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# On firms' product space evolution: the role of firm and local product relatedness

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**Abstract**

We explore the role of firm and local product-specific capabilities in fostering the introduction of new products in the Turkish manufacturing. Firms' product space evolution is characterised by strong cognitive path dependence which, however, is relaxed by firm heterogeneity in terms of size, efficiency and international exposure. The introduction of new products in laggard Eastern regions, which is importantly related to the evolution of their industrial output, is mainly affected by firm internal product specific resources. On the contrary, product innovations in Western advanced regions hinge relatively more on the availability of suitable local competencies. ***JEL:*** *JEL: D22, O53, O12*
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# 1 Introduction

Countries' development histories are the result of a long term sequence of structural changes that explain what they are today. The continuous discovery of new production opportunities is a key factor for prospering in the long run, as it carries ahead the process of creative destruction from which development takes off. The understanding of how countries' production structure evolves, though, entails looking at firms' innovative behaviour which is importantly shaped by the availability of suitable existing local capabilities and relevant firm internal resources. In this work, we aim at exploring the relevance of firm and local technological proximity in shaping the evolution of firms' product space in Turkey during the period 2005-2009.

On one hand, literature has shown that knowledge externalities, which play a relevant role in economic growth (Arrow, 1962; Romer, 1986b,a; Grossman and Helpman, 1993), are geographically localised (Jaffe et al., 1993) and importantly enhance firm innovation, especially in small and medium size firms (Audretsch and Feldman, 2004). Despite the fact that the ongoing capitalist era is characterised by rapid spur and advances in information and communication technologies, the crucial difference between information and knowledge (Gertler, 2003; Howells, 2012) may still make the local dimension matter in the process of innovation creation. Tacit knowledge, indeed, has an important role in developing successful firm routines and represents a key competitive element in a period of widespread access to codified knowledge (Gertler, 2003; Maskell and Malmberg, 1999). The local availability of highly qualified labor, the structure of the local economy, and the presence of research facilities and institutions of higher education are all factors that may favour the diffusion of knowledge. However, geographical proximity is neither a necessary nor a sufficient condition for spurring innovation[1] across firms (Boschma, 2005) and other types of proximity may be necessary to complement the spatial one in favouring the introduction of new products. As a matter of fact in order to learn from the local knowledge pool, firms need to be able to absorb the relevant knowledge and thus need to be cognitively proximate to the local environment (Boschma, 2005). As a consequence, if knowledge can only be transmitted when receiving firms are able to absorb it, the notions of geographical and cognitive proximities become intimately related (Autant-Bernard, 2001; Baptista and Swann, 1998; Orlando, 2000).

On the other hand, firm internal resources are a fundamental driver of innovation and diversification in a highly dynamic global environment. Firm capabilities consist in the combination of technical competences with a general ability to change and adapt to environmental evolution (Teece et al., 1994). As knowledge and technological relatedness are necessary conditions for firm innovation, internal product specific resources drive firms' own path to diversification (Breschi et al., 2003; Neffke and Henning, 2013).

Within this framework, our work aims at providing new insights on the impact of firm and local product specific capabilities on the pattern of firm innovation. We thus contribute to the literature studying the role of technological relatedness for starting a new sector in a country (Hausmann and Hidalgo, 2009; Hidalgo, 2009), a region (Boschma et al., 2012, 2013; Boschma and Iammarino, 2009; Neffke et al., 2011) or a firm (Breschi et al., 2003; Neffke and

[1] Indeed, even if being geographically close facilitates the transmission of tacit knowledge, as the innovation process increasingly benefits from *learning by interacting* (Lundvall and Johnson, 1994), the social dimension of innovation gains in importance and social and relational proximity may also matter for innovation (Boggs and Rantisi, 2003; Breschi and Lissoni, 2001, 2009). In this respect, the so-called "soft location factors" are effective in retaining local qualified workers and encouraging qualified workers migration to the region.

Henning, 2013; Poncet and de Waldemar, 2012) and we also add to the empirical work testing the absolute and relative importance of the existence of a fertile regional environment versus the endowment of relevant intra-firm resources for firm innovation (Pfirrmann, 1994; Sternberg and Arndt, 2001; Beugelsdijk, 2007; Wang and Lin, 2012).

However, compared to the existing evidence, we provide some original contributions.

Firstly, for the first time, to our knowledge, we exploit firm product level data in order to uncover the role of firms' and their local environment current product space for firms' choice and ability of new products. Rather than focusing on firm product exports (Poncet and de Waldemar, 2012), we adopt a broader perspective by describing and inspecting how and which new products are added to firms' existing baskets. We, thus, contribute to shed light on the microeconomics of countries' product diversification and extend insights on the importance of capabilities endowments and on path dependence in productive structures' evolutions from the country to the firm level (David, 1985; Arthur, 1989; Hidalgo, 2009; Hausmann and Hidalgo, 2009, 2011). As a consequence, we can explain the emergence of product clusters across the geographical space which justify the existence of long lasting differences - in terms of diversification, sophistication and, as a consequence, growth - across regions that especially characterise emerging and developing countries.

Secondly, we focus on and compare the impact of firm and local *product* specific capabilities on a firm's decision of which product to add to its existing product portfolio, rather than looking at and comparing the effect of overall local and firm-specific resources on firm innovation propensity (Pfirrmann, 1994; Sternberg and Arndt, 2001; Beugelsdijk, 2007).

Thirdly, our analysis explores the role of several dimensions of firm heterogeneity in terms of internal and environmental resources in relaxing the linkage between the local and firm pre-existing capabilities on the one side and the evolution path of production on the other side, and, as a consequence, in introducing a structural transformation in the economic system. Large, highly productive firms, firms engaged in R&D and in complex productions could better exploit their internal resources to develop new capabilities and gain independence from the context where they operate. Foreign owned firms, on their side, like exporters, importers and multi-plant firms located in different regions, operate within more open and wider networks and, thus, have *weaker* ties with the local environment (Granovetter, 1973). This can favour their escape from the historical regional comparative advantage, due to knowledge spillovers from their international network and, for foreign firms, to the availability of larger intra-group financial resources (Desai et al., 2004, 2008). In all these cases, regardless of local conditions, the availability of a larger knowledge base can importantly contribute to reduce a firm's entry cost in a new brand new technology (Perez and Soete, 1988).

Finally, to the best of our knowledge this is the first piece of research investigating the importance of firm and local capabilities in shaping product innovation in Turkey. Relevant territorial disparities characterise the country. A laggard East contrasts with a more developed West, where most of the Turkish industrial base is located. In this context, it is fundamental to ascertain whether and to what extent geographical and technological proximity explain the innovation performance of firms and the evolution of the country's product space. Our analysis can thus reveal the worthiness of recent cluster policies aiming at favouring the spatial diffusion of local industrial development.

The work is organised as follows: the next section reviews the relevant literature and goes into detail of our contribution; section 3 presents the data sources and our main relatedness indicators; section 4 describes the empirical strategy and presents the results; section 5 concludes.

## 2 Literature Review

In the process of economic development, diversification of production is an important step which ultimately depends on adjustments at the firm margin and at the product margin within the firm. Product innovation, in other words, is a firm level phenomenon which is complex, uncertain and requires time and learning (Dosi, 2011; Feldman, 1994). As a consequence, firm innovation efforts may, in turn, importantly benefit from the availability of a local pool of diverse knowledge and capabilities. Geographical proximity among firms may thus emerge as a fundamental driver of innovation. Indeed, it may reduce uncertainty for firms entering new fields, as it favours the flow of knowledge by enabling firms to exchange ideas and acquire important skills and abilities required for new production processes (Boschma and Frenken, 2011; Audretsch and Feldman, 2004). However, some research in economic geography suggests that, unless complemented by cognitive proximity, geographical proximity may not be *per se* either necessary or sufficient to foster the spur of knowledge (Boschma, 2005; Autant-Bernard, 2001; Orlando, 2000; Baptista and Swann, 1998). In this line, recently Boschma et al. (2012) investigate the importance of diversification in related industries for regional value added and employment growth in Spain at the NUTS3 region level during the period 1995-2007. By comparing the cluster classification introduced by Porter (2003) and the proximity index proposed by Hidalgo et al. (2007), they show that Spanish provinces with a wide range of related industries tend to enjoy higher economic growth rates. Focusing on regional competitiveness, instead, Boschma et al. (2013) explore the role of regional and country level density measures around a product on a region's probability to develop a revealed comparative advantage in that product. By using export data on 50 Spanish regions at the NUTS 3 level in the period 1988-2008, they show that proximity to the regional industrial structure plays a much larger role in the emergence of new comparative advantage industries in regions than does proximity to the national industrial structure. This hints at important complementarities between geographical and cognitive proximity in the spur of knowledge, although regional capabilities favour the maintenance rather than the development of comparative advantages. Neffke et al. (2011) analyse the economic evolution of 70 Swedish regions during the period 1969-2002 and find strong path dependence in the diversification process of Swedish regions. Their results confirm that technological relatedness, measured by a Revealed Relatedness indicator based on the ratio between industries' co-occurrences and their predicted value, is important in rising regions' technological cohesion. Boschma and Iammarino (2009) also look at the role of "related" knowledge on regional economic growth in Italian provinces for the period 1995-2003. Their relatedness indicator hinges on the belonging of sectors/products to the same two digit sector, thus following the notion of relatedness proposed by Frenken et al. (2007). They also point at the important role of related extra-regional knowledge in shaping the process of regional economic growth.

