Spatial agglomeration, innovation clustering and firm productivity in Turkey. [1]

Anna M. Ferragina, DISES-CELPE, University of Salerno, Italy
Giulia Nunziante, University of Rome 2, Italy
Erol Taymaz, METU, Ankara, Turkey

Abstract

In this paper we explore how firms' productivity is affected by agglomeration of firms, clustering of innovation and localisation of FDI in Turkey. We control for the impact of firm characteristics on firm productivity (specifically the role of size, ownership and firm innovation). The firm's absorptive capacity is also taken into account by interacting the main variables of agglomeration and innovation at region-sector level with size and technology level of the firm. We use an unbalanced panel based on a firm level national data base. Our analysis builds upon specifications of panel estimates for output by GMM system methodology to address simultaneity and endogeneity on inputs and reverse causality between agglomeration and productivity. Overall, the estimation results support significant productivity enhancing agglomeration effects, in particular significant spillovers effects stemming from firms operating in the same sector and region, from innovation clustering at local level, and from higher output of foreign firms located in the same region. However, spatial spillovers are specific to technologically more sophisticated firms.

Keywords Multifactor Productivity; Size and Spatial Distributions of Regional Economic Activity; Innovation; Multinational firms.

JEL - Codes: D24 (Multifactor Productivity); R12 (Size and Spatial Distributions of Regional Economic Activity); O3 (Innovation); F23 (Multinational firms).

1. Introduction

The aim of the proposed chapter is to investigate how firms' productivity is affected by agglomeration of firms, clustering of innovation and localisation of FDI in Turkey. The choice of Turkey is based on the relevance that economies of agglomeration play in this economy. Turkey is a very interesting case study also due to the emerging innovation clusters. The last decade was marked by a large diffusion of science parks, innovation clusters, incubators, and by an increasing role of multinational corporations (MNC). Besides, Turkey is among the few countries of the South Mediterranean region well integrated into the global manufacturing markets, with a strong human

1 Part of the Project titled "Spatial proximity and firm performances: how can location-based economies help the transition process in the Mediterranean region? Empirical evidence from Turkey, Italy and Tunisia", funded by EU Commission (euro 10.000) under the 2015 Internal Competition for the FEMISE project on "*Support to economic research, studies and dialogue of the Euro-Mediterranean Partnership*" as per the Contract signed between the Commission and the FEMISE association no. ENPI/2014/354-494 ("Commission-FEMISE contract"). The purpose of this agreement is to provide an original research work in the fields of social and economic analysis by the Team Leader Anna M. Ferragina. Members of the team: Erol Taymaz, Ünal Töngür, Sofiane Ghali, Habib Zitouna, Giulia Nunziante, Fernanda Mazzotta, Anna Ferragina.

capital base, a large number of engineers and skilled workers but at the same time a very high regional unemployment and strong provincial inequalities.

Clustering of economic activities has been traditionally seen as a crucial mechanism for employment, firm growth and resilience. The clustering of industries in specific areas has improved industrial productivity in a number of countries. According to the Marshall theory, specialization economies increase the interaction between firms and workers, and speed up the process of innovation and growth, as firm agglomeration in the same sector produces positive externalities and facilitates the growth of all manufacturing units within the sector. These advantages are mainly based on information sharing and intra-industry communication. On the other hand, according to the Jacobs theory (1969), knowledge externalities are associated with the diversity of neighbour industries (urbanisation economies). Clustering can also be an important driver of R&D via a broad range of processes like learning-by doing, externalities on inputs, labour markets pooling and R&D cooperation between firms (Baltagi et al., 2012). Porter (1998) also emphasized cluster's significant role in a firm's ongoing ability to innovate and further enhance firm's productivity. Besides, an extensive literature shows that firms' behaviour depends on the spatial availability of territorial resources devoted to innovation and growth (Henderson et al., 2002).

Following this background literature, we explore the role of spatial externalities by considering agglomeration economies and external knowledge spillovers. The questions investigated are the following. Do firms localised in clusters of production exhibit a higher productivity? How far concentration of innovation of firms in the same cluster is likely to increase productivity? Furthermore, as not all firms are able to benefit from spillovers and enjoy agglomeration effects it is important to also control for the role of the absorptive capacity. Hence, we interact the main variables of agglomeration and innovation at region-sector level with firm size (measured by the number of employees) and innovation investment. These interaction variables reveal if large firms and innovation performers benefit more from agglomeration effects and spillovers.

Hence, the analysis aims to provide a measure of spillovers on productivity from geographical and sectorial clustering of firms and from their innovation. We build specific indexes of agglomeration and innovation activity at territorial level. We also use indicators of innovation performed by domestic and by foreign multinationals at the spatial level of analysis adopted.

The specific additional insights are the focus on agglomeration economies and innovation spillovers taking into account a multidimensional approach, both at spatial and firm level, in the effort to catch at the same time regional characteristics of the economic systems and firm heterogeneity. The analysis at firm level is crucial to detect agglomeration economies as some factors are firm-specific because they are driven by factors relating to the individual skills of owners, workers and managers, to different sizes, specific approaches to production and different innovation strategies (Bloom and Van Reenen, 2010). Hence, we control for the impact of firm characteristics (specifically the role of size, ownership and firm innovation). Furthermore, we also check whether the regional endowment of territories where firms are located and in particular their R&D and location of foreign multinationals exerts a positive effect on firms' productivity. The research, by focusing on the agglomeration economies in the local context within which firms operate, and at the same time concentrating on firm-specific determinants of productivity, fills a gap in the literature. There is an almost complete lack of studies addressing such issues for Turkey at micro level: most of the studies are carried out at industry level (Coulibaly et al., 2007; Önder et al., 2003; Öztürk and Kılıç, 2015) and only a recent analysis exploit firm level information on R&D spillovers in Turkey using spatial econometrics in a cross section frame at province level (Çetin and Kalayci, 2016).

We use an unbalanced panel data including all private establishments employing 25 or more people for 2006-2013. Spatial unit of analyses are the provinces.

We adopt panel estimates of output by GMM system methodology controlling for time fixed effects. Using system GMM dynamic panel estimation techniques we try to address simultaneity

and endogeneity on inputs and also the possible endogeneity between agglomeration and productivity.
Our reults confirm the outcome often found that firms in the same industry benefit more from each other as they are more technologically similar and the sector distance matters as this may facilitate the flow and absorption of knowledge among firms. We also found that FDI impact is positive albeit limited, the territorial and social redistribution depending on quality of investors and distribution by sectors. This might also occur because firms opened to the foreign market are in general a subcontractor which don't have the autonomy to conduct neither technological nor non-technological innovation. Generally, it is argued that in an open economy agglomeration leads to higher efficiency. We find support to such conclusion. However, there is evidence that technology play a critical role and policies should pay specific effort to enhance the absorptive capacity of less technology sophisticated firms.
The following chapter is organised as follows. After a literature review of the main strands of analysis and on the specific studies carried out on Turkey on the topics of interest, we describe in section 3 the data and in section 4 the features in terms of spatial concentration of firm, employment, FDI, innovation and relationships between these variables. In section 5 and 6 we develop the country specific analysis and describe our results by considering the specific empirical methodology and econometric specification carried out to catch regional innovation and productivity spillovers deriving from the geographical and sector clustering of firms.
The results from the overall empirical analysis emphasises what are the policy recommendations in this context regarding promotion of agglomeration, localised innovation and foreign investment which may support the structural transformation of the economy.

2. Literature review

2.1. Spatial agglomeration, innovation and firm performance

The literature on agglomeration economies effects is extensive and dates back to some seminal papers (Marshall, 1920; Glaeser et al. 1992; Porter, 1998; Jacobs, 1969; Audretsch and Feldman, 1996) which describe the positive effects related to technology transfers and to pro competitive effects (increased competition, reallocation of resources towards more productive firms, productivity improvements of incumbent firms).
The theory surrounding agglomeration economies and spillover effects mainly identifies two types of externalities: localization (or specialization) economies and diversification economies. The localization economies may rise from industry specialization available to the local firms within the same sector (the Marshall- Arrow-Romer or MAR externalities) and by the emergence of the intra-industry transmission of knowledge (Glaeser et al. 1992) as firms learn from other firms in the same industry (Porter 1998). These economies explain the development of industrial districts (ID). Unlike localization economies, however, Jacobs (1969) economies indicate that the diversity of industries and knowledge spillovers across geographically close industries promote innovation and growth via inter-industry knowledge spillovers (Acs et al., 2007). The latter reflects external economies passed to enterprises as a result of the large-scale operation of the agglomeration, independent of the industry structure. For instance, relatively more densely populated areas are more likely to house universities, industry research laboratories and other knowledge generating facilities.
It is recognized that clustering is especially important as a driver of R&D via a broad range of processes like learning-by doing, externalities on inputs, labour market and knowledge, R&D cooperation between firms (Rosenthal and Strange; 2001; Ellison et al., 2010; Baltagi et al., 2012). The theory on agglomeration economies also argues that positive knowledge spillovers are more

likely to occur if firms are located in the same area, as geographical proximity encourages the diffusion of ideas and technology due to the concentration of customers and suppliers, labour market pooling, worker mobility, and informal contacts (Greenstone et al. 2010). Technology transfers (intra and inter industry knowledge spillovers) may occur via vertical linkages (along the supply chain and the creation of specialized suppliers) and horizontal linkages (collaboration among firms, imitation, concentration of customers and suppliers; labour market pooling and workers mobility; informal contacts).

