as variations in the definitions, intra-industrial linkages and spatial scale. Furthermore, every author used a different indicator to calculate the MAR and Jacobs externalities even some (Loikkanen and Susiluoto, 2002) used only one variable (Hirschman–Herfindahl index) to distinguish them according to the sign of the variable.

Glaser et al. (1992) and Henderson et al. (1995) used employment growth as the explained variable while de Lucio et al. (2002) used productivity growth. Different variables are used to measure the externalities. Beaudry and Schiffauerova (2009) indicate that location quotient and own-industry employment are common indicators (used in %75 of the studies) for MAR externalities, the Hirschman–Herfindahl index is the most common one for Jacobs externalities which have different indicators for a variety of purposes.

3. Model (Export Function)

In a research which analysis the export behavior of firms, the researcher might choose either the decision to export or the total value of exports for analyzing. As our main concern is on knowledge spillovers, the total value of exports might be misleading and

3 Beaudry and Schiffauerova (2009, 320) demonstrates the sources of knowledge within a table. In this table, they indicate that specialization is the source for MAR externalities while diversity and competition is features of Porter externalities; on the other hand, Jacob externalities attributes to specialization and competition. De Lucio et al. (2002) indicate specialization for MAR externalities, diversity for Jacobs and competition for Porter.

4 Most of the time Porter externalities are tested as a sub hypothesis of MAR externalities. According to Beaudry and Schiffauerova (2009), only 25 out of 67 articles investigates the three types of externalities; on the other hand, others just focus on two theories (MAR and Jacobs) only.

hinder our understanding of the dynamics of knowledge spillovers on a firm level study. In a region or a province, several large firms or multinational enterprises (MNEs) mislead the analysis. In a study analyzing knowledge spillovers, the focal point is on the interaction between the regions or provinces or firms. Furthermore, the important issue is whether or not the firm has the knowledge. In this study, the knowledge which is spilling is to learn the necessary information for exporting. The firm that exports needs some critical information or knowledge such as connections in the foreign market. Therefore, not the volume of exports but the decision to export is more meaningful for the analysis.

Our aim is to ascertain the determinants of the export function. This issue can be investigated at either macro, meso or micro level. Before the 1990's, the studies were mainly focused on the macro level, but with the availability of the firm level datasets, later studies were made predominantly at the micro level. At the macro level, the studies mainly focus on the one country or cross-country analysis (Andersson and Ejermo, 2008: Alguasil et al., 2002: Montobbio and Rampa, 2005) meanwhile at the micro level, the primary concern of the studies is to investigate the export behavior on the firm level (Wakelin, 1998: Rodriguez and Rodriguez, 2005: Barrios et al., 2003). Comparison of the industries are studied at the meso level (Kumar and Siddharthan, 1994: Dijk, 2002) especially comparison of high-tech industries and low-tech industries.

At micro studies, the common finding is that exporters when compared to non-exporters are more productive, more efficient, more technological and also larger in size (Aw et al., 1998: Bernard and Jensen, 1999: Bleaney and Wakelin, 2002: Aitken et al., 1997: Bernard and Jensen, 1999: Clerides et al., 1998). Most of the studies in this area show that productive firms are more likely to export which can be explained by the self-selection hypothesis (Clerides et al., 1998: Aw et al., 1998: Bernard and Jensen, 1999). Self-selection is defined as "that exporters learn from their contacts in the export market and this results in the adoption of better production methods and higher productivity. Alternatively, the higher productivity of exporting firms reflects the self-selection of more efficient producers into a highly competitive export market (Aw et al., 1998).

The relationship between firm size and trade has been investigated by many studies (e.g. Berry, 1992; Muranda, 1999). Muranda (1999) defines the firm size in terms of employment The relationship between firm size and trade has been investigated by many studies (e.g. Berry, 1992; Muranda, 1999). Muranda (1999) defines the firm size in terms of employment level for the textile and clothing firms in Zimbabwe since those industries are relatively labor-intensive. Sterlacchini (1999) explains the reasons behind the positive relationship between firm size and export performance as economies of scale in production and in export marketing, higher capacity for taking risks, better opportunities to raise financing and sufficient managerial, financial, R&D, and marketing resources.