At the firm level, firm expansion can be viewed as a process of exploitation of productive opportunities (Penrose, 1959). Firms can be viewed as unique bundles of resources where firm specific abilities and general organisational routines are combined with product-specific competencies related to the production of a particular product [2]. Thus, product-specific *capabilities* can constitute an important knowledge base to explore new production fields and can be exploited by firms to diversify into technologically related products (Danneels, 2002). In this line, on a sample of United States, Italian, French, UK, German, and Japanese firms patenting to the European Patent Office from 1982 to 1993 Breschi et al. (2003) show

[2] A similar view of the firm is reproduced by recent mainstream models of multi-product firms (Bernard et al., 2011).

that knowledge-relatedness, measured on the basis of the co-classification codes contained in patent documents, is a major determinant of firm diversification, measured as the firm probability to be simultaneously active in another activity other than the core one. In a similar way, Neffke and Henning (2013) identify skill relatedness by using information on cross-industry labour flows and show that firms are more likely to diversify into industries that are more "skill" related to their core activities than into industries without such ties or into industries that are linked by value chain linkages or by classification-based relatedness.

These firm level studies, thus, suggest that, although inter-firm technologically related knowledge spillovers may play a role in the evolution of firms' production structure, the necessity of firms' internal product specific knowledge and abilities cannot be neglected. In particular, the local environment can be considered of minor importance for the introduction of brand new products and sectors because of the large distance between the existing pool of capabilities and the requirements of the new firms/products on the one side and its environment on the other (Boschma and Frenken, 2006). In this respect, a stream of literature has focused on quantification of the relative importance of firm and local resources and capabilities in favouring firm innovation. Pfirrmann (1994) for a sample of SMEs in Germany, Sternberg and Arndt (2001) on a sample of European firms mainly of medium and small size and Beugelsdijk (2007) for a sample of Dutch firms, all show that the firm-specific drivers of innovation are more important than is a firm's regional environment. This evidence calls into question the existence of a regional environment effect *tout-court* and suggests that the relevant inter-firm interactions within bounded territories need to be more carefully assessed. This once again brings us back to the important complementarity between cognitive and geographical proximity among firms in favouring the flow of tacit knowledge which enhances firm growth and diversification processes. In this line, and closer to our work, Poncet and de Waldemar (2012) show that the export performance of Chinese firms in a product depends on their product relatedness to the local comparative advantage, with product relatedness being measured on the basis of the proximity index proposed by Hidalgo et al. (2007). This effect is particularly strong for domestic firms and for ordinary trade activity and for more productive firms, thus showing the need for sufficient absorptive capacity for the spillover to occur.

In the present work we test the impact of both firm and local *product*-specific *capabilities* measured by Hidalgo et al.'s 2007 density indicators in shaping the process of firm introduction of new products. We also inspect the role of firm heterogeneity in affecting the dependence of firms' product portfolio choices on the firm internal and local *product*-specific *capabilities*.

# 3 Data and Measurement Issues

## 3.1 Data Sources

For the implementation of our analysis we make use of three different firm level data sources provided by the Turkish Statistical Office (TurkStat).

Our main variables of interest are computed from the Annual Industrial Product Statistics (AIPS). AIPS contains firm level information on each produced good, its volume and value of production and sales. These data are available for the years 2005-2009 and are collected at 10-digit PRODTR level. The latter is a national product classification with the first 6 digits corresponding to CPA codes and including about 3,700 different products. Production data are collected for all firms with more than 20 persons employed and whose primary or secondary

activity is either in section C (Mining&Quarrying) or section D (Manufacturing) of NACE Rev 1.1. This database allows for the identification of new products introduced by firms and of firms' and provinces' production structure.
Information on firms' characteristics and location is from the Structural Business Statistics (SBS). The latter contains information on output, input costs, employment, foreign ownership and the province of location over the period 2005-2009 for the whole population of firms with more than 20 employees and for a representative sample of firms with less than 20 employees. The SBS covers all firms contained in AIPS. The SBS also provides information on firms' plants, in particular their number, location, employment, turnover and NACE sector. We then exploit these plant level data to recover production value at the province-product level.
Information on firms' export and import activities is available for the period of our analysis from Foreign Trade Statistics. Finally, we use BACI (Gaulier and Zignago, 2010) trade data at country-product level to compute the product proximity indicator (Hidalgo et al., 2007) and, as a consequence, the firm and local product density indicator.

While production data are recorded according to the PRODTR classification system, BACI trade data are recorded according to the 1996-HS classification. In order to match firm-product level production data with the proximity indicator computed by exploiting product level export information retrieved from BACI, we first converted 1996-HS flows into CPA by means of the HS-CPA correspondence table available from RAMON website and we constructed a harmonised classification that is just slightly more aggregated than the CPA classification, which we call HCPA. The latter contains 1,297 products of which 1,030 are actually produced in Turkey. Hereafter, product code refers to HCPA classification.

It is worth highlighting that our location specific characteristics are measured at the NUTS3 province level. In order to calculate production value at the province level we had to cope with the presence of multi-plant firms in our database. For single-product multi-plant firms we assumed that the value of the single product produced by each plant is proportional to its declared turnover. In order to split the production of multi-product and multi-plant firms across plants located in different NUTS 3 regions, we assumed that each plant produces the same products and we attributed the production value to each plant in proportion to its turnover.[3]

## 3.2 Measuring product innovation and product relatedness

**Product Innovation -** To explore whether the introduction of a new product is affected by its proximity to firm and local existing *capabilities* we define $I_{ip\ t}$ as our dependent variable that is a dummy taking value 1 if at time $t$ firm $i$ starts producing product $p$, not previously - in $t-1$ - produced. Since we observe the production flow of new goods, we directly observe the variable when it takes value 1. On the contrary, we do not observe the whole set of production possibilities for each firm and thus we decided to set $I_{ip\ t}$ to zero for the whole set of products that the firm is not producing at time t and that belong to one of the 2digit NACE codes where the firm is actually producing at time *t-1* (Frenken et al., 2007). This notion of product diversification is narrower than the one that considers as potential choice any

[3]We compared the territorial distribution of production stemming from this assumption to the emerging one by attributing to the plant the production of those products falling within the 4digit NACE sector declared as the plant's main activity. The two territorial distributions of production are rather close.

of the existing HCPA 1297 products not previously produced. Such a definition of the possible cases, though, would make the analysis computationally unfeasible, due to the very high number - roughly thirteen millions - of observations. Nonetheless, as the definition adopted in this paper actually restricts product addition possibilities to those products that in a way may be technically related according to their classification code (Frenken et al., 2007), in the robustness checks we will consider this possibility by repeating the baseline estimations by year and for a random selection of zeros on the entire sample of all possible product-firm combinations.

It is worth noticing that our sample is made up of innovators only, and thus our results are conditional on the firm innovation status. This choice follows from the goal of our empirical exercise. Indeed, we aim at highlighting how the local and firm production structure affect firm product choice among all the alternatives rather than studying how it may determine firm innovation propensity.[4]

In Table 1 we show the share of new products with respect to all potential products belonging to one of the 2 digit codes within which a firm was active in the previous year. It emerges that product addition is indeed a rare activity and the percentage of potential product introduced by innovators remains substantially unchanged during the period of our analysis.

Table 1: Product Introduction by Turkish Innovators

| year | Number New Product-Firm pairs | $I_{ip}$% |
|---|---|---|
| 2006 | 6,075 | 1.74 |
| 2007 | 4,251 | 1.81 |
| 2008 | 3,453 | 1.82 |
| 2009 | 3,871 | 1.77 |
| Total | 17,650 | 1.78 |

Authors' elaborations on AIPS and SBS data. $I_{ip}$% displays the percentage of new firm-product pairs on the sample of innovators.

To assess the importance of new products for the geography of manufacturing production in Turkey, we analyse their impact on the evolution of industrial output across regions. In figure A.1 Panel A documents the unequal distribution of industrial production between Eastern and Western regions at the beginning of our sample period, while Panel B and C reveal that new products importantly contribute to explain the dynamics of regional industrial growth[5], especially in laggard regions. This implies that new products can represent an important factor helping to reduce the historical territorial divide.

[4]As sample selection bias could affect our main insights in a robustness check we include non innovators in the sample.

[5]The evidence from Panel B is strongly supported by official data on the spatial distribution of average annual export growth. As exports are out of the scope of our analysis the corresponding map is not shown for brevity, nonetheless it is available from the authors upon request.

**Product Relatedness -** In order to calculate the extent of relatedness between firms' new products and their own and local capabilities we hinge on the proximity indicator introduced by Hidalgo et al. (2007) between each pair of products which is based on the co-occurrence of products in the export basket of countries.[6] To compute this index we converted HS export flows from the BACI CEPII trade dataset for year 2002 into the HCPA classification and we calculated it as:

$$\phi_{pj} = min\{P(RCAx_p|RCAx_j), P(RCAx_j|RCAx_p)\}$$

that is the distance between HCPA good $p$ and HCPA good $j$ is equal to the minimum between the probability that good *p* is exported conditional on good *j* being exported and the probability that good *j* is exported conditional on good *p* being exported. The Hidalgo et al.'s 2007 proximity indicator is a more comprehensive and superior proxy of technological and cognitive relatedness across products compared to the traditional sector/product classification. It is indeed able to capture the similarity between two goods in the use of capabilities, regardless of their location in the standard product classification. The lack of perfect overlapping between the product/sector definition is shown in Table 2. Proximity decreases when considering more aggregate sector codes, however the means and medians of goods belonging to the same four, three and two digits are quite close thus hinting at the fact that product proximity can hide more than what is recorded by a conventional classification system. As a matter of fact, although the mean and median proximity values between couple of products belonging to different two, three, and four digit sectors are lower than across all products, the maximum reveals that, as expected, product proximity indicator captures more than the simple belonging to the same NACE sector.