The nexus between spatial agglomeration and knowledge spillovers has been largely emphasized within the “geography of innovation” literature, which concentrates on measuring localized spillovers from R&D spending (Griliches, 1979; Breschi and Malerba, 2001; Bottazzi and Peri, 2003; Audretsch and Feldman, 2004). Within this literature, the private technology of individual firms spills over to other firms and becomes public knowledge increasing the productivity of all firms. Rosenthal and Strange (2001) and Ellison et al. (2010) consider the importance of input sharing, matching, and knowledge spillovers for manufacturing firms at various levels of geographic disaggregation, and other studies have found that knowledge spillovers tend to vanish rapidly as distance increases (Audretsch and Feldman, 1996; Keller, 2002). The concentration generates dynamic processes of knowledge creation, learning, innovation and knowledge transfer (diffusion and synergies). As a result, the cluster becomes a center of accumulated competence across a range of related industries and across various stages of production (De Propris and Driffield, 2006).

Another important strand of research related to these issue is the large literature which has focused on detecting spillovers from the presence of multinational enterprises, where horizontal and vertical spillovers can be inferred indirectly, though the estimation of their effects on firms’ total factor productivity The location choice of foreign Multinational Enterprises (MNEs) as source of potential spillovers from FDI is stressed by a large amount of research through a range of different channels including the creation of forward and backward linkages, competitive and demonstration effects, transfer of skilled workforce, transfer of (pecuniary and non-pecuniary) externalities to local firms (Aitken and Harrison, 1999; Gorg and Greenaway, 2004; Haskel et al., 2002; Javorvick, 2004, Ferragina, and Mazzotta, 2014). These spillover effects from MNEs, either intra- or inter-industry ones, are more likely to materialize when firms are geographically closer.

2. 2. Studies on localisation economies in Turkey

The regional inequality in Turkey has become more persistent after the 1980 liberalization. Filiztekin (1998), Dogruel and Dogruel (2003), Karaca (2004), Gezici and Hewings (2007), Yıldırım and Öcal (2006), Kılıçaslan and Özatagan (2007), and Filiztekin and Çelik (2010) all focus on the way regional income gaps evolved concluding that even though there are small signs of convergence, they are far from successful and the east-west duality is an ongoing problem to the Turkish economy.

There is a limited number of studies on productivity for Turkish manufacturing which generally focus on the relationships productivity and export, FDI, trade, or technical efficiency (see Aslanoğlu, 2000; Taymaz and Saatçi, 1997; Taymaz and Yılmaz, 2007; Lenger and Taymaz, 2007). FDI is found to be an important channel for transfer of technology. It is suggested that modern, advanced technologies introduced by multinational firms can diffuse to domestic firms through spillovers.

Taymaz and Saatçi (1997) is among the first attempt to identify the effects of regional agglomeration. They estimated stochastic production frontiers with efficiency effects and found that regional agglomeration of firms enhance technical efficiency.

Önder et al. (2003) analyzed spatial characteristics of TFP in Turkish manufacturing. They investigate technical efficiency, technical change and TFP changes by estimating a trans-log Cobb-Douglas production function employing stochastic frontier analysis (SFA) methodology using regions' share in production, population density and a specialization index based on the value added to represent regional characteristics. Their findings suggest that average firm size and regional characteristics are the main determinants of technical efficiency. They also indicate that firms operating with a larger scale are more efficient than small scale ones, and that industries located in metropolitan areas are more technically efficient than their peers in the peripheries.
Coulibaly et al. (2007) attempt to capture the relationship between productivity and agglomeration using two-digit Turkish manufacturing data for 1980-2000 period and several proxies such as accessibility, localization and urbanization. The estimation results suggest that both localization and urbanization economies, as well as market accessibility, are productivity-enhancing factors in Turkey.
Karacuka and Catik (2011) examine productivity spillovers from foreign and domestic companies based in Turkey and also report spillover effects from neighbouring companies. However, these results are not confirmed by Öztürk and Kılıç (2015) analysis of the link between productivity and agglomeration employing Ellison and Glaeser index and Total Factor Productivity to represent agglomeration economies and productivity levels in Turkish manufacturing industries on 1980-2001 data. TFP is measured using SFA and then regressed along agglomeration and other control variables using a dynamic system GMM estimation method. The results indicate that Turkish manufacturing industries stand as an example of negative externalities.
Çetin (2016) employs spatial econometric methods in analyzing intra and inter industry knowledge spillovers in industrial zones and concludes that there are spillover effects in the industrial zone of Ankara, and that more than half of the spillovers are due to geographical factors. Çetin and Kalayci (2016), investigate the effects of R&D spillovers at province level also using spatial econometric. The results of the analyses suggest the presence of R&D knowledge spillovers at provincial level in Turkey, shown by spatial spillover effects in nearly one third of the total effects.
We may conclude that the literature is only based on regional, industrial or provincial analyses whereas the novelty we propose is the investigation at firm level of the impact of localisation economies on co-located firm performances based on the emphasis on two mechanisms of analysis: firm heterogeneity and complementarity between micro and macro dimension.

3. Data description

We use an unbalanced panel data of all enterprises[2] that either employ at least 20 people or have at least 3 local units during the 2006-2013. Spatial unit of analysis is the "region" defined at the NUTS 2 level (a typical NUTS 2 region covers 3-4 provinces). The data source is the Turkish Statistics Institutes (TurkStat) Longitudinal Database. The database is unbalanced because of exit from and entry into the industry and/or the database.
Table 1 contains the number of all firms, domestic firms and foreign firms[3] from 2003 to 2013 and the share and the number of R&D performers among all these three groups. Foreign firms are more likely to conduct R&D. About 4-5% of domestic firms perform R&D whereas about 18-19% of foreign firms perform R&D. However, there is a decline in the share of domestic R&D performers after the 2009 crisis in spite of an increase in the number of firms doing R&D.

2 We use the terms "firm" and "enterprise" interchangeably.
3 A firm is "foreign" if at least 10% of its shares is held by foreign agents. Note that the most of the foreign firms are majority owned, i.e., foreign agents own more than 50% of shares.

Table 1. Number of firms in Turkey sample

	Number of firms			Share of R&D performers		
	All	Domestic	Foreign	All	Domestic	Foreign
2003	13936	13499	437	3.4	2.9	18.1
2004	16869	16318	551	3.1	2.7	15.1
2005	20060	19442	618	3.8	3.4	17.6
2006	21215	20428	787	3.3	2.9	14.9
2007	20556	19780	776	4.0	3.4	17.3
2008	22533	21772	761	4.2	3.7	17.5
2009	19526	18812	714	5.4	4.9	18.2
2010	23735	22896	839	5.4	5.0	16.9
2011	28657	27691	966	4.9	4.5	17.5
2012	30867	29927	940	5.0	4.5	19.3
2013	33630	32634	996	4.5	4.1	18.5

Table 2 shows the share of foreign firms in total number of firms, employment and value added, and their relative size and labor productivity. The share of foreign firms both as number and as employment and value added decreased after the 2009 crisis mainly because of the increase in the number of domestic firms (entry rate for domestic firms is higher than foreign firms after 2009). Foreign firms are about 4 times larger than domestic firms (in terms of the number of employees per firm) and 2 times more productive (in terms of value added per employee). However, the sectoral distribution highly explains this asymmetry.

Table 2. Share of foreign firms, 2003-2013

	# of firms %	Employment %	Value added %	Relative size	Relative labor productivity
2003	3.1	11.7	24.1	3.7	2.1
2004	3.3	12.0	25.8	3.7	2.2
2005	3.1	11.2	24.1	3.6	2.2
2006	3.7	13.4	28.6	3.6	2.1
2007	3.8	13.5	28.5	3.6	2.1
2008	3.4	13.1	25.9	3.9	2.0
2009	3.7	13.1	27.0	3.6	2.1
2010	3.5	11.7	23.8	3.3	2.0
2011	3.4	12.2	23.4	3.6	1.9
2012	3.0	11.6	23.0	3.8	2.0
2013	3.0	11.1	22.2	3.8	2.0

In table 3, where the sectoral distribution of foreign firms is described for the 2011-2013 average, it appears that foreign firms have larger share in Tobacco products, Chemicals, Pharmaceuticals and Motor vehicles. Foreign firms are two to five times larger, on average, than domestic firms. Foreign firms' labor productivity is almost equal to that of domestic firms in pharmaceuticals, basic metals, computers, and other transportation equipment industries. The productivity differential (the productivity of foreign firms relative to the productivity of domestic firms) is higher than two in non-metallic mineral and fabricated metal industries. There is a weak positive correlation between relative size and productivity of foreign firms across industries, i.e., productivity differential between domestic and foreign firms is explained partly by differences in firm size.