In the literature, R&D expenditures are often used as a proxy for the innovation capacity of firms. The findings are ambiguous. Although Wagner (2001) finds a positive relationship between R&D expenditures of German firms and their exports, Lall and Kumar (1981) finds a negative relationship between them in a sample of 100 Indian firms. Knowledge and technology accumulation in a region is mutually related according to Andersson and

Ejermo (2008). Multinational enterprises are expected to export more. Ramstetter (1999) justifies this expectation. Special features of the administrator are also making it easier to export. Some of the characteristics are the level of education, age, foreign language knowledge (Obben and Magagula, 2003).

As far as we know, no studies are found on analyzing the spatial effects on the export function either at regional or at a provincial level. In summary, on the firm level studies, export is affected by a firm's characteristic such as the firm's size and the age of the firm; technology and innovation - especially variables which show the innovative capabilities of the firm; FDI; and the characteristics of the administrator. At Table 2, independent variables which are used in the export decision function in the literature are summarized. Some variables (age, size) are common but most of them are subject or data specific.

Table 2: The summary Table for the Independent Variables Used for Export Decision in the Literature

Author	Dependent	Independent
Aitken et al. (1997)	X(0,1)	Industry Concentration, Local Export Concentration, MNE Export Activity, Plant FDI (USA, Europe, Japan, other), Tariffs on Output, Quotas on Output, Price Index(Construction, Machinery, Transportation, Office Equipment, Raw Material, Electiricity), State-Industry Wage
Barrios et al. (2003)	X(0,1) X/sales	Age, Age2, Size, Size2, Productivity, Wage, R&D Intensity, Domestic R&D, MNE R&D, R&D interaction, Domestic Export, MNE Export, Export Interaction
Bernard & Jensen (2004)	X(0,1)	X(-1), X(-2), Employment, Wage, Non-prod./Emp, Productivity, New Product, Industry Exchange Rate, Multi-plant Dummy, Multinational Dummy, State Exporters, Industry Exporters, State-Industry Exporters
Rodriguez & Rodriguez (2005)	X(0,1) X/sales	RD/Sales, Product Innovation, Number of innovation in products, Patents, Number of Patents, Process Innovation, Number of Employees, Foreign Capital, Technology Intensive Sector
Roper & Love (2002)	X(0,1) X/Sales	Part of a Multiplant Group, Graduate Employees, RD Department in Plant, RD in Plant, Plant Employment, Plant Employment2, Product Innovation, Regional GDP per capita, Sector dummy, Regional Supply Shain,
Sjoholm (2003)	X(0,1)	District Export, Size, Skill(Share of Labor Higher than Primary School), Capital Stock per Labor, R&D, Age, Import, Foreign Ownership, Spillovers
Wagner (2001)	X/Sales	Firm Size, Firm Size2, Branch Plant Status, Craft Job, Percentage of Jobs Demanding University Degree, R&D/Sales, Patents, Product Innovation, Industry Dummies
Wakelin (1998)	X(0,1) X/Sales	Average Capital Intensity, Average Wages, Size, Size2, Number of Innovations used in the Sector, Unit Labor Cost, Dummy for Innovating Firms, Number of Firm Innovations

From the firm level studies, the determinants of export function are summarized in five main headlines; characteristics of the firm, technology, characteristic of the administrator, other variables which are research specific variables and dummies.

$$X = f(Chr_{firm}, Tech, Chr_{administrator}, Other, Dummy) \quad (1)$$

In export function studies on the firm, either the decision or the volume of exports is used. The variable on export decision is not only accurate to use, but also logical for analyzing the knowledge spillovers. The volume of exports of neighboring firms is not as important as the number of neighbors who performs exports. This is mainly due to the large firms around and MNEs. The larger the firm, the larger the export level is. The higher volume of exports of a neighboring firm might mislead the results. The main concern is here whether or not the neighboring firms know how to export. The dependent variable is the export decision of firms:

$$X = \begin{cases} 1, \text{when}\, x_q > 0 \\ 0, \text{when}\, x_q = 0 \end{cases} \quad (2)$$

where X is the export decision and x_q is the volume of exports of a firm.

The most important and indispensable part of the export function is the part which defines the characteristics of the firm. Firm size has a special importance in export function; there is an abundance of literature on this relation. Firm size is generally proxied by the employment level, i.e. number of labor. There are also other proxies such as total sales or capital intensity. The positive sign of this variable indicates economies of scale (or scale advantage), i.e. big firm advantage. Another variable which is used to define the characteristics of the firm is the number of years that the firm has been in business. New firms are more risky and more market oriented than the older firms, although older firms have the advantage of having established relationships and networks to reach the necessary knowledge. Productivity, efficiency and capital-related variables are also used. In the calculation of productivity, either the total production or the value added per worker is used.