Table 2: Proximity values within group of HCPA codes

| | Mean | Median | Sd | Min | Max |
|---|---|---|---|---|---|
| Across all products | 0.172 | 0.160 | 0.104 | 0 | 0.864 |
| Within the same 2 digit | 0.223 | 0.212 | 0.119 | 0 | 0.864 |
| Among different 2 digit | 0.169 | 0.156 | 0.102 | 0 | 0.797 |
| Within the same 3 digit | 0.237 | 0.222 | 0.135 | 0 | 0.864 |
| Among different 3 digit | 0.171 | 0.159 | 0.103 | 0 | 0.797 |
| Within the same 4 digit | 0.245 | 0.231 | 0.142 | 0 | 0.864 |
| Among different 4 digit | 0.172 | 0.160 | 0.104 | 0 | 0.851 |

Authors' elaborations on AIPS and SBS data and BACI dataset. The Table shows the descriptive statistics of the product proximity indicator $\phi$ (Hidalgo et al., 2007) for different sub-samples of product pairs, on the basis of their CPA sectoral classification.

In order to measure the relatedness between firms' and provinces' capabilities endow-

[6] Several further measures of product relatedness have been used in the literature (Teece et al., 1994; Fan and Lang, 2000; Porter, 2003; Neffke and Henning, 2008; Bryce and Winter, 2009). However, the Hidalgo et al.'s 2007 proximity indicator is in our view the most comprehensive, detailed and less computationally demanding. This is indeed confirmed by the widespread use of such an indicator in recent empirical work to investigate structural change issues (Poncet and de Waldemar, 2012; Felipe et al., 2012).

ment on the one hand and the new products firms introduce on the other, we adopt the density measure proposed by Hidalgo et al. (2007). The latter measures the weight of links of the new product with a specific firm and local subset of products relative to the product's total proximity to all of the available products. Thus, it reflects the relative proximity between the capabilities required for the new product and the main firm and local capabilities. For each firm *i* the firm product density indicator is measured as follows:

$$dens_{ip} = \frac{\sum_{j=1}^{N} \phi_{pj} * d_i}{\sum_{j=1}^{N} \phi_{pj}} \tag{1}$$

where $d_i$ is a dummy equal to 1 for those products produced by the firm, and equal to 0 otherwise. This dummy variable, therefore, identifies the relevant subset of products as those already produced by the firm.[7]

For each firm *i*, we calculate a measure of provincial density around product $p$ as

$$dens_{ip}^{l} = \sum_{l=1}^{L_i} s_{il} [\frac{\sum_{j=1}^{N} \phi_{pj} * x_{j\ RCA}^{l}}{\sum_{j=1}^{N} \phi_{pj}}] \ with \ \sum_{l=1}^{L_i} s_{il} = 1 \, \forall i \tag{2}$$

In the formula $x_{j\ RCA}^{l}$ is a dummy equal to 1 for products in which province $l$ has a comparative advantage, and equal to zero otherwise.[8] In this case the relevant subset of products is made up of those products where the province has manifested its expertise and thus owns a revealed comparative advantage. In the formula, the term in brackets represents the local density of province $l$. To account for firms with plants located in different provinces, $s_l$ indicates the weight of province *l* in firm *i*'s total turnover and $L_i$ the total number of provinces where firm $i$ is present with its own plants. Thus, for each firm the local density around its new products is a firm level variable that represents the weighted average of province densities where weights are equal to the share of firm *i*'s plant located in province *l* in total firm *i*'s turnover.

Our aim in the present paper is thus to highlight whether the technological proximity of the firm and provincial production structure is a significant driver of firm's choices over new products and their abilities to expand their product basket. Preliminary evidence on the positive relationship between technological relatedness and innovation is available in Table 3

[7]We tried to adopt a further measure of firm density based on product p's proximity to the firm's main product but the analysis was basically unchanged. For the sake of brevity we do not show these results here, nevertheless they are available upon request.

[8]We compute the RCA index on the basis of the province-product level production data that we obtained by aggregating plant level production data at the province level for each HCPA code. Thus, province *l* has a comparative advantage in product *p* if the following index is higher than 1:

$$RCA_{pl} = \frac{\frac{y_{pl}}{\sum_{j=1}^{N} y_{jl}}}{\frac{\sum_{l=1}^{L} y_{pl}}{\sum_{l=1}^{L}\sum_{j=1}^{N} y_{jl}}}$$

where in the formula $L$ is the total number of provinces in the Turkish economy, and $y$ denotes the value of production. The province RCA index is then computed by considering the whole Turkish territory as reference.

where t-tests reveal that newly introduced product-firm combinations systematically present higher firm and local densities.

Table 3: T-test

| | $I_{ip} = 1$ | $I_{ip} = 0$ | T-test |
|---|---|---|---|
| $dens$ | 0.007 | 0.004 | -88.796 |
| $dens^l$ | 0.287 | 0.254 | -28.339 |

# 4 Empirical Analysis

## 4.1 Empirical model and estimation issues

To explore whether the introduction of a new product is affected by its proximity to firm and local existing *capabilities* we estimate the following Linear Probability Model (LPM):

$$I_{ip\ t} = \alpha_0 + \alpha_1 dens^l_{ip\ t-1} + \alpha_2 dens_{ip\ t-1} + \Gamma' X_{i\ t-1} + \eta_i + \chi_p + \phi_t + \epsilon_{ipt} \tag{3}$$

where $I_{ip\ t}$ is the dummy identifying the introduction of new product $p$ by firm $i$, defined as above and our right hand side variables of interest are $dens^l_{ip\ t-1}$ and $dens_{ip\ t-1}$, which, as previously stated, respectively measure firm and local density at time $t-1$ around a firm's potential new product $p$. Due to the inclusion of the local and firm density measures, our analysis is carried on the 2006-2009 panel. In the model, $X_{i\ t-1}$ is a vector of firm level characteristics all measured in $t-1$ and including firm size, labour productivity, export, import and foreign ownership status.

$\eta_i$, $\chi_p$ and $\phi_t$ respectively denote firm, product and time fixed effects, while $\epsilon_{ipt}$ represents an idiosyncratic error term.

Table A.1 in the Appendix contains a detailed description of all the variables included in the various specifications of model 4.2.

Despite the pitfalls of the LPM, the latter does not need any distributional assumption to model unobserved heterogeneity - in particular firm and product time invariant characteristics that may drive a firm's product choice - and in general delivers good estimates of the partial effects on the response probability near the center of the distribution of the regressor (Wooldridge, 2002). As the LPM is affected by heteroskedasticity, our standard errors are robust and clustered by firm[9] and our predicted probabilities always lie between zero and one. Nevertheless, in the robustness checks we adopt alternative nonlinear models to test the robustness of our findings based on the LPM.

## 4.2 Baseline Results

Table 4 shows results for a baseline specification of model . In columns 1 to 6 only firm and local density measures are included in the specifications and estimates reveal that, regardless of the inclusion of year, product and firm fixed effects, both the existence of firm and local capabilities which are proximate to those required for the new product positively affect its introduction. The introduction of fixed effects increases the coefficient of local density which becomes stable even when accounting for the impact of firm density. Thus, fixed effects reduce the interdependence between local and firm densities around new products, by capturing those factors that are common to the firm and the local capabilities in determining the choice of new products. The role of firm internal product specific capabilities is instead downsized by the inclusion of fixed effects.

In columns 7-9 we control for further firm level variables that are expected to affect a firm's product innovation activity: firm size and productivity levels, importer, exporter, foreign ownership and multiplant status dummies and the firm's local RCA index. Detailed description of the computation of all the variables included in the analysis is available in Table A.1 in the Appendix.

Larger firms are more likely to invest in R&D and to gather the necessary financial resources,

[9] When we cluster standard errors at the product level our results are not affected at all.