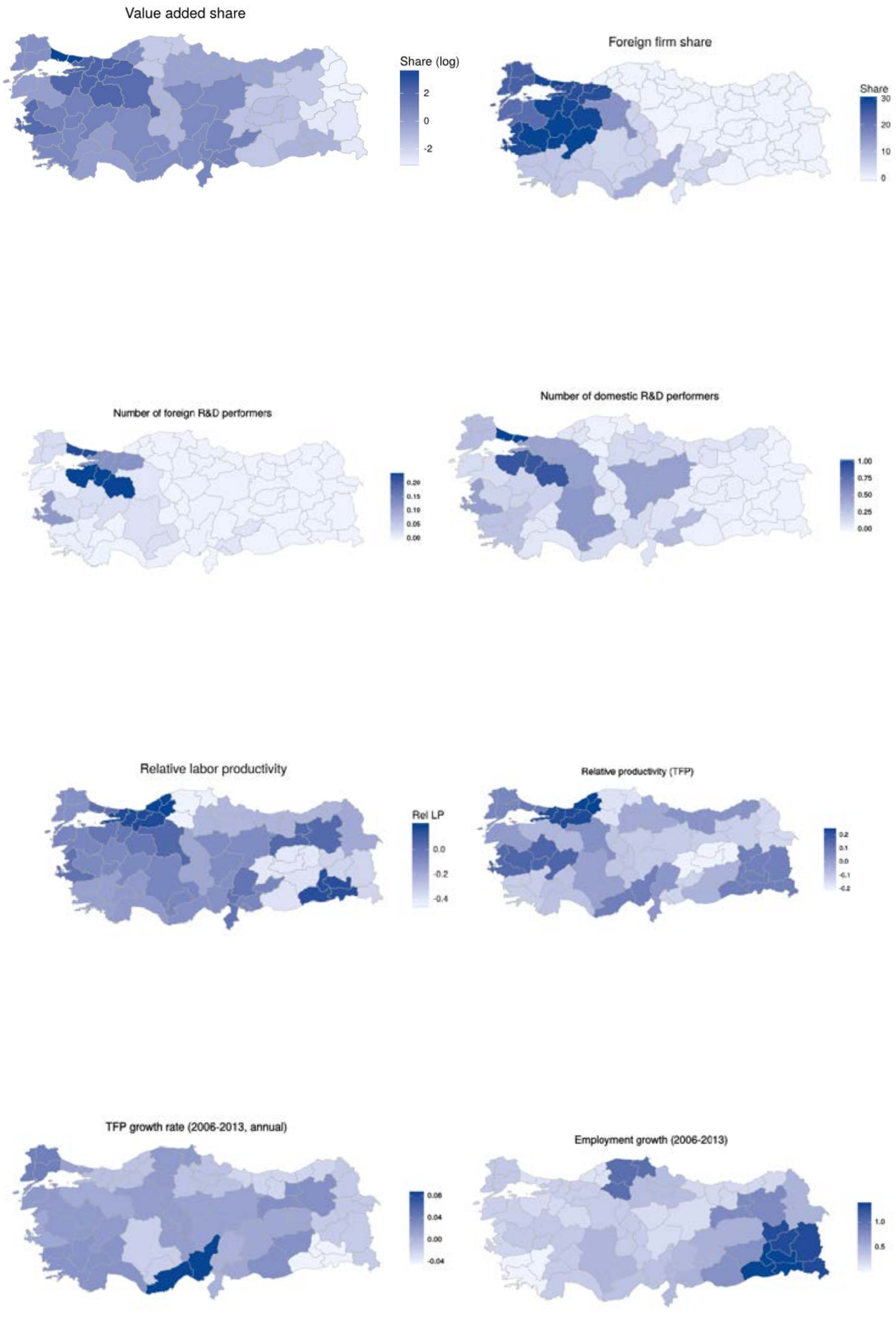
Table 3. Sectoral distribution of foreign firms, 2011-2013 average

		Firms %	Employment %	Value added %	Relative size	Relative labor productivity
10	Food	3.34	12.35	20.35	3.70	1.65
11	Beverages	6.57	30.86	48.98	4.70	1.59
12	Tobacco products	34.21	59.54	99.49	1.74	1.67
13	Textiles	1.77	3.02	3.62	1.71	1.20
14	Wearing apparel	0.85	4.36	7.82	5.13	1.79
15	Leather products	0.78	1.76	1.98	2.24	1.13
16	Wood products					
17	Paper products	5.69	15.13	23.52	2.66	1.55
18	Printing					
19	Coke and refined pet					
20	Chemicals	12.47	24.22	33.76	1.94	1.39
21	Pharmaceuticals	19.05	37.46	43.08	1.97	1.15
22	Rubber and plastics	4.08	13.41	25.94	3.29	1.93
23	Non-metallic mineral	2.31	8.39	22.22	3.63	2.65
24	Basic metals	3.16	10.09	10.49	3.19	1.04
25	Fabricated metal	2.65	6.69	14.32	2.52	2.14
26	Computers, electronics	5.65	17.73	15.89	3.14	0.90
27	Electrical equipment	4.97	17.39	28.34	3.50	1.63
28	Machinery	3.54	15.91	30.25	4.49	1.90
29	Motor vehicles	11.53	47.90	64.38	4.16	1.34
30	Other transport equipment	6.95	14.16	15.45	2.04	1.09
31	Furniture	0.76	1.83	3.32	2.42	1.81
32	Other manufacturing	3.62	9.51	17.60	2.62	1.85
33	Repair and installation	2.93	4.23	8.44	1.44	1.99
Total		3.12	11.61	22.80	3.73	1.96

4. Stylised facts on firm clustering, spatial productivity, and innovation in Turkey

We provide a preliminary descriptive part as a background for our econometric analysis. We illustrate the pattern of clustering using maps that exploit information on the exact location of firms (also considering foreign firms location). They picture at province level the concentration of value added, the foreign firms shares, the relative labour and TFP productivity, which is a way to answer the question: do firms cluster? The number of foreign and domestic R&D performers give us a hint on spatial innovation spillover. These maps show the unique nature of Turkish economy in terms of strong regional imbalances.

Maps 1-8



Furthermore, figures 1-2 help investigating in a preliminary unconditional way the benefits of regional agglomeration using the correlations between some of the variables mapped above. TFP growth and employment growth maps give us a preview of the potential benefits of clustering. In particular, fig. 1 shows the positive correlation between regional agglomeration (log regional share of value added) and regional relative productivity. The picture suggests that more concentrated regions are more productive. In fig. 2 regional agglomeration is compared with the share of foreign firms in regional output: it appears evident that more concentrated regions attract more foreign firms.

Figure 1. Geographical concentration and productivity in Turkey

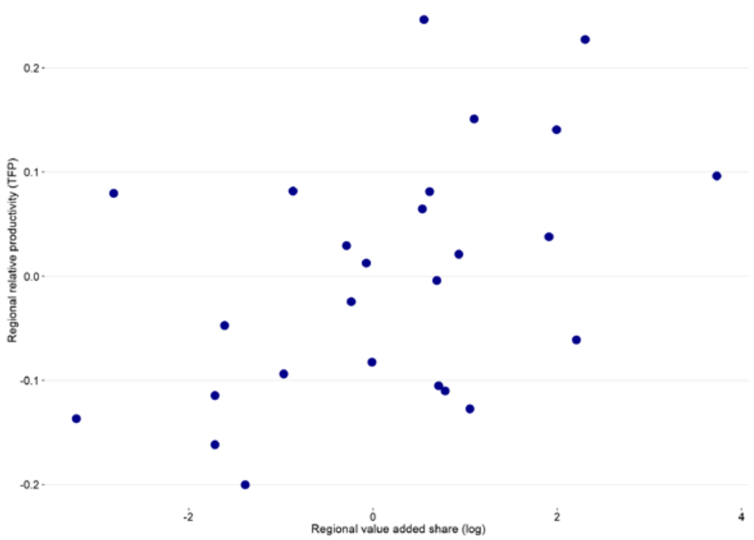
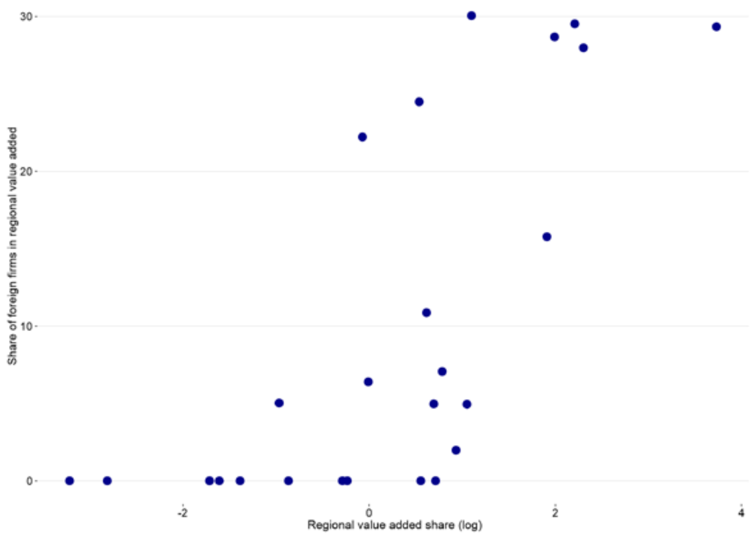