4. Methodology

To analyze whether there are knowledge spillovers intra/inter region or provinces or OIZs, the spatial econometric methods are the appropriate one to use. The roots of spatial analysis arise from the question of whether or not "space matters". Actually, the real question is whether or not a spatial unit which might be a region, province or a country is affected by its neighbors. This is explicitly defined by Tobler (1979)'s First Law of Geography, "everything is related to everything else, but closer things more so".

The main difference between the standard and the spatial estimation is that the weight matrix is used. Weight matrix basically indicates the neighbors and their distance from the analyzed spatial unit. Weight matrix is formed from contiguity matrix. Contiguity and weight matrix is one of most controversial issues in spatial econometrics.

LeSage (1998, 1999a, 2000, 2004) focused on the spatial analysis of limited dependent variables. Until LeSage, only McMillen (1992) have worked on this. The structural form of spatial probit for error models is (Franzese and Hays, 2008, 8),

$$\begin{aligned} y^* &= X\beta + \varepsilon \\ \varepsilon &= (I - \lambda W)^{-1}\epsilon \end{aligned} \tag{3}$$

The marginal probabilities are estimated as,

$$p(y_i = 1 \mid x_i) = p(\epsilon_i < \frac{[x_i\beta]_i}{\sigma_i}) \tag{4}$$

LeSage (1999a, 155-6)[5] explains the basic estimation steps with the Gibbs sampler for the spatial probit models. The steps are basically as follows. It starts with arbitrary values for β^0 and ρ^0. Subscript 0 indicates the arbitrary initial values to find σ. This is used in the calculation of β. In the next step, with estimated values of σ and, β, ρ is predicted. Finally, in the last step, all these estimated values are used in the prediction of y. In this study, our preference is to use LeSage's (1998, 1999a, 1999b, 2000) Gibbs sampling method in the estimation of spatial probit models because it works perfectly under the heteroscedasticity and the outlier problem.

5. Data

In this study, "Field Research Survey" which was collected by Small and Medium Enterprises Development Organization (SMEDO) was used. This survey is restricted to those firms which have applied for assistance, so sample selection bias arises because the firms are not chosen randomly. It is assumed that there are 250,000 SME's in Turkey according to TURKSTAT, in the SMEDO sample there are 62,137 firms which is almost one fourth of all the firms in Turkey. The coverage of the data wipes out the sample selection bias.

The SMEDO data includes 62,137 firms from 24 industries in 81 provinces between 2004 and 2007. 62.87 % (39,065 firms) of it comes from the year 2004. In this data only 33.42 % (20,767) of the firms are exporters while 66.58 % (41,370) of the firms are non-exporters.

To define the characteristics of the firm, LNAGE (logarithm of age of the firm or years in business), LNLAB (logarithm of total labor for firm size) and HSLAB (high skilled labor) is used. When the sign of the LNAGE is positive, it indicates that the older firms have an advantage for exporting and vice versa. If the coefficient of the LNAGE variable is

5 LeSage (1998, 194) explain Gibbs Sampling for standard econometrics.

insignificant, this basically means that newly formed firms have the same chance to export as the old firms. According to economies of scale hypothesis, it is expected that the sign of LNLAB is positive. According to the skill-based technological change hypothesis, skilled labor triggers technological change which fosters productivity. As more productive firms are expected to export more, the sign of the HSLAB variable which is university graduates over total labor is positive.

Although different proxies are used for technology, on every level of the study related to export, either macro or micro or meso level, technology is an inevitable variable in estimating the propensity or the decision of exports. In macro studies, the main proxy for technology is patents which are also used in meso or micro level studies. Product or process innovation is used in addition to the R&D expenditure in firm level studies. In the existing literature, findings are ambiguous about the relationships of the exports and the R&D expenditures. While this relation is positive for a developed country (Germany) (Wagner, 2001), it is negative for a developing country (India) (Lall and Kumar, 1981).