Table 4: Results - Firm & Local Capabilities in Product Innovation

| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] |
|---|---|---|---|---|---|---|---|---|---|
| $dens^l$ | 0.025*** | | 0.005*** | 0.044*** | | 0.044*** | 0.040*** | | 0.040*** |
| | [0.001] | | [0.001] | [0.007] | | [0.007] | [0.007] | | [0.008] |
| $dens$ | | 2.706*** | 2.657*** | | 1.860*** | 1.860*** | | 1.848*** | 1.846*** |
| | | [0.071] | [0.073] | | [0.190] | [0.190] | | [0.205] | [0.205] |
| $Size$ | | | | | | | 0.002 | 0.001 | 0.001 |
| | | | | | | | [0.001] | [0.001] | [0.001] |
| $LP$ | | | | | | | 0.000 | 0.000 | 0.000 |
| | | | | | | | [0.001] | [0.001] | [0.001] |
| $Importer$ | | | | | | | -0.001 | -0.001 | -0.001 |
| | | | | | | | [0.001] | [0.001] | [0.001] |
| $Exporter$ | | | | | | | -0.001 | -0.001 | -0.001 |
| | | | | | | | [0.001] | [0.001] | [0.001] |
| $Foreign$ | | | | | | | 0.008** | 0.008* | 0.010** |
| | | | | | | | [0.003] | [0.004] | [0.004] |
| $Multi-plant$ | | | | | | | 0.002 | 0.001 | 0.002 |
| | | | | | | | [0.001] | [0.001] | [0.001] |
| $RCA^L$ | | | | | | | 0.001*** | 0.001*** | 0.001*** |
| | | | | | | | [0.000] | [0.000] | [0.000] |
| **FE:** | | | | | | | | | |
| Year | y | y | y | y | y | y | y | y | y |
| Product | n | n | n | y | y | y | y | y | y |
| Firm | n | n | n | y | y | y | y | y | y |
| Observations | 991,398 | 991,398 | 991,398 | 991,398 | 991,398 | 991,398 | 897,344 | 897,344 | 897,344 |
| R-squared | 0.001 | 0.008 | 0.008 | 0.079 | 0.079 | 0.079 | 0.081 | 0.082 | 0.082 |

$^*p < 0.10;^{**} p < 0.05;^{***} p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are lagged to one year.
$dens^l$ and $dens$ captures the firm and local product relatedness measured by resting on the Hidalgo et al.'s 2007 density indicator.
Columns 7-9 control for further firm level variables: firm size, $Size$, productivity, $LP$, a dummy for the status of importer, $Importer$, a dummy for the status of exporter, $Exporter$, foreign ownership dummy, $Foreign$, multi-plant dummy, $Multi-plant$, and the local RCA index, $RCA^L$.

either internally or from the local banking system (Beck et al., 2005, 2008). In addition, for a given size more efficient firms may more easily overcome the fixed cost of innovating. Actually, recent literature on firm heterogeneity shows that firm innovation patterns are closely related to heterogeneous efficiency levels, which are in turn very much related to the diversity of firms' export activities (Melitz and Burstein, forthcoming). Finally, firms active in international markets may be more likely to innovate, as trade can be regarded as the flow of extra-regional knowledge (Boschma and Iammarino, 2009). On the one hand, importers may access new, better quality and more suitable inputs (Krishnan and Ulrich, 2001; Goldberg et al., 2009; Colantone and Crinò, 2013). On the other hand, exporters may dramatically be pushed to innovate by their own foreign customers (Baldwin and von Hippel, 2011; Goh, 2005; Egan and Mody, 1992; Salomon and Shaver, 2005; Bratti and Felice, 2012; Hahn and Park, 2011; Lo Turco and Maggioni, 2012). Foreign owned firms, then, besides being more export and import intensive, may further benefit from technological spillovers from their headquarters and from the availability of intra-group financial resources (Desai et al., 2004, 2008). The latter may offset the negative impact of financial constraints that usually affect firms operating in less developed economies (Gorodnichenko and Schnitzer, 2010). As a consequence, we included firm size and productivity level together with export, import and foreign ownership status dummies. Furthermore, we included a dummy variable for multi-plant firms to address any possible externality stemming from their simultaneous presence in different locations. The inclusion of the local RCA index value in the new product, $RCA^l$, is aimed to ensure that the local density indicator does not actually capture the extent of local specialisation in that product (Hausmann and Klinger, 2007; Poncet and de Waldemar, 2012; Boschma et al., 2013) instead of the availability of proximate capabilities around the firm's local units. Results in columns 7-9 show that, among firm level characteristics included in the basic specification, only foreign ownership exerts a positive and significant direct effect on the introduction of new products. Among innovators, foreign firms are more likely to introduce a larger number of new products, possibly due to their wide international network and their larger knowledge base. The poor performance of other firm level characteristics in predicting the pattern of product innovation may stem from the inclusion of firm fixed effects in a short-panel dataset. Alternatively, it may also indicate that while firm characteristics determine firm propensity to innovate, firm-product specific capabilities especially matter for the choice of product additions. Furthermore, local specialisation in the product is a significant determinant of the firm's probability to introduce that product in that location. However, the inclusion of this set of controls does not dramatically alter either the size or significance or the relative importance of our density indicators.

In order to account for and compare the economic magnitude of the effects of local and firm densities around the new product, taking partial effects in column 9 as a benchmark and the average density values for innovating and non innovating firm-product groups from Table 3 above, we calculate the relative importance of firm and local resources for new product introductions. If the level of densities of non innovators jumped to the values of innovators a firm average innovation probability would increase by 0.6 and by 0.1 percentage points because of firm and local density, respectively. These figures respectively imply an increase of 34% and 6% in the average innovation rate displayed in Table 1 and hint at the possible higher responsiveness of innovation to firm internal product specific resources rather than to the local ones. In the first column of Table 5 we actually confirm this insight. When we smooth the density indicators by taking their log, the estimated semi-elasticities imply a larger role for firm rather than local product-specific capabilities. This finding is confirmed by Figure A.2 which shows the relative importance of firm density compared to the total - firm and local - technological proximity in explaining the spatial distribution of firms' introduction of new products.[10] The comparison of Figures A.2 and A.1 suggests that firm product specific capabilities could have led the dynamics of industrial production and innovation experienced by laggard Eastern regions - such as Ağrı, Iğdır, Hakkari, Van and Erzurum - in the time span considered in our analysis. Local product specific capabilities, instead, emerge as the main driver of new product introduction for all richer and more industrial regions - such as Ankara, Istanbul, Manisa, Bursa and Konya - as highlighted in the top panel of Figure A.1.

In Table 5 also further alternative density indicators are used to check the robustness of the baseline findings. In column 2 firm local density - such as the local RCA measure - is based on RCAs calculated as the province product share over the world export share in the product. This is to account for a possible mis-measurement of provinces' revealed comparative advantage indexes due to the use of Turkish industrial structure as the benchmark for the comparison of each province production structure. In column 3, we enlarge the scope of local RCA products by defining a product with RCA when the latter indicator is above 0.5 rather than above 1. In column 4, to account for the possible dependence of our density measures on the number of products that firms produce and in which locations own a comparative advantage, we normalise them by dividing them by the total number of firm products and the total number of local RCA products. For the same purpose of checking the robustness of our preferred technological proximity indicators to any possible scale effect, in column 5 we substitute average local and firm proximity for firm and local densities.[11] Finally, in column 6 the local density indicator is referred to the NUTS 2 region(s) where the firm is active. All these changes, which try to account for potential pitfalls of the original density indicators, leave our insights substantially unaltered.

In Table 6 we show some further checks to prove the validity of our baseline results from Table 4. Firstly, to account for the possible selection bias in our estimates stemming from the exclusion of non innovating firms, we randomly select 20% of them from the same two digit codes where firms in our sample are active and attribute to them the local and firm density measures around the products they could potentially introduce. Results in terms of significance and relative importance of the two density measures are unaffected. Secondly, we exclude those firms that have at least one plant located in the Istanbul province from the analysis. This is to verify that our findings are not just driven by this province, which presents a higher agglomeration of firms and variety of products. Thirdly, to check the validity of our provincial production data aggregated from firm-level information, we exclude those provinces for which we have less than 20 firms in AIPS. The small number of firms used to reconstruct the production data may indeed lead to poor aggregate production value proxies. Fourthly, we include the log of the number of products produced by the firm and the log of the number of products in which the province(s) where the firm unit(s) is(are) located has a revealed comparative advantage in order to ensure that our firm and local density indicator are not capturing a scale effect, rather than the availability of suitable firm and local product specific capabilities.[12] Fifthly, we include the local value of production in the product. Finally, we include further observable firm characteristics at our disposal to check that our evidence

[10]The relative importance of firm density in explaining NUTS 3 region average innovation rates is calculated as $\frac{\alpha_2 * dens}{\alpha_1 * dens^l + \alpha_2 * dens}$ with coefficients $\alpha_1$ and $\alpha_2$ taken from column 9 of Table 4.

[11]Instead of computing a density indicator we average the proximity indicator between the potential product $p$ and each product produced by firm $i$ and products in which the province enjoys an RCA.

[12]For firms located in different provinces we consider the weighted average number of RCA products across the provinces of localisation.

## Table 5: Robustness - Alternative Density Indicators

| | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| | **Logarithm Density Measures** | **RCA based on World product Shares** | **Different RCA Threshold** | **Normalised Density** | **Proximty** | **NUTS II Local unit** |
| $Logdens^L$ | 0.005*** | | | | | |
| | [0.001] | | | | | |
| $Logdens$ | 0.008*** | | | | | |
| | [0.001] | | | | | |
| $dens$ | | 1.852*** | 1.849*** | | | 1.844*** |
| | | [0.206] | [0.205] | | | [0.205] |
| $dens^{L\ RCA^{World}}$ | | 0.016* | | | | |
| | | [0.009] | | | | |
| $dens^{L\ RCA^{05}}$ | | | 0.020*** | | | |
| | | | [0.006] | | | |
| $dens^{L\ Norm}$ | | | | 6.409** | | |
| | | | | [2.676] | | |
| $dens^{F\ Norm}$ | | | | 37.530*** | | |
| | | | | [0.906] | | |
| $\phi^l$ | | | | | 0.049*** | |
| | | | | | [0.008] | |
| $\phi$ | | | | | 0.153*** | |
| | | | | | [0.004] | |
| $dens^R$ | | | | | | 0.045*** |
| | | | | | | [0.008] |
| $Size$ | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $LP$ | 0 | 0 | 0 | 0 | 0 | 0 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Importer$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Exporter$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Foreign$ | 0.009*** | 0.009** | 0.010** | 0.008*** | 0.009*** | 0.010** |
| | [0.003] | [0.004] | [0.004] | [0.003] | [0.003] | [0.004] |
| $Multi-plant$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $RCA^l$ | 0.001*** | | 0.001*** | 0.001*** | 0.001*** | |
| | [0.000] | | [0.000] | [0.000] | [0.000] | |
| $RCA^{l^{World}}$ | | 0.000*** | | | | |
| | | [0.000] | | | | |
| $RCA^R$ | | | | | | 0.002*** |
| | | | | | | [0.000] |
| **FE:** | | | | | | |
| Year | y | y | y | y | y | y |
| Product | y | y | y | y | y | y |
| Firm | y | y | y | y | y | y |
| Observations | 895,823 | 897,344 | 897,344 | 897,344 | 897,344 | 897,344 |
| R-squared | 0.082 | 0.081 | 0.082 | 0.089 | 0.088 | 0.082 |

$^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are one-year-lags of the corresponding variables.
Column 1 tests for the logarithmic transformation of the density indicators. Columns 2 and 3 test for the local density measures built by computing the local RCA indicator as the provincial product share over the world export share and by selecting the local RCA products as the ones displaying a RCA index above 0.5 rather than above 1, respectively. In Column 4 firm and local density have been normalised by dividing them by the total number of firm products and the total number of local RCA products. Column 5 explores the role of firm and local proximity indicators. In column 6 the NUTS 3 local density indicator has been replaced by the more aggregated NUTS 2 local density indicator.