Figure 2. Geographical concentration and foreign investment in Turkey



5. Empirical methodology: geographical and sectorial clustering of firms, innovation spillovers and productivity

The issue we want to analyse is the relationship between agglomeration, innovation and firms' productivity. This entails the consideration of proximity between firms, agglomeration indicators and R&D spillovers. The questions are: do firms localised in clusters of production exhibit higher productivity? How far concentration of innovation of co-located firms in the same cluster are able to increase it? Furthermore, we explore the complementarity between domestic and foreign firms. Firms should benefit from the experience of other firms in the vicinity, especially from the one of large foreign multinational firms. So we ask how localisation of firms nearby multinationals operating in the same localised cluster would contribute to develop their productivity and would allow innovation to circulate.

Hence, the analysis for each economy aims to provide a measure of spillovers on productivity from geographical and sectorial clustering of firms and from their innovation. In addition to considering innovation measures at firm level, we build specific indexes of innovation activity at territorial level (provinces). We also use indicators of innovation performed by domestic and by foreign multinationals at the spatial level of analysis adopted.
To sum up, we try to capture regional and sectoral spillovers from agglomeration of activities, from foreign firms and from innovation performers (both domestic and foreign) in the sector and in the spatial unit under analysis.
We directly contribute to the wide literature on productivity spillovers from agglomeration economies, as well as to the literature on localized knowledge spillovers from innovation checking for spillovers between firms taking place within regions and controlling for regional features being more conducive to productivity growth. In order to distinguish between the two effects we have used a proxy for regional attractiveness, i.e the. value added per head. This controls for initial regional factors. We do also include time dummies. However, we do not include regional dummies as controlling on average across the years for regional fixed effects might absorb some of the regional and sector externalities we are trying to estimate.
We use panel estimates for output (by GMM-system), controlling for time fixed effects. Simultaneity and endogeneity is hence addressed using system Generalized Method of Moments (GMM) dynamic panel estimation techniques. This methodology allows us to distinguish the direction of the nexus clustering and productivity and to focus on whether more regional clustering lead to higher productivity, ruling out the other direction of causality, i.e. that higher productivity leads to more regional clustering.
We consider different externality transmission channels, and which variable available in the data might best capture that. The first most important channel is to catch the spillovers between firms in the same industry (horizontal spillovers). Three variables are adopted to this purpose: the regional share variables by sector, i.e. the output share of the region in the sectors output, the number of firms by sector-region and the output of firms by sector-region.
Then, we look at the R&D/innovation performed by domestic and by foreign firms which can be considered as an innovation spillover channel. The share of output of R&D performing domestic and foreign firms in the region/sector and the number of R&D performing domestic and foreign firms in the region/sector are the two proxies considered.
The third important issue is related to the presence of spillovers by foreign firms. We consider to this purpose the shares of foreign firms in the region and in the sector.
As not all firms are able to benefit from spillovers and enjoy agglomeration effects it is important to also control for the role of firms' absorptive capacity. Hence, we interact agglomeration and spillover variables with firm size (measured by the number of employees) and with innovation variables. These interaction variables will reveal if large firms and innovation performers benefit more from agglomeration effects and spillovers. For example, if large firms benefit more, the coefficient of firm size-agglomeration effect interaction variable will be positive.

5.1. Model and descriptive statistics

In order to test the effects of agglomeration economies and spillovers, a Cobb-Douglas production function is estimated:

$$q_{i,t} = \alpha_i + \alpha_{Lq}q_{i,t-1} + \alpha_K K_{i,t} + \alpha_{LK}K_{i,t-1} + \alpha_L L_{i,t} + \alpha_{LL}L_{i,t-1} + \alpha_M M_{i,t} + \alpha_{Lm}M_{i,t-1} + D_t + \Sigma\beta_j X_{i,j,t} + e_{it} \qquad [1]$$

where q is real output, K capital, L labor, M inputs, D time dummies, and e the error term. Subscripts i and t denote firm and time, respectively. α_i's accounts for unobserved, time-invariant firm-specific effects. *X* is a vector of variables that explain total factor productivity, and it includes the variables that measure agglomeration effects and spillovers.

The *output variable* of the production function is the value of production (sales adjusted by changes in final product inventories). It is deflated by sectoral prices indices at NACE 4-digit level to find real output.

Inputs of the production function are capital, labor and inputs (raw materials, parts and components). Capital is measured by depreciation allowances, labor by the average number of employees, and inputs by the value of all inputs adjusted by changes in raw materials and work-in-process inventories. The Capital variable is deflated by investment price index whereas the input variable is deflated by sectoral price indices.

We use GMM-system method to estimate the production function that controls for the endogeneity of inputs, autocorrelation and heteroscedasticity. The methodology we use, GMM system, takes care of endogeneity of input by creating instrumental variables from existing variables. In the case of GMM-system, two equations are estimated jointly, the differenced equation and the level equation where first differences are used as instruments.

The GMM-system model is defined as a dynamic model: it includes the lagged values of the dependent variable (output) and all inputs. This specification allows for a flexible functional form and incorporates various adjustments.

The output and all input variables are used in log form. Therefore, the coefficients of input variables give us short-term factor elasticities. The long run factor elasticities are defined by

$$\varepsilon_i = (\alpha_i + \alpha_{Li}) / (1 - \alpha_{Lq}) \qquad [2]$$

where ε is the long-term elasticity of factor *i*, α_i the coefficient of factor *i*, α_{Li}) the coefficient of the lagged value of factor *i*, and α_{Lq} the coefficient of the lagged value of output.

The returns to scale parameter is defined by

$$\kappa = \varepsilon_K + \varepsilon_L + \varepsilon_M \qquad [3]$$

where κ is the returns to scale parameter, and the subscripts K, L and M denote capital, labor and inputs, respectively. There are constant returns to scale when $\kappa = 1$, increasing (decreasing) returns when $\kappa > 1$ ($\kappa < 1$).

In order to capture the effects of all shocks and exogenous technological change, all models include time dummies, i.e., a dummy variable for each year.

A dummy variable for foreign ownership is included into the model to capture the effects of foreign ownership on productivity. Foreign firms are, by definition, multinational firms, and are able to transfer technology from abroad, mainly from the parent firm. Therefore, foreign firms are likely to be more productive than domestic firms.

Technological activities of the firms is captured by a dummy variable that is equal to 1 if the firm performs R&D activities, and 0 otherwise. Since the firm can generate new products and/or processes as a result of R&D activities, the R&D dummy variable is expected to have a positive coefficient, i.e., R&D performers would be more productive.

Since the main purpose of our study is to analyse the effects of agglomeration and spillovers, especially from foreign firms, we use a number of proxy variables that are expected to capture the effects of these factors. Note that there are a number of alternative proxy variables. For example, agglomeration can be measured by the density of firms (the number of firms), or by the density of production activities (output). Therefore, we experimented with a number of alternative variables, and replaced a set of explanatory variables by another set.

The first set of proxy variables for agglomeration effects includes the (log) numbers of domestic and foreign firms in the same sector (defined at the NACE 4-digit level) and region (defined at NUTS 2 level). These variable will have positive coefficients if agglomeration of firms leads to higher productivity. We use the number of domestic and foreign firms separately because the extent of spillovers could differ between domestic and foreign firms.

We use two additional variables, the number of domestic and foreign R&D performers in the same sector and region to test if R&D performers are more likely to spillover knowledge and technology to other firms that operate in the same sector and region.

The second set includes the (log) output of domestic and foreign R&D performers in a given sector and region. This set defines agglomeration in terms of output instead of the number of firms as defined in the first set. The number of firms variable would be meaningful if spillovers takes the form of imitation, whereas the output variable could reflect spillovers in the form of externalities and labor turnover.

The third set includes a number of variables about output shares. “Regional share (sector)” is the share of the region in total output of the sector in which the firm operates. The “Foreign share (sector)” and “Foreign share (region)” variables are defined similarly for foreign firms. If there are agglomeration economies in a sector, the firms located in a region where that sector is concentrated in would be more productive. If there are spillovers from foreign firms within a sector, then the “Foreign share (sector)” variable will have a positive coefficient. However, if spillovers from foreign firms have a geographical dimension, then the coefficient of the “Foreign share (region)” variable will be positive.