Three different variables are used as a proxy or technology. In the questionnaire, questions are asked about whether or not the firm has any PLC (programmable logic controller), CNC (computer numerical control) or robot. It summed up each "yes" answer to constitute the first technology proxy, the PLCNCR. The second technology proxy is TMPUM which is a binary variable. The firms were asked whether or not they had a trade mark, patent or useful model. The last variable for technology is computer usage (COMPUSE) calculated from the question of whether or not the firm uses computers in production, design and research. All the expected signs of technology proxies are positive.

At the firm level studies, the characteristics of the administrator are also used as exogenous variables in the export function especially the "familiarity with the language of the foreign market". The education level (EDUCA) and the foreign language knowledge (FORLA) of the administrator are chosen as the characteristic of the administrator. Expected signs of these two variables are positive.

In the literature, there are also variables which are research or paper specific such as government export incentive, policy factor, advertising and promotion. In this study, it is used three extra variables not specified in the main headlines, SMEDO (SMEDO incentives), ORGPROX (organizational proximity) and CLUSTER (cluster proximity). SMEDO is a binary variable which indicates whether or not the firm uses any credit or incentives from the SMEDO. ORGPROX is constructed from how many professional institutions the firm is member of. In the questionnaire there are six questions in which the firm has to identify five firms they are in close relationship with and also the location of these firms whether or not they are in the OIZ, in the same province, a different province or outside the country. These six questions ask; i) where the firm bought it machineries and equipments, ii) where the firm bought its spare parts, iii) where they employed maintenance services, iv) where the firm bought its inputs, v) where the firm sold out it products, vi) where its competitors are. When the firm asserted that it bought any of them from OIZ, it is counted as one. It is expected that SMEDO and ORGPOX variables are positively effecting the export decision although it is ambiguous about the CLUSTER variable due to its close relations with the OIZ made the firm embedded in OIZ or in the province but for sure in the country.

Location dummies are also used. As we focus on the export decision, the location of the firm also matters. It is a two-sided question of either the exporting firm chooses border or seaside provinces or the firm which is on the border or seaside prefers outside markets. Whatever the answer is, being on the border or on the seaside totally affects the export behavior as it is virtualized by maps in the fourth chapter. While twenty eight provinces[6] are on the seaside, only fifteen[7] of the provinces are on the border.

In Table 3 all the variables chosen for analysis are summarized. In the literature, one of the important headlines is foreign direct investments (FDI) and multinational enterprise (MNE) relations of the firm. In macro studies, FDI is not only important for export function, but it also is a major component in the knowledge spillovers. For micro or firm level studies percent of the foreign ownership is a suitable variable. Furthermore, relations with geographically or economically close MNE are essential in the decision-making process of the firm. Unfortunately, no information about these issues is available in the data.

Table 3: Summary of the Definition of Variables

Variable Name	EXPLANATION
Dependent	
EXP	Export decision
Characteristics of the Firm	
LNAGE	Logarithm of age of the firm
LNLAB	Logarithm of total labor
HSLAB	High Skilled Labor
Technology level of the Firm	
PLCNCR	To have PLC, CNC and robot
TMPUM	To have trade mark, patent and useful model
COMPUSE	Computer usage in production, design or research
Characteristics of the Administrator	
EDUCA	Education Level of Administrator
FORLA	Foreign Language Knowledge of the Administrator
Other	
SMEDO	Usage of SMEDO incentives
ORGPROX	Organizational Proximity
CLUSTER	Cluster Proximity

6 Kirklareli(39), Edirne(22), Tekirdag(59), Canakkale(17), Istanbul(34), Kocaeli(41), Sakarya(54), Duzce(81), Zonguldak(67), Bartin(74), Kastamonu(37), Sinop(57), Samsun(55), Ordu(52), Giresun(28), Trabzon(61), Rize(53), Artvin(08), Hatay(31), Adana(01), Mersin(33), Antalya(07), Mugla(48), Aydin(09), Izmir(35), Balikesir(10), Bursa(16), Yalova(77).

7 Kirklareli(39), Edirne(22), Artvin(08), Ardahan(75), Kars(36), Igdir(76), Agri(04), Van(65), Hakkari(30), Sirnak(73), Mardin(47), Sanliurfa(63), Gaziantep(27), Kilis(79), Hatay(31).