## Table 6: Robustness - Further Controls and Firm Level Determinants

| | [1] | [2] | [3] | [4] | [5] | [6] |
|---|---|---|---|---|---|---|
| | **Inclusion of randomly selected 20% of Non Innovators** | **Exclusion of Istanbul** | **Drop of Provinces with less than 20 firms in AIPS** | **Nr. of Products in Firm and Province** | **Local Production Value** | **Further Firm Controls** |
| $dens^l$ | 0.012*** | 0.055** | 0.042*** | 0.077*** | 0.030*** | 0.037*** |
| | [0.003] | [0.025] | [0.008] | [0.010] | [0.008] | [0.008] |
| $dens$ | 1.037*** | 2.327*** | 1.861*** | 3.703*** | 1.851*** | 2.287*** |
| | [0.142] | [0.419] | [0.206] | [0.202] | [0.205] | [0.204] |
| $Size$ | 0 | 0.003 | 0.001 | 0.004*** | 0.001 | 0.003* |
| | [0.000] | [0.002] | [0.001] | [0.001] | [0.001] | [0.001] |
| $LP$ | 0 | 0 | 0 | 0 | 0 | 0 |
| | [0.000] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Importer$ | 0 | 0 | -0.001 | 0 | -0.001 | -0.001 |
| | [0.000] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Exporter$ | 0 | 0.001 | 0 | -0.001 | -0.001 | 0 |
| | [0.000] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $Foreign$ | 0 | 0 | 0.010** | 0.007 | 0.010** | 0.013*** |
| | [0.002] | [0.000] | [0.004] | [0.005] | [0.004] | [0.005] |
| $Multi-plant$ | 0 | 0.001 | 0.002 | 0.002* | 0.001 | 0.002 |
| | [0.000] | [0.002] | [0.001] | [0.001] | [0.001] | [0.001] |
| $RCA^L$ | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| $N$ | | | | -0.031*** | | |
| | | | | [0.001] | | |
| $N^{RCA\ L}$ | | | | -0.011*** | | |
| | | | | [0.002] | | |
| $y_l$ | | | | | 0.000*** | |
| | | | | | [0.000] | |
| $R\&D$ | | | | | | 0.027** |
| | | | | | | [0.013] |
| $w$ | | | | | | -0.001 |
| | | | | | | [0.002] |
| $Multi-product$ | | | | | | -0.019*** |
| | | | | | | [0.001] |
| **FE:** | | | | | | |
| Year | y | y | y | y | y | y |
| Product | y | y | y | y | y | y |
| Firm | y | y | y | y | y | y |
| Observations | 1,642,911 | 415,209 | 891,101 | 897,344 | 897,344 | 897,344 |
| R-squared | 0.059 | 0.076 | 0.082 | 0.085 | 0.082 | 0.083 |

$^{*}p < 0.10$;$^{**}$ $p < 0.05$;$^{***}$ $p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are one-year-lags of the corresponding variables.
In Column 1 a randomly selected sample of 20% of innovators is included in the estimation. In Columns 2 and 3 firms with at least one plant located in the Istanbul province and firms located in all the provinces for which AIPS presents less than 20 firms have been excluded from the analysis, respectively. Column 4 controls for the number of products produced by the firm, $N$, and the number of local RCA products, $N^{RCA\ L}$. Column 5 controls for the local value of production in the product, $y_l$. Column 6 finally adds further firm level variables: the share of R&D workers, $R\&D$, the average wage, $w$, and a dummy for multi-product firms, $Multi-product$.

is not driven by the omission of some further important time-varying firm level characteristics possibly driving a firm's choice of products to add to its product basket. We thus include the share of R&D workers, the average wage and a dummy for multi-product firms. The latter are found to have a lower propensity to innovate, whereas a higher share of $R\&D$ workers is positively related to a larger extent of product innovation.
Our insights are unchanged in all cases.

We further tested the robustness of our findings to alternative sample compositions and modelling choice and results are shown in Tables A.2-A.3 in the Appendix.
The first Table shows results stemming from different sample selection rules. On the one hand, we differently select our sample within our basic *conservative* definition of new product as a new HSCPA product within any of the two digits previously produced by the firm. First, in column 1, we randomly select the set of new potential products in order to account for the low percentage of product innovations in our sample. We thus repeat our baseline estimation on a subsample obtained by a random draw of 10% of the zero values in order to take into account the low percentage of 1 we have[13]. Second, in column 2, we restrict the analysis to the sample of new potential products belonging to the same 2 digit NACE code where the firm was already producing to have a homogenous definition of 1s and 0s values. Thus, we discard those products whose production was actually initiated, but whose NACE code falls outside any of the firm's 2 digit NACE code. Third, in column 3, we focus on the sample of new potential products belonging to any 2 NACE code where the firm was active, but which do not belong to any 4digit NACE code where the firm was already producing. In all these cases we adopt a narrower diversification definition and nevertheless our main findings are unchanged. On the other hand, in columns 4 to 8, we expand the number of possible product choices by considering all of the 1297 possible HCPA products present in our database as new potential products. In this respect, we also include those products belonging to those two digit codes where the firm is not active in firms' innovation possibilities set (Neffke and Henning, 2013). In this respect, we also consider a more radical definition of innovation. However, this choice substantially increases the number of potential firm-product combinations to include in our analysis. Due to computational constraints, we implement this analysis by year and by selecting the 10% of combinations. This set of results confirms the relevance of firm and local technological relatedness for the introduction of new products.

Finally, in Table A.3 in the Appendix we present estimates of nonlinear models for the firm's product choice. As running a conditional logit for the whole sample was computationally unfeasible, we present estimates of a conditional logit model by year in columns 1 to 4. Finally, the significance of our variables of interest is confirmed in logit, rare event logit[14] and probit models.

## 4.3 Does Firm Heterogeneity shape the role of capabilities?

Results from the previous Tables show the importance of the existing firm and local capabilities as a driver of firms' product space evolution. However, they also reveal that firm level heterogeneity hardly directly affects the choice of which product to introduce. This can be driven by the introduction of fixed effects in the model with the short time span at our disposal. However, a further possibility is that, rather than exerting a direct effect, firm heterogeneity

[13]We also tested for different shares of zero observations.
[14]The ReLogit STATA command has been used.

dimensions may act as a mediating factor of local and firm product specific capabilities absorption. The existing set of local capabilities around a product could exert heterogeneous effects according to different endowment levels of firm internal resources and according to the extent of diversity of the firm specific environment. On the one hand, as larger, more productive, R&D intensive firms and firms producing more sophisticated goods own an important stock of knowledge on their own, their extent of innovation could be less affected by the local pool of product specific capabilities. They could then be more autonomous in their innovation efforts than smaller, less productive and less R&D intensive firms and firms producing simple goods. On the other hand, internationalised firms such as multi-plant firms are active in a larger number of diverse domestic, international and more knowledge intensive networks - i.e. foreign networks made up of more competitive and productive firms - and, as a consequence, can draw on several pools of different knowledge stocks. Their exposure to multiple environments reduces the contribution of product specific capabilities available in a particular geographical location to their innovation effort.
In a dynamic capabilities perspective, all these firm internal and *environmental* features allow firms to better grasp and exploit new opportunities across available technologies and existing markets (Teece, 2007). Thus, we repeat the estimation in equation 4.2 for different groups of firms and we compare small vs large firms, high vs low productivity firms, high vs low product sophistication firms and high vs low $R\&D$ employment share firms. Product sophistication is measured *à la* Hausmann et al. (2007) by means of the *Prody* indicator. Finally, to account for heterogeneous environmental exposure of firms we compare multi vs single plant firms, exporters vs non exporters, regular exporters vs non regular exporters, importers vs non importers, foreign owned vs domestic firms.