Benefiting from spillovers is not a passive process, and all firms cannot enjoy agglomeration effects to the same extent. To control for the role of the absorptive capacity, we interact agglomeration and spillover variables with firm size (measured by the number of employees) and R&D dummy variable. These interaction variables will reveal if large firms and R&D performers benefit more from agglomeration effects and spillovers. For example, if large firms benefit more, the coefficient of firm size-agglomeration effect interaction variable will be positive.

Finally, we also include into the model the output share of large firms in the same sector and region to test if spillovers originate only from large firms.

Descriptive statistics for all variables for the analysis period are presented in Table 2. Note that with the exception of dummy variables (FDI and R&D performer) and share variables (Regional output share, Foreign share sector and Foreign share region), all variables are in log form. As shown in the table, the share of foreign firms was 3.2% and the share of R&D performers 4.6%. The average number of domestic firms in the same sector and region is 36.9 ($e^{3.608}$). In the most concentrated case of the agglomeration of domestic firms, it reaches 1663, i.e., 1663 firms operating in a sector are located in the same region.

The average number of foreign firms in the same sector-region is much smaller (only 2.1) and its maximum value becomes 33. The average number of R&D performing domestic (foreign) firms in the same region/sector is 2.01 and 1.16. Although the number of foreign firms is small, the average sectoral share of foreign firms is 11.4%, and the average regional share of foreign firms is 19.7%. The significant difference between the number and output of foreign firms shows that these two measures could reflect different aspects of agglomeration effects and spillovers emanating from foreign firms.

Table 4. Descriptive statistics on Turkey sample

Variable	Mean	Std dev	Min	Max
Output	14.634	1.790	-1.265	23.018
Number of employees	3.664	1.153	0.000	9.663
Capital stock	11.074	1.983	-0.604	20.111
Inputs	14.400	1.970	-1.295	22.968

FDI	0.032	0.175	0.000	1.000
R&D performer	0.046	0.210	0.000	1.000
Number of domestic firms (region/sector)	3.608	1.756	0.000	7.416
Number of foreign firms (region/sector)	0.740	0.869	0.000	3.497
Number of R&D performing domestic firms (region/sector)	0.700	0.784	0.000	3.332
Number of R&D performing foreign firms (region/sector)	0.148	0.372	0.000	2.398
Regional output share	0.291	0.281	0.000	1.000
Foreign share (sector)	0.114	0.156	0.000	1.000
Foreign share (region)	0.197	0.106	0.000	0.534
Output of domestic firms (region/sector)	16.385	4.848	0.000	21.364
Output of foreign firms (region/sector)	0.351	2.435	0.000	21.810
Output of R&D performing domestic firms (region/sector)	3.052	6.975	0.000	24.097
Output of R&D performing foreign firms (region/sector)	9.994	9.233	0.000	24.395

Notes: All variables are in log form.
FDI and R&D performer are dummy variables.
Regional output share, Foreign share (sector) and Foreign share (region) are in percentage.

5.2. Estimation results

Estimation results are presented in Table 5a (without interaction effects) and Table 5b (with interaction effects). We included agglomeration and spillover variables in blocks of variables to check the effects of correlations between explanatory variables.

Estimation results for production function are quite robust and sensible. The returns to scale parameter is around 1.05 for almost all models that indicates that there are mild increasing returns to scale in Turkish manufacturing. The (long run) elasticities of capital, labor and inputs are around 0.055, 0.356 and 0.635 which are reasonable. The coefficient of the lagged output variable is small (around 0.2), i.e., output adjusts quickly.

The coefficients of foreign ownership and R&D variables are statistically significant[4] in all models. Foreign firms in Turkish manufacturing are around 13% more productive than domestic firms. As may be expected, R&D performers are more productive than non-performers, and the average productivity differential between R&D performers and non-performers is around 5-6%.

Estimation results suggest that there are productivity spillovers from foreign firms operating in the same sector-region. The coefficient of the number of foreign firms operating in the same sector-region is positive and statistically significant. If the number of foreign firms increase by 1%, productivity of all firms operating in that sector and region increases by 0.04% (Model 4, Table 5a), i.e., these effects are economically significant too.

The number of domestic firms operating in the same sector-region seems to have a negative effect on productivity when the model includes the variable on foreign firms (compare models 3 and 4, Table 5a). There could be congestion or negative competition effects due to agglomeration of domestic, and, most probably, technologically inferior firms.

In order to check if agglomeration and spillovers effects differ by firm characteristics, we use the number of R&D performing domestic and foreign firms in the same sector-region instead of total number of firms (Model 5, Table 5a). In that case, the coefficients of both domestic and foreign firms become positive and statistically significant. The coefficient of the number of R&D performing foreign firms is almost equal to the coefficient of the number of foreign firms (around 0.04), but the coefficient of the number of domestic R&D performers is somewhat smaller (0.008). These results reveal that the extent of spillovers from R&D performing and non-performing firms is quite similar. Domestic R&D performers generate positive spillovers, but they are weaker compared to those generated by foreign firms.

4 Unless otherwise noted, "statistically significant" means statistically significant at the 1% level.

In another group of regressions, we used proxy variables defined in terms of total output instead of total number of firms produced by domestic and foreign firms in the same region. Model 7 shows that when the outputs of both domestic and foreign firms are higher in a sector-region, firms operating in that sector-region are likely to be more productive. These results, when compared to those of Model 4, support the congestion and competition arguments for domestic firms. If there are more domestic firms in a sector-region, it creates negative effects, but if total output produced by domestic firms increase in a sector-region, then firms become more productive. Note that, in this case too, the coefficient of output of foreign firms is higher that the coefficient for domestic firms, i.e., foreign firms' output generate more spillovers.

When the output variables are replaced by the output of R&D performers, the results are the same: there are strong spillovers from the output of both domestic and foreign R&D performers, and the spillovers from foreign firms are stronger that those from domestic firms.

Finally, in order to check if regional spillovers are specific to those firms operating in the same sector, we redefined agglomeration and spillover variables separately at the sectoral and regional level instead of narrower sector-region level. In this case (Model 6) the "Regional share (sector)" variable shows the share of that region in the sectors' total output, the "Foreign share (sector)" the share of foreign firms in the sectors' total output, and the "Foreign share (region)" the share of foreign firms in the regions' total output. Therefore, for example, the "Foreign share (region)" variable shows if there are regional spillovers from foreign firms that benefit to firms operating in the same region but in different sectors, whereas the "Foreign share (sector)" variable shows if there are spillovers from foreign firms that are beneficial to all firms operating in the same sector irrespective of its location.

Estimation results show that there are pure agglomeration effects ("Regional share (sector))", i.e., if a regions share in a sectors' total output is higher, the firms operating in that region and sector are more productive. Moreover, there are additional spillovers from foreign firms to all firms operating in the same sector, and to all firms operating in the same region, i.e., there are spillovers at the sectoral and regional level independent form each other.