After the cleaning process, 1,545 observations remained for OIZs for Ankara. In Table 4 the statistics for the variables are summarized. The exporters' rate is 29.64% which is approximately the same as the whole sample. The average age of the firms is 9.41 which is lower than the whole sample. The average firm size of the Ankara OIZ is 8.80 while in the whole sample it is 16.19. The rate of high skilled labor to total labor is 9.29% while 82.46% of the firms do not use any PLC, CNC or robot in Ankara OIZs. One fifth of the firms have either a trade mark, patent or useful model. In Ankara OIZ data, the firms have less of not only PLC, CNC and robot but also less trademarks, patents and useful models than the whole sample. The average of the cluster variable is stronger in OIZs. The firms in OIZs prefer to interact geographically with nearby firms. The distribution of firms according to their sectors shows that Ankara OIZs are more specialized in scale-intensive and specialized-suppliers industries with 33.27% and 34.56%, respectively.

Table 4: Summary Statistics for Ankara OIZ Data (# of obs: 1545)

Variable	Mean	Std. Dev.	Min	Max
exp	0.296	0.457	0	1
age	9.414	8.895	0	53
lnage	1.947	0.958	0	3.970
lab	8.799	10.952	1	143
lnlab	1.738	0.897	0	4.963
hslabor	0.101	0.171	0	1
plcncr	0.207	0.487	0	3
tmpum	0.201	0.401	0	1
compuse	1.176	1.174	0	3
smedo	0.060	0.238	0	1
orgprox	1.216	0.622	0	5
cluster	4.368	4.523	0	27
educa	0.987	1.911	0	5
forla	0.396	0.568	0	3

The correlations between the variables are given in Appendix 1. As in the sample, the cluster variable is consistent and negatively related to the dependent and the independent variables. Except for the cluster variable, the only negatively correlated pair is the age and the high skilled labor.

6. Estimation Results

In spatial analysis, the basic assumption is that the spatial unit is affected from the neighboring units. In this study, our spatial unit is a firm in an OIZ of a province. The main hypothesis is to analyze whether intra-OIZ and intra-industry knowledge spillovers exist or not. As an estimation method, Gibbs sampling which is a Bayesian technique is used in the estimation of spatial probit. Calculation of marginal effect in spatial econometrics is different than standard microeconometrics. Three types of effects are computed: Direct, indirect and total. Direct effect is the marginal effect from standard logit or probit regression. Indirect effect is indicating the spatial effect. Finally, total effect is the sum of direct and indirect effect (Le Sage and Pace, 2009).

6.1. Intra-OIZ Neighborhood

The main hypothesis of this study is to investigate the existence of intra-OIZ relations in a province. For intra-OIZ relations, w_1 weighting matrix is used in the spatial econometric estimation. In w_1, the firms in the same OIZs are assumed to be neighbors. If the firms are in same OIZ, it takes the value of 1, or vice versa. At Table 5 estimation results for Ankara for w_1 weighting matrix is shown. At the bottom of the table; LM-error, LM-sar and Moran's I test results are presented.

According to Moran's I and LM-error test results, the existence of spatial dependence in Ankara OIZs is proved. LM-sar test indicates the presence of SAR model. ρ value of the spatial model is significant at 5 percent level with a value of 0.2986. Size of the firm (LNLAB), high skilled labor (HSLAB), computer usage (COMPUSE), organizational proximity (ORGPROX) and administrator's foreign language ability (FORLA) are variables that are significant at 5%. Age of the firm (LNAGE); own a PLC, CNC or robot (PLCNCR), and own a trade mark, patent and useful model (TMPUM) are the variables that significant at %10. To use a SMEDO incentive (SMEDO), cluster proximity (CLUSTER) and education of the administrator (EDUCA) have no effect on the export decision of the firm when the spatial effects are not ignored.

Table 5: Bayesian Spatial Autoregressive Probit Model for Ankara OIZ Data with w1 (intra-OIZ neighborhood) Matrix[8] by Gibbs Sampling Method

Variable	Coefficient	Std Deviation	p-level
LNAGE	0.0066	0.0043	0.0570
LNLAB	0.3077	0.0527	0.0000
HSLAB	0.3929	0.2475	0.0440
PLCNCR	0.1065	0.0743	0.0760
TMPUM	-0.1364	0.1025	0.0880
COMPUSE	0.2026	0.0366	0.0000
SMEDO	0.1552	0.1583	0.1630
ORGPROX	0.1662	0.0608	0.0020
CLUSTER	-0.0099	0.0091	0.1400
EDUCA	-0.0069	0.0507	0.4550
FORLA	0.2873	0.0726	0.0010
constant	-1.5704	0.1588	0.0000
rho	0.2986	0.1390	0.0270
LM-error	30.1106	17.6110*	0.0000
LM-sar	11.8468	6.6350*	0.0006
Moran's I	6.1231	0.0029	0.0000
# of obs.	1545		