Results are shown in Tables 7 and 8 where the last four rows present the Wald test for equality of the density coefficients of the two groups which are compared, group A and group B.[15] Table 7 focuses on heterogeneous effects according to different levels of some specific firm level characteristics and highlights that the coefficient on the local density is significantly higher for smaller than for larger firms. Among the remaining groups no statistically significant difference emerges in the local density coefficient estimates. Interestingly enough, firm density is statistically higher for firms producing less complex products, as the role of firm internal capabilities shrinks when firms are engaged in the production of more sophisticated goods. The coefficients estimates for High and Low $R\&D$ employment share firms would imply a higher return from internal resources for High $R\&D$ firms and a higher return from local resources for the Low $R\&D$ ones. These results are in line with the higher ability of High $R\&D$ firms to innovate on the bases of their own skills and the greater Low $R\&D$ firms' need of the local pool of capabilities to introduce new products. However, possibly due to the low number of $R\&D$ intensive firms in the sample, the differences between the two sets of coefficients are not statistically significant, possibly due to the small number of firms hiring R&D workers in our sample.

From Table 8, instead, it emerges that the coefficient on local density is statistically significantly lower for multi-plant, exporting and importing firms. As expected, these firms are less affected by the local pool of capabilities when introducing a new product. From the Table, an interesting finding concerns regular exporters. Our data, indeed, allows for the identification of export products that are actually produced by the firm and export products that

[15]The two groups are defined as above and below the median of the corresponding indicator. As an example Large and Small firms are those whose labour units are above/equal or below the median of the variable $size$ that identifies the number of employed persons in the firm.

correspond to a pure intermediary activity of the firm. Regular exporters are exporters that export at least one of their products. Coefficient estimates imply a higher return from firm capabilities in terms of innovation for this group of firms compared to non-regular exporters. This result could suggest that higher export embeddedness in the firm productive capabilities enhances the acquisition and exploitation of product specific knowledge. Thus, among exporters, own product exporters are more able to employ their own internal resources to innovate. Finally, no statistically significant difference emerges between foreign and domestic firms, although the coefficients of the two density measures are significant only on the domestic firms' sub-sample. This outcome, however, could be driven by the much lower number of foreign owned firms in our sample.

## Table 7: Results - Heterogeneous internal resources

| | [1] | | [2] | | [3] | | [4] | |
|---|---|---|---|---|---|---|---|---|
| | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** |
| | **Large** | **Small** | **High Productivity** | **Low Productivity** | **High *Prody*** | **Low *Prody*** | **R&D** | **No R&D** |
| $dens^l$ | 0.030*** | 0.066*** | 0.037*** | 0.065*** | 0.046*** | 0.042*** | 0.031* | 0.045*** |
| | [0.011] | [0.014] | [0.011] | [0.016] | [0.012] | [0.012] | [0.019] | [0.009] |
| $dens$ | 2.357*** | 2.089*** | 2.150*** | 2.594*** | 0.706** | 2.087*** | 2.886*** | 1.909*** |
| | [0.279] | [0.288] | [0.310] | [0.295] | [0.306] | [0.239] | [0.817] | [0.215] |
| $Size$ | | | -0.001 | 0.001 | -0.002 | 0.001 | 0.001 | 0.001 |
| | | | [0.002] | [0.002] | [0.001] | [0.002] | [0.004] | [0.002] |
| $LP$ | 0 | -0.002* | | | -0.001 | 0 | -0.001 | 0 |
| | [0.001] | [0.001] | | | [0.001] | [0.001] | [0.003] | [0.001] |
| $Exporter$ | -0.003 | -0.001 | -0.003 | 0.002 | -0.001 | -0.001 | -0.012* | 0 |
| | [0.003] | [0.002] | [0.003] | [0.002] | [0.001] | [0.002] | [0.006] | [0.001] |
| $Importer$ | -0.004 | 0.002 | -0.003 | 0 | -0.001 | -0.002 | 0.005 | -0.001 |
| | [0.003] | [0.002] | [0.002] | [0.002] | [0.001] | [0.002] | [0.004] | [0.001] |
| $Foreign$ | 0.017** | 0.002 | 0.013 | 0.002 | 0.008* | 0.009 | 0.013 | 0.011* |
| | [0.008] | [0.007] | [0.009] | [0.005] | [0.005] | [0.009] | [0.013] | [0.006] |
| $Multi-plant$ | 0 | 0.003 | -0.001 | 0.003 | 0 | 0.004 | -0.004 | 0.002* |
| | [0.002] | [0.002] | [0.002] | [0.002] | [0.001] | [0.002] | [0.006] | [0.001] |
| $RCA^L$ | 0.002*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.002*** | 0.001*** | 0.001*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| **FE:** | | | | | | | | |
| Year | y | y | y | y | y | y | y | y |
| Product | y | y | y | y | y | y | y | y |
| Firm | y | y | y | y | y | y | y | y |
| Observations | 438,368 | 458,976 | 448,340 | 449,004 | 447,746 | 449,598 | 83184 | 814160 |
| R-squared | 0.088 | 0.084 | 0.078 | 0.095 | 0.069 | 0.098 | 0.09 | 0.084 |
| **Tests:** | | | | | | | | |
| $\alpha_1^A = \alpha_1^B$ | | 4.036 | | 0.049 | | 0.391 | | 0.46 |
| P-value | | 0.045 | | 0.144 | | 0.825 | | 0.498 |
| $\alpha_2^A = \alpha_2^B$ | | 0.447 | | 12.62 | | 27.856 | | 1.335 |
| P-value | | 0.504 | | 0.3 | | 0 | | 0.248 |

$^*p < 0.10$;$^{**}$ $p < 0.05$;$^{***}$ $p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are one-year-lags of the corresponding variables.
Regressions are separately estimated for firms in groups A and B. The two groups are identified as above and below the median values of firm size, productivity, firm $Prody$ and R&D employment share. The value of the t-test for the difference between the coefficients of the two groups and the their p-value are reported at the bottom of the table.

Table 8: Results - Heterogeneous environmental resources

| | [1] | | [2] | | [3] | | [4] | | [5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** |
| | **Multi-Plant** | **Single-Plant** | **Exporters** | **Non Exporters** | **Regular Exporters** | **Non Regular Exporters** | **Importers** | **Non Importers** | **Foreign** | **Domestic** |
| $dens^l$ | 0.027** | 0.090*** | 0.035*** | 0.082*** | 0.034*** | 0.053*** | 0.027*** | 0.114*** | 0.038 | 0.039*** |
| | [0.013] | [0.013] | [0.010] | [0.016] | [0.011] | [0.011] | [0.008] | [0.018] | [0.025] | [0.008] |
| $dens$ | 2.216*** | 2.026*** | 2.116*** | 2.105*** | 2.971*** | 1.973*** | 2.072*** | 2.047*** | 0.629 | 1.896*** |
| | [0.370] | [0.256] | [0.263] | [0.394] | [0.312] | [0.297] | [0.231] | [0.532] | [1.439] | [0.203] |
| $Size$ | 0.003 | 0 | 0 | 0.001 | -0.004 | 0.002 | 0.001 | 0.003 | 0.002 | 0.001 |
| | [0.003] | [0.002] | [0.002] | [0.003] | [0.003] | [0.002] | [0.002] | [0.003] | [0.008] | [0.001] |
| $LP$ | 0 | -0.001 | 0 | 0.002 | -0.001 | 0 | 0 | 0 | 0.003 | 0 |
| | [0.001] | [0.001] | [0.001] | [0.002] | [0.001] | [0.001] | [0.001] | [0.002] | [0.004] | [0.001] |
| $Exporter$ | -0.002 | 0 | | | | | -0.004* | 0.002 | -0.015* | 0 |
| | [0.003] | [0.002] | | | | | [0.002] | [0.002] | [0.008] | [0.001] |
| $Importer$ | -0.002 | -0.001 | -0.001 | -0.004** | -0.001 | -0.003** | | | 0.012*** | -0.001 |
| | [0.003] | [0.002] | [0.002] | [0.002] | [0.003] | [0.002] | | | [0.003] | [0.001] |
| $Foreign$ | 0.007 | 0.015** | 0.012** | 0 | 0.011* | 0.016*** | 0.012** | 0.014** | | |
| | [0.006] | [0.006] | [0.006] | [0.000] | [0.006] | [0.003] | [0.005] | [0.006] | | |
| $Multi-plant$ | | | 0.001 | 0.006** | 0.001 | 0.003 | -0.001 | 0.004** | -0.002 | 0.002 |
| | | | [0.002] | [0.003] | [0.003] | [0.002] | [0.002] | [0.002] | [0.006] | [0.001] |
| $RCA^L$ | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.001*** | 0.002*** | 0.001*** | 0 | 0.001*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| **FE:** | | | | | | | | | | |
| Year | y | y | y | y | y | y | y | y | y | y |
| Product | y | y | y | y | y | y | y | y | y | y |
| Firm | y | y | y | y | y | y | y | y | y | y |
| Observations | 301,654 | 595,690 | 559,377 | 337,967 | 363,374 | 533,970 | 573,304 | 324,040 | 27,047 | 870,297 |
| R-squared | 0.085 | 0.085 | 0.082 | 0.095 | 0.087 | 0.088 | 0.083 | 0.095 | 0.141 | 0.083 |
| **Tests:** | | | | | | | | | | |
| $\alpha_1^A = \alpha_1^B$ | | 11.397 | | 6.252 | | 1.472 | | 18.803 | | 0.002 |
| P-value | | 0.001 | | 0.012 | | 0.225 | | 0 | | 0.962 |
| $\alpha_2^A = \alpha_2^B$ | | 0.177 | | 0 | | 5.368 | | 0.002 | | 0.76 |
| P-value | | 0.674 | | 0.983 | | 0.021 | | 0.966 | | 0.383 |

$^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are one-year-lags of the corresponding variables.
Regressions are separately estimated for firms in groups A and B. The two groups are identified on the basis of the following firm status: multi-plant firm, exporter, regular exporter, importer and foreign owned firm.