Table 5a. Production function estimation results for Turkey (2006-2013, GMM-System results)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	GMM	GMM	GMM	GMM	GMM	GMM	GMM	GMM
Returns to scale	1.051	1.046	1.044	1.045	1.046	1.046	1.048	1.047
Lag output	0.217**	0.217**	0.216**	0.214**	0.217**	0.213**	0.218**	0.216**
	(0.0207)	(0.0208)	(0.0207)	(0.0207)	(0.0207)	(0.0208)	(0.0208)	(0.0207)
Labor	0.485**	0.488**	0.479**	0.485**	0.501**	0.500**	0.497**	0.497**
	(0.0555)	(0.0556)	(0.0544)	(0.0546)	(0.0563)	(0.0558)	(0.0559)	(0.0560)
Lag labor	-0.208**	-0.211**	-0.207**	-0.209**	-0.218**	-0.215**	-0.216**	-0.215**
	(0.0331)	(0.0333)	(0.0327)	(0.0328)	(0.0336)	(0.0333)	(0.0335)	(0.0335)
Capital	0.0370**	0.0374**	0.0369**	0.0370**	0.0380**	0.0378**	0.0379**	0.0379**
	(0.00439)	(0.00442)	(0.00436)	(0.00436)	(0.00445)	(0.00444)	(0.00445)	(0.00444)
Lag capital	0.00586**	0.00592**	0.00587**	0.00598**	0.00608**	0.00615**	0.00608**	0.00607**
	(0.00205)	(0.00205)	(0.00204)	(0.00204)	(0.00205)	(0.00205)	(0.00206)	(0.00205)
Inputs	0.485**	0.479**	0.487**	0.482**	0.466**	0.468**	0.472**	0.471**
	(0.0556)	(0.0560)	(0.0551)	(0.0553)	(0.0567)	(0.0563)	(0.0564)	(0.0564)
Lag inputs	0.0184	0.0198	0.0166	0.02	0.026	0.0261	0.0229	0.024
	(0.0278)	(0.0279)	(0.0276)	(0.0276)	(0.0282)	(0.0280)	(0.0281)	(0.0281)
Foreign (dummy)		0.133**	0.130**	0.115**	0.130**	0.109**	0.138**	0.130**
		(0.0188)	(0.0182)	(0.0171)	(0.0186)	(0.0173)	(0.0199)	(0.0187)
R&D performer (dummy)		0.0602**	0.0590**	0.0539**	0.0576**	0.0509**	0.0617**	0.0545**
		(0.00949)	(0.00919)	(0.00893)	(0.00934)	(0.00907)	(0.00956)	(0.00906)
N domestic firms (sector-region)			-0.00099	-0.0161**				
			(0.00149)	(0.00263)				
N foreign firms (sector-region)				0.0427**				
				(0.00390)				
N domestic R&D performers (sect-reg)					0.00771**			
					(0.00184)			
N foreign R&D performers (sect-reg)					0.0416**			
					(0.00395)			
Regional share (sector)						0.0663**		
						(0.00811)		
Foreign share (sector)						0.198**		
						(0.0179)		
Foreign share (region)						0.0614**		
						(0.0150)		
Q domestic firms (sect-reg)							0.00255**	
							(0.000408)	
Q foreign firms (sect-reg)							0.00359**	
							(0.000865)	
Q domestic R&D performers (sect-reg)								0.000750**
								(0.000158)
Q foreign R&D performers (sect-reg)								0.00169**
								(0.000181)
Firm size * Regional output share								
Fİrm size * Foreign share (sector)								
Firm size * Foreign share (region)								
R&D performer * Regional output share								
R&D performer * Foreign share (sector)								
R&D performer * Foreign share (region)								
Firm size * Q domestic R&D performers (sect-reg)								
Firm size * Q foeign R&D performers (sect-reg)								
R&D performer * Q domestic R&D performers (sect-reg)								
R&D performer * Q foreign R&D performers (sect-reg)								
Q share of large firms (sect-reg)								
Constant	2.795**	2.837**	2.802**	2.886**	2.904**	2.889**	2.824**	2.876**
	(0.245)	(0.248)	(0.249)	(0.255)	(0.251)	(0.251)	(0.250)	(0.249)
Observations	123947	123947	123947	123947	123947	123947	123947	123947
Number of ID	32739	32739	32739	32739	32739	32739	32739	32739
AR1	-20.33	-20.11	-20.53	-20.31	-19.61	-19.73	-19.85	-19.79
AR2	2.964	2.961	2.953	2.843	2.924	2.827	2.982	2.937
AR3	2.015	1.993	1.981	2.003	1.991	1.954	1.988	1.999
Hansen J	37.05	35.75	36.26	35.78	33.74	34.74	34.16	34.13
Jdf	22	22	22	22	22	22	22	22
Jp	0.0234	0.0323	0.0285	0.032	0.0522	0.0413	0.0473	0.0477
Standard errors in parentheses								
** p<0.01	* p<0.05							

Notes: Standard errors in parentheses (** p<0.01, * p<0.05)

In Models 9 and 10 (Table 5b), different variables used to capture agglomeration and spillover effects are included into the model to check the robustness of estimation results. There is no significant change in estimation results. The only exception is that the coefficient of the output of foreign R&D performers becomes insignificant when the model also includes other variables about spillovers from foreign firms.

Finally, in Models 11-14 (Table 5b) we include interaction variables that are used to understand if absorptive capacity is important in benefiting from agglomeration effects and spillovers. Most of the variables interacted with firm size have statistically insignificant coefficients at the 5% level, i.e., firm size does not matter in benefiting from spillovers. The only exception is the interaction with "Foreign share (sector)" variable that has a negative and statistically significant coefficient. It seems spillovers from foreign firms operating in the same sector are more important for small firms than large firms.

Regarding the interactions with R&D performer variables, the estimation results show that R&D does not matter much for benefiting from spillovers. It seems that R&D non-performers benefit more from spillovers from foreign firms operating in the same sector (Model 12), but when we look at spillovers from foreign R&D performing firms in the same sector-region, R&D activity enhances absorptive capacity, i.e., absorptive capacity created by R&D activity matters for spillovers from other (foreign) R&D performers. These results may indicate that there could be spillovers specific to technologically sophisticated firms.

Models 15 and 16 are estimated to check if only large firms generate spillovers. When the output share of large firms in the same sector-region is the only spillover variable (Model 15), the estimation results suggest that there are spillovers from large firms to others operating in the same sector-region. However, even when three aggregate spillover variables are included into the model (Model 16), the coefficient of the output of large firms in the same sector-region becomes insignificant, i.e., the existence of large firms does not create more spillovers.

To summarize, the estimation results for Turkey suggest that:

- there are significant productivity enhancing agglomeration effects
- there are significant productivity enhancing spillovers between firms operating in the same sector, and these spillovers are stronger if firms operate in the same region
- spillovers emanating from foreign firms are stronger than those from domestic firms
- spillovers from R&D performers are stronger
- there are spillovers specific to technologically sophisticated firms
- there seems to be no spillovers specific to large firms.

Table 5b. Production function estimation results for Turkey (2006-2013, GMM-System results)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
VARIABLE	GMM	GMM	GMM	GMM	GMM	GMM	GMM	GMM
Returns to	1.041	1.040	1.085	1.046	1.043	1.047	1.047	1.046
Lag output	0.210**	0.210**	0.204**	0.213**	0.207**	0.216**	0.220**	0.216**
	(0.0207)	(0.0207)	(0.0205)	(0.0208)	(0.0203)	(0.0207)	(0.0210)	(0.0210)
Labor	0.482**	0.483**	0.521**	0.500**	0.451**	0.499**	0.487**	0.488**
	(0.0549)	(0.0548)	(0.0737)	(0.0558)	(0.0531)	(0.0560)	(0.0563)	(0.0559)
Lag labor	-0.207**	-0.208**	-0.208**	-0.215**	-0.189**	-0.216**	-0.208**	-0.205**
	(0.0329)	(0.0328)	(0.0344)	(0.0333)	(0.0314)	(0.0335)	(0.0336)	(0.0332)
Capital	0.0366**	0.0367**	0.0364**	0.0378**	0.0353**	0.0380**	0.0374**	0.0372**
	(0.00435)	(0.00435)	(0.00444)	(0.00444)	(0.00423)	(0.00444)	(0.00454)	(0.00452)
Lag capital	0.00606**	0.00607**	0.00559**	0.00615**	0.00516**	0.00608**	0.00522*	0.00536*
	(0.00203)	(0.00203)	(0.00202)	(0.00205)	(0.00196)	(0.00205)	(0.00211)	(0.00210)
Inputs	0.485**	0.483**	0.487**	0.468**	0.518**	0.469**	0.477**	0.475**
	(0.0558)	(0.0557)	(0.0575)	(0.0563)	(0.0528)	(0.0564)	(0.0569)	(0.0567)
Lag inputs	0.0201	0.0207	0.0213	0.0262	0.00679	0.025	0.0179	0.0197
	(0.0278)	(0.0278)	(0.0284)	(0.0281)	(0.0267)	(0.0281)	(0.0282)	(0.0280)
Foreign (du	0.0974**	0.0985**	0.119**	0.109**	0.127**	0.137**	0.134**	0.108**
	(0.0162)	(0.0164)	(0.0190)	(0.0173)	(0.0187)	(0.0193)	(0.0194)	(0.0177)
R&D perfo	0.0445**	0.0426**	0.0595**	0.0481**	0.0648**	-0.0125	0.0603**	0.0497**
	(0.00833)	(0.00803)	(0.00788)	(0.0117)	(0.00772)	(0.0153)	(0.00955)	(0.00908)
N domestic	-0.0181**	-0.0187**						
	(0.00358)	(0.00358)						
N foreign fi	0.0199**	0.0217**						
	(0.00261)	(0.00266)						
N domestic	0.00225							
	(0.00258)							
N foreign F	0.00702*							
	(0.00350)							
Regional s	0.0906**	0.0906**	0.135**	0.0656**				0.0659**
	(0.0144)	(0.0143)	(0.0517)	(0.00807)				(0.00790)
Foreign sh	0.136**	0.141**	0.124	0.205**				0.205**
	(0.0126)	(0.0129)	(0.0857)	(0.0186)				(0.0183)
Foreign sh	0.0613**	0.0611**	0.848*	0.0587**				0.0550**
	(0.0146)	(0.0146)	(0.397)	(0.0155)				(0.0154)
Q domestic firms (sect-reg)								
Q foreign firms (sect-reg)								
Q domestic R&D perf		0.000408*			0.00438	0.000678**		
		(0.000207)			(0.00227)	(0.000158)		
Q foreign R&D perforr		-8.8E-05			0.00296**	0.00177**		
		(0.000170)			(0.00105)	(0.000190)		
Firm size * Regional output share			-0.0173					
			(0.0126)					
Fİrm size * Foreign share (sector)			0.0192					
			(0.0193)					
Firm size * Foreign share (region)			-0.198*					
			(0.0995)					
R&D performer * Regional output share				0.0179				
				(0.0185)				
R&D performer * Foreign share (sector)				-0.0627**				
				(0.0209)				
R&D performer * Foreign share (region)				0.0463				
				(0.0394)				
Firm size * Q domestic R&D performers (sect-reg)					-0.00033			
					(0.000250)			
Firm size * Q foeign R&D performers (sect-reg)					-0.00092			
					(0.000567)			
R&D performer * Q domestic R&D performers (sect-reg)						-0.00013		
						(0.000460)		
R&D performer * Q foreign R&D performers (sect-reg)						0.00392**		
						(0.000831)		
Q share of large firms (sect-reg)							0.0331**	-0.00601
							(0.00701)	(0.00642)
Constant	2.881**	2.886**	2.728**	2.891**	2.690**	2.887**	2.848**	2.854**
	(0.261)	(0.260)	(0.250)	(0.251)	(0.244)	(0.250)	(0.254)	(0.254)
Observatio	123947	123947	123947	123947	123947	123947	121218	121218
Number of	32739	32739	32739	32739	32739	32739	32403	32403
AR1	-20.3	-20.28	-20.08	-19.71	-21.69	-19.72	-20.1	-20.08
AR2	2.793	2.792	2.686	2.82	2.829	2.931	2.989	2.877
AR3	1.952	1.957	1.887	1.956	1.935	1.998	1.996	1.925
Hansen J	37.76	37.78	39.71	34.51	41.78	33.97	35.04	34.6
Jdf	22	22	22	22	22	22	22	22
Jp	0.0195	0.0194	0.0117	0.0436	0.00665	0.0495	0.0383	0.0426
Standard errors in parentheses								
** p<0.01								