*chi(1), 0.01 value

8 DSS is chosen as a base industry due to the highest number of observation (534) it has.

The variables which are significant at 5% level are the same with the standard probit estimation of the data which can be found at Appendix 2. TMPUM, CLUSTER and EDUCA variables which are not significant 5% level and have negative sign despite our expectations. The sign of CLUSTER variable can be explained logically although the other two cannot. As the closer the relations with the OIZ, the firm prefers to buy/sell its product in the province instead of foreign countries. At Appendix 3, marginal effects of Table 5 is shown. For all variables almost two third of the total effect is coming from direct effect. When the spatial dependence is ignored, one third of the effect is disregarded. The indirect effect points out the spatial effect. The highest marginal effect belongs to the high skilled labor (HSLAB) variable. Second and third ones are size of the firm (LNLAB) and foreign language knowledge of the administrator (FORLA).

6.2. Intra-Industry Neighborhood

One of our main aim is to test the spatial dependence in within the industries in a province. In other words, we try to test for the within(intra)-industry knowledge spillovers. For Ankara, the firms from the same industry are assumed to be neighbors for testing the hypothesis. w_2 weighting matrix is used in estimation of spatial econometric model. It takes the value 1 when two firms are from the same industry according to ISIC Rev.3 classification.

At Table 6 the estimation results for the intra-industry relations for Ankara are presented. According to Moran's I and LM-error test, spatial dependence is realized in the data set. Moreover LM-sar test indicates the appropriateness of the SAR model although the ρ value estimated from the model is insignificant at 5% level but significant at 10% level. The results of the tests and the significance of the estimated ρ value is not compatible but still acceptable at 10% level.

Age of the firm (LNAGE), size of the firm (LNLAB), computer usage (COMPUSE), organizational proximity (ORGPROX) and administrator's foreign language ability (FORLA) are variables that are significant at 5%. High skilled labor (HSLAB); own a PLC, CNC or robot (PLCNCR); own a trade mark, patent of useful (TMPUM); cluster proximity (CLUSTER) and are the variables that significant at %10. To use a SMEDO incentive (SMEDO), and education of the administrator (EDUCA) have no effect on the export decision of the firm when the spatial effects are not ignored.

Table 6: Bayesian Spatial Autoregressive Probit Model for Ankara OIZ Data with w2 (intra-industry neighborhood) Matrix[9] by Gibbs Sampling Method

Variable	Coefficient	Std Deviation	p-level
LNAGE	0.0075	0.0041	0.0330
LNLAB	0.3298	0.0557	0.0000
HSLAB	0.3765	0.2400	0.0590
PLCNCR	0.1116	0.0755	0.0750
TMPUM	-0.1415	0.0941	0.0790
COMPUSE	0.1925	0.0360	0.0000
SMEDO	0.1811	0.1543	0.1210
ORGPROX	0.1760	0.0623	0.0000
CLUSTER	-0.0121	0.0091	0.0850
EDUCA	-0.0061	0.0500	0.4530
FORLA	0.2947	0.0747	0.0000
constant	-1.6603	0.1628	0.0000
rho	0.2240	0.1678	0.0950
LM-error	17.2068	17.6110*	0.0000
LM-sar	49.5728	6.6350*	0.0000
Moran's I	4.4501	0.0043	0.0000
# of obs.	1545		

*chi(1), 0.01 value

The direct, indirect and marginal effects of the estimations presented at Appendix 4. For all variables one fourth of the total effects are from indirect effects, i.e. spatial effects. The spatial effects in intra-industry relations are lower than intra-OIZ relations. One fourth of the total effect is from indirect effect in intra-industry relations. The highest marginal effects belongs to the high skilled labor (HSLAB), size of the firm (LNLAB) and foreign language knowledge of the administrator (FORLA) variables which are the same as intra-OIZ relations in Ankara.