**Contribution of local and firm product specific resources to innovation rates by firm groupings -** Table 9 shows back of the envelope calculations to assess what would happen to innovation rates in each group of firms if firm and local densities for non innovating firm-product pairs jumped to the values observed for innovating firm-product pairs.[16] Thus we take the observed differences of densities between observations with $I_{ip} = 1$ and observations with $I_{ip} = 0$, multiply them by the estimated coefficients on local and firm densities, respectively, and divide them by the group's observed innovation rate ,$I_{ip}$%. Thus we get how much of the observed innovation rate is explained by firm and local product specific capabilities.
In line with the previous results concerning different levels of firm internal resources, a higher relative importance of local capabilities for smaller firms emerges. In addition, we find that the contribution of the local environment is much higher, both in absolute and relative terms, for less productive and non R&D intensive firms, regardless of any statistically significant difference in the coefficient estimates. The contribution of the local set of product specific capabilities is much higher for less complex products in absolute terms, although only local resources appear to drive the innovation rate of more complex firm-product pairs.
Turning to firm heterogeneity based on firms' exposure to more or less diverse environments, the Table shows that the local environment particularly affects innovation rates of single plant and non internationalised firms, while firm internal resources,both in absolute and relative terms, have a much more relevant role for regular exporters and for importers especially. Thus we do find some differences in the observed relative contribution of firm internal resources for large, R&D intensive, highly productive, multi-plant and internationalised firms, regardless of the lack of a statistically significant difference in coefficient estimates.

# 5 Conclusions

This paper has explored whether and how local and firm product specific *capabilities* shape firms' introduction of new products in the context of the Turkish economy. The empirical analysis has revealed a number of interesting facts. Firstly, firms' product choices are characterised by strong path dependence. The availability of internal and local competencies that are technologically and, thus, cognitively proximate to those required for the new product indeed explain the product scope evolution of innovators. Secondly, we find that firm internal resources are more relevant than the local set of available product specific knowledge in the process of new product choice. Thirdly, firm heterogeneity acts as a mediating factor of the impact of firm and local product specific capabilities. Firm size and international exposure play a role in relaxing ties with the local environment for a given level of firm internal product specific resources, while firm regular export activity and low production complexity enhance the role of firm product competencies for a given level of local product specific capabilities. All this evidence thus suggests that the positive industrial output dynamics experienced by Eastern regions is mainly driven by firm internal product specific resources. Product innovation in more advanced regions, instead, rests more on local competencies, possibly due to local firms' involvement in relatively more complex productions which importantly hinge on the availability of a wide and thick pool of diverse knowledge.

Compared to existing related literature, our analysis, therefore, extends the importance of product relatedness and cognitive proximity from the export performance of firms and

[16] For convenience of exposition, we omit calculations for the subgroups of domestic and foreign firms, as no significant difference actually emerged in the previous Table.

Table 9: Contribution of Local and Firm Capabilities by Firm Groupings

| | **Large** | **Small** | **High Productivity** | **Low Productivity** | **High *Prody*** | **Low *Prody*** | **R&D** | **No R&D** |
|---|---|---|---|---|---|---|---|---|
| $dens^l(I_{ip}=1) - dens^l(I_{ip}=0)$ | 0.032 | 0.035 | 0.035 | 0.035 | 0.006 | 0.046 | 0.016 | 0.002 |
| $dens(I_{ip}=1) - dens(I_{ip}=0)$ | 0.003 | 0.002 | 0.003 | 0.003 | 0.00004 | 0.004 | 0.035 | 0.003 |
| | **Observed Innovation Rate** | | | | | | | |
| $I_{ip}\%$ | 1.9% | 1.7% | 1.7% | 1.9% | 1.25% | 2.38% | 1.41% | 1.82% |
| | **Contribution of Local and Firm Capabilities to the Observed Innovation Rate** | | | | | | | |
| $\alpha_1 * \frac{dens^l(I_{ip}=1)-dens^l(I_{ip}=0)}{I_{ip}}\%$ | 5.1% | 13.6% | 7.7% | 11.9% | 2.24% | 8.17% | 3.46% | 8.60% |
| $\alpha_2 * \frac{dens(I_{ip}=1)-dens(I_{ip}=0)}{I_{ip}}\%$ | 42.9% | 29.0% | 39.6% | 39.7% | 0.21% | 35% | 42.55% | 31.27% |
| | **Multi-Plant** | **Single-Plant** | **Exporters** | **Non Exporters** | **Regular Exporters** | **Non Regular Exporters** | **Importers** | **Non Importers** |
| $dens^l(I_{ip}=1) - dens^l(I_{ip}=0)$ | 0.034 | 0.032 | 0.031 | 0.037 | 0.036 | 0.032 | 0.036 | 0.032 |
| $dens(I_{ip}=1) - dens(I_{ip}=0)$ | 0.032 | 0.003 | 0.003 | 0.003 | 0.004 | 0.002 | 0.004 | 0.002 |
| | **Observed Innovation Rate** | | | | | | | |
| $I_{ip}\%$ | 1.83% | 1.75% | 1.75% | 1.83% | 1.72% | 1.82% | 1.82% | 1.72% |
| | **Contribution of Local and Firm Capabilities to the Observed Innovation Rate** | | | | | | | |
| $\alpha_1 * \frac{dens^l(I_{ip}=1)-dens^l(I_{ip}=0)}{I_{ip}}\%$ | 5.1% | 16.6% | 6.2% | 16.6% | 7.0% | 9.4% | 5.0% | 19.6% |
| $\alpha_2 * \frac{dens(I_{ip}=1)-dens(I_{ip}=0)}{I_{ip}}\%$ | 35.7% | 34.2% | 36.4% | 31.9% | 64.3% | 26.4% | 41.0% | 19.4% |

regions to firm innovation activity and confirms that studying firm innovation patterns requires taking into account firm internal resources, besides the role of the local endowment of related product specific capabilities. Nonetheless, our work clarifies that the local production structure importantly shapes the performance of "weaker" firms.

Some policy implications spring from our work. On the one hand, the evidence on path dependence supports ongoing policy actions in favour of the cluster formation around new products to engender local industrial development. On the other hand, policy makers should sustain firm growth and international activities that can lead to higher innovation rates and favour a break with the dependence on historical local specialisation and thus promote regional production diversification.

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# Appendix

## A Additional Tables

Table A.1: Variables Definition and Description

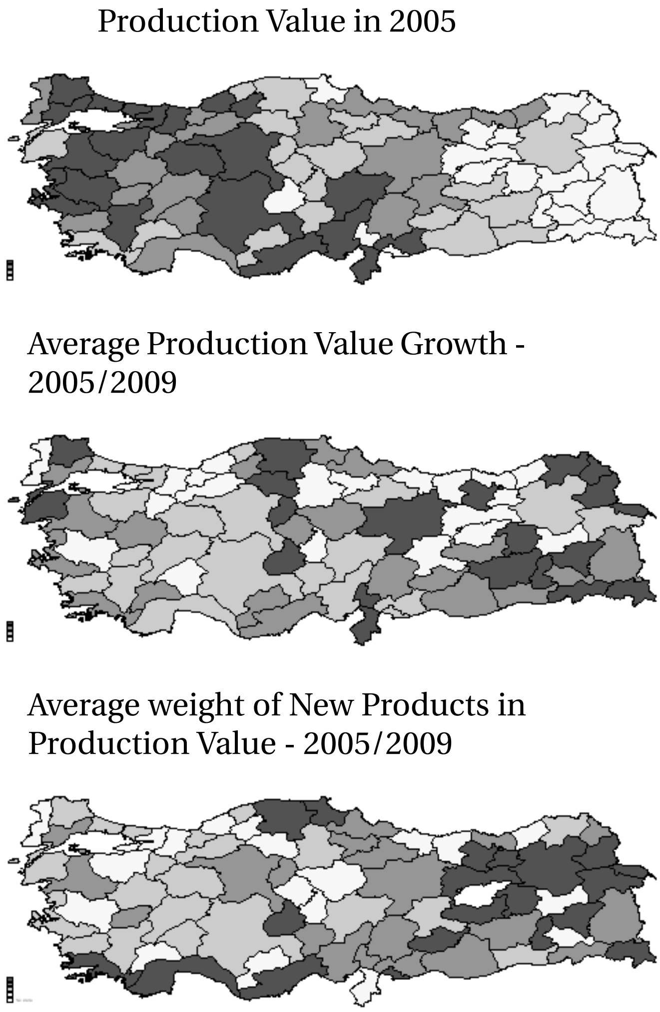
| Variable | Description |
|---|---|
| $Size$ | firm size measured as the log of the number of employees |
| $LP$ | labour productivity measured as the log of real value added per worker |
| $Exporter$ | exporter dummy equal to 1 if the firm exports in that year and 0 otherwise |
| $Importer$ | importer dummy equal to 1 if the firm imports and 0 otherwise |
| $Foreign$ | foreign ownership dummy equal to 1 if the firm is foreign owned |
| $Multi-plant$ | multi-plant dummy equal to 1 if the firm has more than one production unit and 0 otherwise |
| $R\&D$ | share of $R\&D$ workers in total employment |
| $w$ | log of average wage, calculated as the log of the total wage bill over number of employees |
| $Multi-product$ | multi-product dummy equal to 1 if the firm produces more than one product and 0 otherwise |
| $RCA^l$ | RCA index. For each product is calculated as $\frac{\frac{y_{pl}}{\sum_{j=1}^{N} y_{jl}}}{\frac{\sum_{l=1}^{L} y_{pl}}{\sum_{l=1}^{L}\sum_{j=1}^{N} y_{jl}}}$ where in the formula $L$ is the total number of NUTS3 provinces in the Turkish economy, and $y$ denotes the value of production |
| $N$ | log of the number of products produced by the firm |
| $N^{RCA\ l}$ | log of the number of products with RCA in the province(s) where the firm is active |
| $Logdens$ | log of density indicator described in equation 1 |
| $Logdens^l$ | log of density indicator described in equation 2 |
| $y_l$ | log of average local production value in the product calculated as: $Logy_l = Log[\sum_{l=1}^{L_i} s_l y_{pl}]$ with $\sum_{l=1}^{L_i} s_l = 1\ \forall i$ |
| $dens^{l\ RCA^{World}}$ | local density measure calculated as in equation 2, but with the set of RCA products selected on the basis of $RCA = \frac{\frac{y_{pl}}{\sum_{j=1}^{N} y_{jl}}}{\frac{WorldExports_p}{TotalWorldExports}}$ |
| $dens^{l\ RCA^{05}}$ | average local density measure calculated as in equation 2, but with the set of RCA products selected on the basis of $RCA > 0.5$ |
| $dens^{Norm}$ | firm density measure from equation 1 divided by the total number of products that the firm produces |
| $dens^{l\ Norm}$ | average local density measure where local densities in equation 2 are divided by the number of RCA products in each NUTS 3 Province |
| $dens^R$ | average local density measure calculated in equation 2 on the basis of NUTS 2 regions locations |
| $RCA^R$ | RCA index. For each product is calculated as $\frac{\frac{y_{pr}}{\sum_{j=1}^{N} y_{jr}}}{\frac{\sum_{r=1}^{R} y_{pr}}{\sum_{r=1}^{R}\sum_{j=1}^{N} y_{jr}}}$ where in the formula $R$ is the total number of NUTS2 regions in the Turkish economy, and $y$ denotes the value of production |