Notes: Standard errors in parentheses (** p<0.01, * p<0.05)
All variables are in log form. There are 123,947 observations (32,739 firms) in the sample.
FDI and R&D performer are dummy variables.
Regional output share, Foreign share (sector) and Foreign share (region) are in percentage.
All model includes time dummies.
GMM instruments: From the 2nd lag for output, labor, and inputs, and from the 1st lag for capital.

5.3. Productivity dynamics and differentials

The previous section summarizes the results of production function estimates that reveal which factors contribute to total factor productivity. In this section, we will look at the dynamics of productivity by region and firm size.

By using the estimated coefficients of the production function, the (log) level of total factor productivity for each firm-year is calculated as follows:

$$TFP_{i.t} = q_{i,t} - \alpha^*_{Lq}q_{i,t-1} + \alpha^*_{K}K_{i,t} + \alpha^*_{LK}K_{i,t-1} + \alpha^*_{L}L_{i,t} + \alpha^*_{LL}L_{i,t-1} + \alpha^*_{M}M_{i,t} + \alpha^*_{Lm}M_{i,t-1} \qquad [4]$$

where $TFP_{i,t}$ is the (log) TFP level of firm i at time t. α^*'s are estimated values of production function coefficients.

We estimated TFP levels by coefficients estimated for all models, and checked if there are significant differences between TFP levels calculated for each model. The coefficients of correlation between TFP levels are above 0.99 for all models, i.e., all models give similar TFP estimates at the firm level. We use the coefficients of Model 9 (Table 5b) in the following analysis.

We ranked all regions by GDP per capita and formed 5 regions on the basis of their ranking. Region 1 has the highest and Region 5 the lowest GDP per capita. Figure 4 presents the mean TFP levels for those five regional groups for the period 2006-2013. It seems that regions 1 and 2 have similar TFP levels, whereas regions 3, 4 and 5 lag behind the more developed regions. It is interesting to observe that the economic crisis in 2009 had a stronger negative effect on less-developed regions (especially the least developed one) in terms of productivity level whereas the developed regions (1 and 2) were able to increase their productivity throughout the period. The less developed regions, after stagnation until 2011 achieved a rapid increase in productivity in 2012 and 2013.

Figure 5 presents similar data grouped by firm size. All firms are classified into three groups, large (employing 250 or more people), medium (50-249 employees) and small (20-49) categories. There are significant productivity differentials between large firms on the one hand, and small and medium-sized firms on the other. Small and medium-sized firms have, on average, similar productivity level. The effect of economic crisis on productivity across size categories is similar to that for regions. Less productive categories (small and medium-sized firms) felt the effect of economic crisis more than large firms did. Although the TFP level for small and medium-sized firms stagnated before and during the crisis, it increased almost continuously for large firms throughout the period.

Fig. 4. Mean TFP by region (weighted)

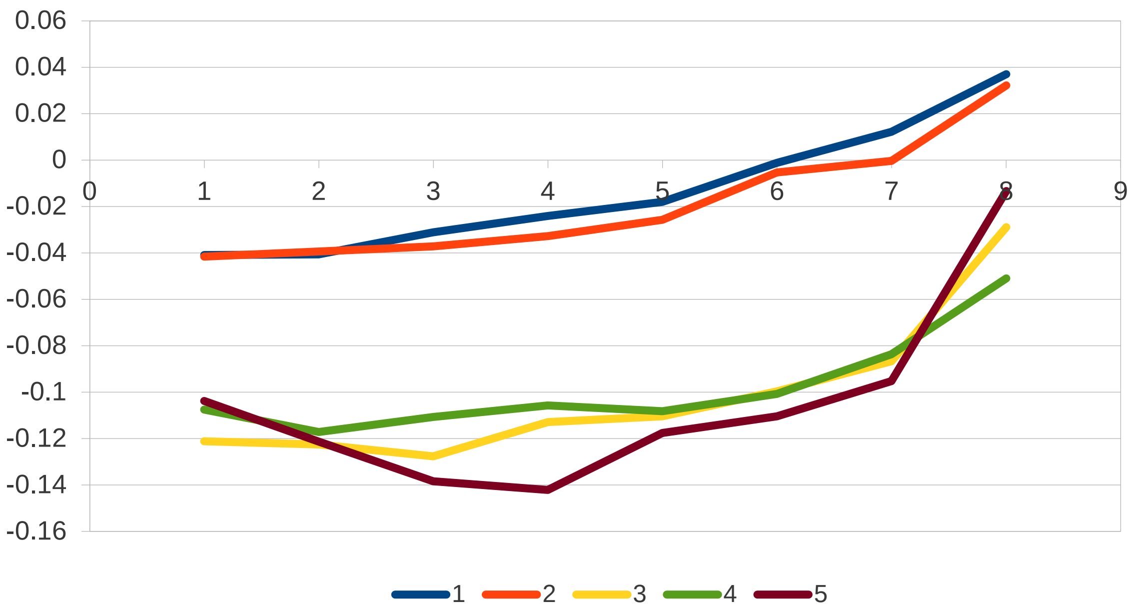
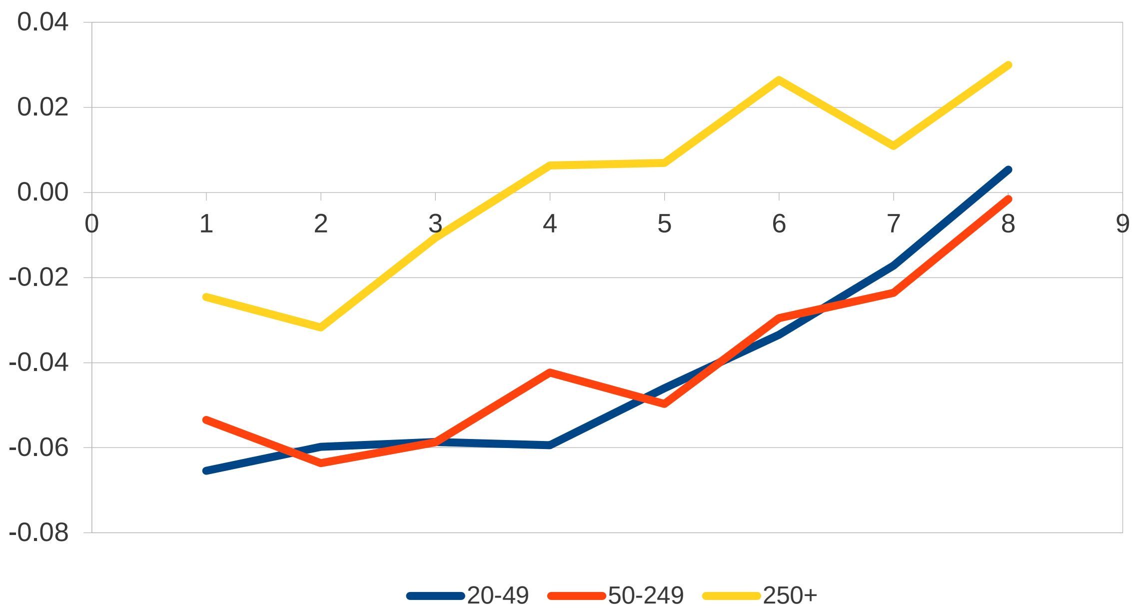


Fig . 5. Mean TFP by firm size (weighted)



6. Conclusions

We investigate what are the benefits of clustering estimating the effects of aggregation and other localisation variables on firms' productivity. First of all, we considered how far intense competition and polarisation in clusterised areas is able to promote higher productivity. Overall, our results emphasise the relevance of agglomeration economies in Turkey. More in detail, there are positive externalities from foreign firms' agglomeration, conversely the externalities from agglomeration of domestic firms are negative suggesting congestion effects. The estimation results also suggest a crucial role for foreign firms in terms of high FDI spillovers at local level and that spillovers emanating from foreign firms are stronger than those from domestic firms.