9 DSS is chosen as a base industry due to the highest number of observation (534) it has.

7. Conclusion

The main aim of this study to reveal the knowledge spillovers in intra-OIZ and intra-region in Ankara by utilizing the SMEDO data on firm level. The five variables are prominent in our study: Logarithm of total labor (LNLAB); high skilled labor (HSLAB); computer usage in production, design and research (COMPUSE); organizational proximity (ORGPROX); and finally foreign language knowledge of the administrator (FORLA) are significant for Ankara OIZs in the spatial econometric estimation of the export decision function for both intra-OIZ and intra-industry knowledge spillovers. Insignificant variables indicate the unimportant issues in the export decision of a firm. For example, age of the firm (LNAGE) have no influence on the export decision of the firm. The hypothesis of the advantage of the incumbent or the advantage of newly established firm is rejected.

For intra-OIZ, one third of the effect is from spatial (indirect) effect while one fourth is for the intra-regional effect. Our study reveals that knowledge spills in intra-OIZ and intra-industry in Ankara.

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Appendix

A.1: Correlation between the variables for Ankara OIZ data (# of obs.: 1545)

	exp	lnage	lnlab	hslabor	plcncr	tmpum	compuse	smedo	orgprox	cluster	educa	forla
exp	1.000											
lnage	0.104	1.000										
lnlab	0.337	0.172	1.000									
hslabor	0.134	-0.025	0.047	1.000								
plcncr	0.175	0.082	0.278	0.085	1.000							
tmpum	0.141	0.137	0.347	0.128	0.1413	1.000						
compuse	0.046	0.468	0.260	0.232	0.274	0.322	1.000					
smedo	0.152	0.112	0.293	0.036	0.161	0.239	0.180	1.000				
orgprox	0.182	0.147	0.271	0.066	0.171	0.168	0.164	0.096	1.000			
cluster	-0.084	-0.080	-0.100	-0.064	-0.057	-0.088	-0.083	-0.057	-0.103	1.0000		
educa	0.210	0.063	0.296	0.451	0.140	0.236	0.382	0.114	0.099	-0.094	1.000	
forla	0.244	0.039	0.226	0.322	0.132	0.182	0.323	0.116	0.106	-0.094	0.518	1.000

A.2: Probit estimations for Ankara OIZ data

VARIABLES	exp	exp
	(1)	(2)
lnage	0.00241*	0.00143
	(0.00136)	(0.00139)
lnlab	0.108***	0.116***
	(0.0170)	(0.0174)
hslabor	0.135*	0.170**
	(0.0786)	(0.0807)
plcncr	0.0352	0.0272
	(0.0242)	(0.0246)
tmpum	-0.0420	-0.0325
	(0.0298)	(0.0311)
compuse	0.0637***	0.0619***
	(0.0118)	(0.0121)
smedo	0.0611	0.0580
	(0.0540)	(0.0550)
orgprox	0.0577***	0.0578***
	(0.0198)	(0.0203)
cluster	-0.00348	-0.00579**
	(0.00284)	(0.00295)
educa	-0.00240	0.00482
	(0.0167)	(0.0169)
forla	0.0960***	0.0936***
	(0.0241)	(0.0244)
Industry Dummies		YES
Observations	1,545	1,541