## Table A.2: Robustness - Alternative Diversification Definitions

| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] |
|---|---|---|---|---|---|---|---|---|
| | **Conservative Diversification** | | | **Radical Diversification** | | | | |
| | **Within Produced 2 Digit Codes** | | | **Outside Produced 2 Digit Codes** | | | | |
| | **Random Selection of 10% of Zeroes** | **Exclusion of New 2 digit Codes** | **Exclusion of Produced 4 Digit Codes** | **2006** | **2007** | **2008** | **2009** | **Random Selection of 10% of Zeroes** |
| $dens^L$ | 0.247*** | 0.030*** | 0.014*** | 0.009*** | 0.007*** | 0.011*** | 0.011*** | 0.059*** |
| | [0.049] | [0.006] | [0.005] | [0.001] | [0.001] | [0.002] | [0.002] | [0.010] |
| $dens$ | 6.092*** | 1.953*** | 0.787*** | 2.610*** | 2.605*** | 2.496*** | 2.194*** | 13.677*** |
| | [0.782] | [0.184] | [0.158] | [0.079] | [0.081] | [0.106] | [0.085] | [0.257] |
| $Size$ | 0.007 | 0.001 | 0 | | | | | -0.003* |
| | [0.008] | [0.001] | [0.001] | | | | | [0.001] |
| $LP$ | -0.003 | 0 | 0 | | | | | 0 |
| | [0.004] | [0.001] | [0.000] | | | | | [0.001] |
| $Importer$ | -0.009 | -0.001 | -0.001 | | | | | -0.003** |
| | [0.008] | [0.001] | [0.001] | | | | | [0.001] |
| $Exporter$ | 0.004 | 0 | 0.001* | | | | | 0.001 |
| | [0.008] | [0.001] | [0.001] | | | | | [0.001] |
| $Foreign$ | 0.023 | 0.009** | 0.006 | | | | | 0.022** |
| | [0.031] | [0.004] | [0.006] | | | | | [0.009] |
| $Multi-plant$ | 0.003 | 0.002 | 0 | | | | | 0.001 |
| | [0.008] | [0.001] | [0.001] | | | | | [0.002] |
| $RCA^L$ | 0.006*** | 0.001*** | 0.001*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.002*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| **FE:** | | | | | | | | |
| Year | y | y | y | y | y | y | y | y |
| Product | y | y | y | y | y | y | y | y |
| Firm | y | y | y | y | y | y | y | y |
| Observations | 104256 | 893,401 | 762,795 | 4,531,279 | 3,109,521 | 2,499,714 | 2,795,065 | 1,190,127 |
| R-squared | 0.338 | 0.07 | 0.058 | 0.038 | 0.04 | 0.042 | 0.039 | 0.144 |

$^{*}p < 0.10;^{**}p < 0.05;^{***}p < 0.01$. Dependent variable: firm probability to introduce a new product.
Standard errors are clustered by firm. All regressors included in the estimation are one-year-lags of the corresponding variables.

Figure A.1: Turkish Manufacturing Production, 2005/2009



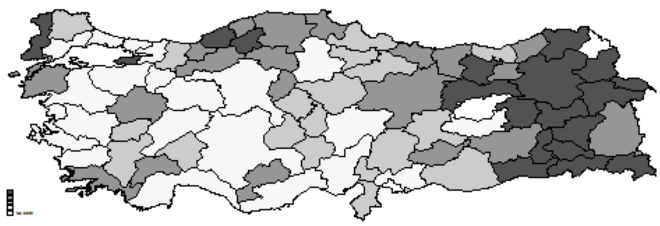

*Notes:* Quartiles of variables distribution are represented by means of different grey tonalities, with the darker ones identifying upper quartiles.
The top panel displays the NUTS3 spatial distribution of Turkish manufacturing production value. The middle panel chart displays the NUTS3 spatial distribution of Turkish manufacturing production value average growth. The lower panel chart displays the NUTS3 spatial distribution of the 2005-2009 average weight of new products in manufacturing production value.
*Source:* TurkStat SBS and AIPS. Own calculations.

## Table A.3: Robustness - Alternative Modelling Choice

| | [1] | [2] | [3] | [4] | [5] | [6] | [7] |
|---|---|---|---|---|---|---|---|
| | | **Conditional Logit** | | | **Logit** | **RELogit** | **Probit** |
| | **2006** | **2007** | **2008** | **2009** | | | |
| $dens$ | 24.904*** | 26.243*** | 18.504*** | 13.972*** | 75.445*** | 75.447*** | 34.051*** |
| | [2.449] | [2.887] | [3.444] | [3.315] | [1.722] | [1.722] | [0.756] |
| $dens^l$ | -0.161 | 0.279** | 0.538*** | 0.228* | 0.808*** | 0.808*** | 0.310*** |
| | [0.108] | [0.131] | [0.141] | [0.129] | [0.080] | [0.080] | [0.031] |
| $Size$ | 0.007 | 0.031 | 0.028 | 0.002 | 0.039*** | 0.039*** | 0.014** |
| | [0.016] | [0.022] | [0.025] | [0.022] | [0.015] | [0.015] | [0.006] |
| $LP$ | 0.006 | -0.015 | -0.043* | -0.047* | -0.075*** | -0.075*** | -0.030*** |
| | [0.016] | [0.023] | [0.025] | [0.025] | [0.014] | [0.014] | [0.006] |
| $Importer$ | -0.015 | 0.061 | 0.022 | 0.009 | -0.108*** | -0.108*** | -0.043*** |
| | [0.036] | [0.041] | [0.045] | [0.044] | [0.028] | [0.028] | [0.011] |
| $Exporter$ | -0.022 | -0.022 | 0.041 | 0.003 | -0.056** | -0.056** | -0.024** |
| | [0.032] | [0.037] | [0.043] | [0.041] | [0.025] | [0.025] | [0.010] |
| $Foreign$ | -0.086 | 0.242** | -0.026 | 0.021 | -0.051 | -0.05 | -0.013 |
| | [0.085] | [0.097] | [0.134] | [0.130] | [0.064] | [0.064] | [0.026] |
| $Multi-plant$ | -0.036 | -0.043 | -0.018 | -0.042 | 0.03 | 0.03 | 0.013 |
| | [0.031] | [0.036] | [0.040] | [0.039] | [0.024] | [0.024] | [0.010] |
| $RCA^L$ | 0.039*** | 0.035*** | 0.040*** | 0.035*** | 0.034*** | 0.034*** | 0.018*** |
| | [0.002] | [0.002] | [0.002] | [0.002] | [0.001] | [0.001] | [0.000] |
| Observations | 225,853 | 135,002 | 99,357 | 122,709 | 897,344 | 897,344 | 897,344 |

$^{*}p < 0.10;^{**} p < 0.05;^{***} p < 0.01$. Standard errors are clustered by firm. All regressors included in the estimation are lagged to one year.
Year fixed effects are included in all specifications.

## Figure A.2: Relative Contribution of $dens$



*Notes:* Quartiles of variables distribution are represented by means of different grey tonalities, with the darker ones identifying upper quartiles.
The map displays the NUTS3 spatial distribution of the relative importance of firm density in explaining NUTS 3 region average innovation rates, $I_{ipt} : \frac{\alpha_2 * dens}{\alpha_1 * dens^l + \alpha_2 * dens}$.
*Source:* TurkStat SBS and AIPS. Own calculations.