Important localised innovation spillovers are also found. Besides, there is evidence on the usual outcome that firms in the same industry benefit more from each other as they are more technologically similar and the sector closeness also matters as this may facilitate the flow and absorption of knowledge among firms. We also found that the territorial and social redistribution of spillovers may be limited in particular from foreign multinationals. This might also occur because firms opened to the foreign market are in general subcontractor which don't have the total autonomy to conduct technological neither technological innovation. We also consider innovation spillovers by type of firms (SME/large, high/low innovating and hence with high/low absorptive capacity). Hence, we interact agglomeration and spillover variables with firm size (measured by the number of employees) and innovation variables. These interaction variables reveal that the innovation performers benefit more from agglomeration effects and spillovers, as in most of our estimations the coefficient of firm innovation-agglomeration effect interaction variable is positive.

Some answers to crucial policy questions spur from this analysis. Generally, it is argued that, in an open economy, agglomeration leads to higher efficiency. Our result mostly support this conclusion with the due caveat and firm specificity. Polarization of activities, is confirmed to be an enhancing factor of firm performances. However, recent decades witnessed an increasing unbalanced process of regional growth in Turkey which led to large income and employment gaps across regions, consequent massive migration, concentration of population in large cities and along the coast, degradation and isolation of internal areas, environmental impoverishment and abandonment.

While a reallocation of resources to less developed regions could be costly and counterproductive giving that regional tax incentives to poor regions may shift jobs away from territories that do not receive the subsidy, rather than create new ones, the policy target for the government should be investing in transportation infrastructure, ease access to housing, and develop regional complementarities. Such policies would expand job opportunities for the people outside the coastal region and lead in the long term to a more sustainable convergence of standards of living among regions.
The experience drawn by this analysis may give support in identifying key drivers and patterns of localised production and to provide a benchmark to analyse the issue of efficiency of clusters of SMEs in South Mediterranean countries drawing some general directives and policy advices. In particular, results may be useful within the Euro-Med cluster cooperation on industry and innovation framework. The emerging innovation clusters based in Tunisia, Morocco and Lebanon, the CBDs in Tunisia, the Special Economic Zones and the role of MNCs are key elements in this context. These results may also represent the economic underpinning of policy analysis aimed at fostering innovation at regional level. In spite of the challenges of globalization, place still make the difference and can emerge as laboratories of new partnerships: local/global, private/public driven.

References

Acs Z., Armington C., Zhang T. (2007). The determinants of new-firm survival across regional economies. The role of human capital stock and knowledge spillovers. Papers in Regional Science, 86 (3), 367-391.

Aitken, B.J., Harrison, A.E. (1999). Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela. American Economic Review, 89(3), 605-618.

Audretsch D.B., Feldman M. (1996). Knowledge spillovers and the geography of innovation and production. American Economic Review, 86 (3), 630-640.

Audretsch, D.B., Feldmann, M.P. (2004). Knowledge Spillovers and the Geography of Innovation. Handbook of Regional and Urban Economics. 4, 2713-2739.

Baltagi B.H., Egger P.H., Kesina M. (2012). Firm-level Productivity Spillovers in China's Chemical Industry: A Spatial Hausman-Taylor Approach. Mimeo.

Bottazzi, L., Peri, G. (2003). Innovation and spillovers in regions: Evidence from European patent data. European Economic Review. 47, 687-710.

Breschi, S., Malerba, F. (2001). Geography of innovation and economic clustering. Industrial and Corporate Change, 10 (4), 817-833.

Çetin D. (2016). Knowledge Spillovers and Clusters: A Spatial Econometric Analysis on Ankara and Istanbul OIZs, LAP Lambert Academic Publishing: Germany.

Çetin D., Kalaycı E. (2016), Spatial Econometric Analysis of R&D Spillovers in Turkey, Journal of Applied Economics and Business Research, JAEBR, 6 (1): 55-72 .

Coulibaly, S., Deichmann, U., Lall, S. (2007). Urbanization and productivity : evidence from Turkish provinces over the period 1980-2000. Policy Research Working Paper Series 4327, The World Bank.

De Propris, L., Driffield, N. (2006), The importance of clusters for spillovers from foreign direct investment and technology sourcing, *Cambridge Journal of Economics,* 30(2), 277-291.

Ellison, G., Glaeser, E. L., Kerr, W.R. (2010). What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns. American Economic Review, 100 (June), 1195–1213.

Ferragina, A.M., Mazzotta, F. (2014). FDI spillovers on firms' survival in Italy: absorptive capacity matters! The Journal of Technology Transfer.

Filiztekin, A., (1998). Convergence across provinces and industries in Turkey. Koc University Working Paper, N. 08.

Filiztekin, A., Çelik, M.A. (2010). Regional Income Inequality in Turkey. Megaron, 5,116–127

Gezici, F., Hewings, G.J.D. (2007). Spatial analysis of regional inequalities in Turkey. European Planning Studies, 15(3),383–403.

Glaeser, E., Kallal, H., Scheinkman, J., Shleifer, A. (1992). Growth of cities. Journal of Political Economy 100, 1126-1152.

Gorg, H., Greenaway, D. (2004). Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment? World Bank Research Observer, 19(2), 171-97.

Greenstone, M., Hornbeck, R., Moretti, E. (2010). Identifying agglomeration spillovers: Evidence from winners and losers of large plant openings. Journal of Political Economy, 118(3), 536–598.

Haskel, J., Pereira S., Slaughter M. (2002). Does inward foreign direct investment boost the productivity of domestic firms? NBER Working Paper 8724.

Henderson, J.V., Dicken, P., Hess, M., Coe, N. and Yeung, H.W.-C. (2002). Global production networks and the analysis of economic development. Review of International Political Economy 9, 436-464

Jacobs, J. (1969). The Economies of Cities. Random House, New York.

Javorcik, B.S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. American Economic Review, 94(3), 605-627.

Karacuka M., Catik A.N. (2011). A spatial approach to measure productivity spillovers of foreign affiliated firms in Turkish manufacturing industries. DICE discussion paper 21 http://hdl.handle.net/10419/45793,.

Keller, W. (2002). Geographic Localization of International Technology Diffusion, American Economic Review. American Economic Association, vol. 92(1), 120-142, March.

Kılıçaslan, Y., Özatağan, G. (2007). Impact of relative population change on regional income convergence: evidence from Turkey. Review of Urban & Regional Development Studies, 19(3), 210–223.

Levinsohn J., Petrin, A. (2003). Estimating Production Functions Using Inputs to Control for Unobservables, Review of Economic Studies. Oxford University Press, vol. 70(2), 317-341.

Malerba, F. (2002). Sectoral systems of innovation and production, Research Policy, 31(2), 247-264.

Marshall, A. (1890). Principles of Economics. MacMillan, London.

Martin, P., Mayer, T., Mayneris, F. (2011) Spatial Concentration and Plant-Level Productivity in France. Journal of Urban Economics, 69(2), 182–195.

Onder Ã. O., Deliktas E.-R., Lenger A. (2003). Efficiency in the Manufacturing Industry of Selected Provinces in Turkey: A Stochastic Frontier Analysis. Emerging Markets Finance and Trade, Taylor & Francis Journals, 39(2), 98-113, March.

Öztürk S., Kılıç D. (2016). Do Firms Benefit From Agglomeration? A Productivity Analysis For Turkish Manufacturing Industry, Ekonomik Yaklasim. 27(98): 115-140

Paci, R., Usai, S. (2006) Agglomeration economies and growth-The case of Italian local labour systems, 1991-2001. Working Paper CRENoS 200612, Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia.

Porter, M.E. (1998), Location, clusters and the ‘new’ microeconomics of competition, Business Economics, Vol. 33-1: 7-17.

Rosenthal, S.S., Strange, W.C. (2001) The Determinants of Agglomeration. Journal of Urban Economics, 50.

Taymaz, E., Saatci, G. (1997). Technical Change and Efficiency in Turkish Manufacturing Industries. Journal of Productivity Analysis, 8, 461-475.

Taymaz, E., Yilmaz, K. (2007). Productivity and Trade Orientation: Turkish Manufacturing Industry Before and After Customs Union. The Journal of International Trade and Diplomacy, 1, 127-154.

Yıldırım, J., Öcal, N. (2006): Income inequality and economic convergence in Turkey. Transition Studies Review, 13(3), 559–568.