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

A.3: Marginal Effects of Table 5

Direct	**lower 01**	**lower 05**	**Coefficient**	**upper 95**	**upper 99**
LNAGE	-0.0017	-0.0006	0.0019	0.0042	0.0047
LNLAB	0.0485	0.0575	0.0874	0.1170	0.1272
HSLAB	-0.0601	-0.0200	0.1117	0.2550	0.3040
PLCNCR	-0.0267	-0.0101	0.0302	0.0724	0.0895
TMPUM	-0.1146	-0.0949	-0.0387	0.0185	0.0373
COMPUSE	0.0275	0.0370	0.0576	0.0782	0.0851
SMEDO	-0.0824	-0.0526	0.0442	0.1310	0.1524
ORGPROX	0.0030	0.0129	0.0472	0.0824	0.0889
CLUSTER	-0.0096	-0.0081	-0.0028	0.0020	0.0035
EDUCA	-0.0390	-0.0291	-0.0020	0.0268	0.0344
FORLA	0.0277	0.0392	0.0817	0.1213	0.1347
Indirect	**lower 01**	**lower 05**	**Coefficient**	**upper 95**	**upper 99**
LNAGE	-0.0009	-0.0003	0.0009	0.0029	0.0036
LNLAB	-0.0105	-0.0010	0.0403	0.0948	0.1127
HSLAB	-0.0314	-0.0122	0.0518	0.1691	0.2221
PLCNCR	-0.0143	-0.0055	0.0135	0.0437	0.0588
TMPUM	-0.0932	-0.0626	-0.0183	0.0084	0.0195
COMPUSE	-0.0055	-0.0007	0.0270	0.0664	0.0750
SMEDO	-0.0457	-0.0232	0.0198	0.0813	0.1014
ORGPROX	-0.0055	-0.0008	0.0217	0.0538	0.0662
CLUSTER	-0.0063	-0.0049	-0.0013	0.0011	0.0018
EDUCA	-0.0316	-0.0194	-0.0009	0.0152	0.0212
FORLA	-0.0085	-0.0011	0.0378	0.0969	0.1197
Total	**lower 01**	**lower 05**	**Coefficient**	**upper 95**	**upper 99**
LNAGE	-0.0025	-0.0009	0.0027	0.0064	0.0078
LNLAB	0.0661	0.0784	0.1277	0.1875	0.2205
HSLAB	-0.0975	-0.0331	0.1635	0.3767	0.4865
PLCNCR	-0.0378	-0.0157	0.0437	0.1061	0.1222
TMPUM	-0.1883	-0.1446	-0.0570	0.0266	0.0544
COMPUSE	0.0375	0.0482	0.0846	0.1314	0.1500
SMEDO	-0.1191	-0.0694	0.0640	0.1926	0.2253
ORGPROX	0.0048	0.0166	0.0689	0.1255	0.1374
CLUSTER	-0.0145	-0.0116	-0.0041	0.0030	0.0049
EDUCA	-0.0669	-0.0461	-0.0029	0.0396	0.0500
FORLA	0.0368	0.0538	0.1195	0.1962	0.2268

A.4: Marginal Effects of Table 6

Direct	lower 01	lower 05	Coefficient	upper 95	upper 99
LNAGE	-0.0014	-0.0003	0.0021	0.0044	0.0053
LNLAB	0.0518	0.0612	0.0946	0.1264	0.1342
HSLAB	-0.0708	-0.0257	0.1076	0.2404	0.2795
PLCNCR	-0.0250	-0.0098	0.0320	0.0748	0.0831
TMPUM	-0.1054	-0.0919	-0.0406	0.0136	0.0242
COMPUSE	0.0300	0.0348	0.0552	0.0763	0.0824
SMEDO	-0.0562	-0.0379	0.0519	0.1403	0.1596
ORGPROX	0.0034	0.0166	0.0504	0.0865	0.0973
CLUSTER	-0.0102	-0.0086	-0.0035	0.0014	0.0032
EDUCA	-0.0438	-0.0291	-0.0017	0.0271	0.0332
FORLA	0.0303	0.0431	0.0845	0.1284	0.1424
Indirect	**lower 01**	**lower 05**	**Coefficient**	**upper 95**	**upper 99**
LNAGE	-0.0009	-0.0004	0.0007	0.0026	0.0033
LNLAB	-0.0268	-0.0148	0.0310	0.0923	0.1088
HSLAB	-0.0550	-0.0217	0.0357	0.1427	0.1747
PLCNCR	-0.0131	-0.0057	0.0107	0.0412	0.0530
TMPUM	-0.0778	-0.0541	-0.0135	0.0073	0.0146
COMPUSE	-0.0164	-0.0099	0.0178	0.0527	0.0601
SMEDO	-0.0286	-0.0170	0.0170	0.0787	0.1032
ORGPROX	-0.0137	-0.0080	0.0164	0.0510	0.0664
CLUSTER	-0.0072	-0.0052	-0.0011	0.0010	0.0018
EDUCA	-0.0256	-0.0147	-0.0007	0.0124	0.0203
FORLA	-0.0219	-0.0137	0.0275	0.0765	0.1026
Total	**lower 01**	**lower 05**	**Coefficient**	**upper 95**	**upper 99**
LNAGE	-0.0020	-0.0004	0.0029	0.0064	0.0076
LNLAB	0.0614	0.0722	0.1256	0.1992	0.2221
HSLAB	-0.1122	-0.0325	0.1434	0.3579	0.4229
PLCNCR	-0.0271	-0.0123	0.0427	0.1062	0.1256
TMPUM	-0.1627	-0.1341	-0.0541	0.0172	0.0413
COMPUSE	0.0355	0.0413	0.0730	0.1132	0.1240