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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 that, 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 linked to the evolution of their industrial output, is mainly affected by firm's internal product-specific resources. On the contrary, product innovations in Western advanced regions hinge relatively more on the availability of local technological- related competencies.

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1. Introduction

A recent body of literature has highlighted the role of technological relatedness for starting a new sector in a country (Hausmann and Hidalgo, 2009; Hidalgo, 2009), a region (Boschma and Iammarino, 2009; Neffke et al., 2011; Boschma et al., 2012, 2013) or a firm (Breschi et al., 2003; Poncet and de Waldemar, 2012; Neffke and Henning, 2013). In particular, empirical work in economic geography has shown that knowledge spillovers can spur innovation and growth across economic units located in space, as long as the *right*—not too little, not too much (Nooteboom, 2000; Boschma, 2005)—extent of cognitive proximity exists among the relevant economic actors. Therefore, the role of geography in determining economic phenomena is complemented and enlivened by the notion of technological relatedness. The latter also mediates the impact of firms' internal resources on the process of firm expansion. Some firm-level analyses in the field, indeed, have stressed that firms tend to diversify in sectors that are technologically close to their core activity (Breschi et al., 2003; Neffke and Henning, 2013).

The relevance of both within-firm and local cognitive proximities for innovation recalls an important literature debate on the quantification of the absolute and relative contribution of the existence of a fertile regional environment versus a firm's endowment of suitable capabilities for product innovation (Pfirrmann, 1994; Sternberg and Arndt, 2001; Beugelsdijk, 2007; Wang and Lin, 2012).

In this article, we stand at the crossroads of these two streamlines of research and investigate the importance of firm and local technological relatedness—measured *à la* Hidalgo et al. (2007)—in shaping the evolution of firms' product space in Turkey during the period 2005–2009.

The introduction of new products represents a key factor for countries' long-run prosperity. The continuous discovery of new production opportunities, indeed, carries ahead the process of creative destruction from which economic development takes off. Understanding how countries' production structure evolves, though, entails looking at firms' innovative behaviour and at their knowledge accumulation process, which can be both path- and place-dependent (Heimeriks and Boschma, 2014). We, therefore, explore whether a firm's decision over new product addition is affected by cognitive closeness between the new products, on the one side, and the existing firm own and local—NUTS 3 region—product baskets, on the other.

The investigation of this topic in the case of an emergent economy can be considered of particular interest. On the one hand, product innovation in these economies represents an opportunity to upgrade the production structure towards more sophisticated goods and, thus, to promote higher growth (Hausmann et al., 2007). On the other hand, compared with advanced economies, rapid and recent industrialisation countries are usually characterised by initial important ancestral differences in the geographical distribution of economic activities. They, therefore, constitute a good empirical setting for studying the birth and evolution of clustering of industries across space and firms, as the pace of industrialisation accelerates.

With this article, we aim at making three contributions: firstly, we focus on and assess the impact of both firm and local *product*-specific capabilities on a firm's decision over which products to add to its existing portfolio. For the first time to our knowledge, we exploit firm product-level data and inspect firms' product choices, conditional on their status of innovators. This is, in our view, the natural framework in which to analyse path and place dependence in the introduction of new products. As a matter of fact, differently from previous work on the role of within firm and local resources for the overall firms' innovation propensity, our empirical setting allows to identify the product-specific nature of firm and local competencies and to test its effectiveness in shaping the product space of firms. We, therefore, extend the country-level evidence on path dependence in the productive structures' evolution (David, 1985; Arthur, 1989; Hidalgo, 2009; Hausmann and Hidalgo, 2009, 2011) to the firm level and explain the emergence and persistence of geographically bounded product clusters that are at the basis of long-lasting differences across regions.

Secondly, our work explores the role of several dimensions of firm heterogeneity in terms of internal and environmental resources in relaxing the linkage between local and firm pre-existing capabilities and the evolution path of production. 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 they operate in. 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 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 proximities explain the innovation performance of firms and the evolution of the country's product space. Our analysis, thus, contributes to assess the outcome of recent cluster policies that aim at favouring the spatial diffusion of local industrial development. Policies should indeed be directed to avoid that path- and place-dependent engender negative lock-in processes in regional development.

This article is organised as follows: Section 2 reviews the relevant literature; Section 3 presents the sample, the data sources and our main relatedness indicators; Section 4 describes the empirical strategy and presents the results; Section 5 concludes.

2. Geography, technological relatedness, and the relative contribution of space and firm resources to product innovation

The literature has shown that knowledge externalities, which play a relevant role in economic growth (Arrow, 1962; Romer, 1986a,b; 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 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 environment 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 (Maskell and Malmberg, 1999; Gertler, 2003). However, geographical proximity is neither a necessary nor a sufficient condition for spurring knowledge across firms (Boschma, 2005). On the one hand, as the innovation process increasingly benefits from *learning by interacting* (Lundvall and Johnson, 1994), the social dimension of innovation gains in importance and relational proximity could substitute for the geographical one in fostering innovation. In this respect, the literature has shown that knowledge spillovers are localised, as long as the source of knowledge (e.g. inventors) is geographically bounded (Breschi and Lissoni, 2001; Boggs and Rantisi, 2003; Breschi and Lissoni, 2005, 2009). On the other hand, other types of proximity may be necessary to complement the spatial one in favouring the introduction of new products. In order to learn from the local knowledge pool, firms have to absorb the relevant knowledge and, thus, need to be cognitively proximate to the local environment (Boschma, 2005). As a consequence, the notions of geographical and cognitive proximities become intimately related (Baptista and Swann, 1998; Orlando, 2000; Autant-Bernard, 2001). More specifically, the concept of technological relatedness—meant as interactive learning among economic actors stemming from the existence of a certain degree of cognitive proximity among them (Timmermans and Boschma, 2014)—has, therefore, given new momentum to debate in the economic geography literature over the relative importance of regional variety versus specialisation in the mechanics of agglomeration externalities for innovation and growth. In this line, Boschma et al. (2012), recently, investigate the importance of diversification in related industries for regional value-added and employment growth in Spain at the NUTS 3 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. Focussing on regional competitiveness, Boschma et al. (2013) instead 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 relatedness to the national industrial structure. This hints at important complementarities between geographical and cognitive proximity in the spur of knowledge, although the work shows that 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 their diversification process. Their results confirm that technological relatedness—measured by a Revealed Relatedness indicator based on the ratio between industries' co-occurrences in regions' industrial structures and their predicted value—is important in rising regions' technological cohesion. Over the same period and for the same country, Neffke et al. (2012) find that plant survival is importantly and positively affected by technologically related localisation externalities. The role of relatedness between firms and the local pool of knowledge in Sweden is also confirmed by Boschma et al. (2009) who show the positive impact of intra-regional-related skill mobility on firms' productivity growth. 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 proposed by Frenken et al. (2007). Differently from other works, however, they highlight the important role of related extra-regional knowledge in shaping the process of regional economic growth. In this line, Timmermans and Boschma (2014) find that plants' productivity growth in Denmark is importantly fostered by the inflow of skills that are cognitively close to existing skills and, in particular, by inter-regional skilled labour mobility.

All the mentioned evidence suggests that a crucial role for the performance of economic entities is played by technological relatedness to the local or external pool of knowledge.

Technological proximity also matters within a firm's boundaries and is found to affect a firm's diversification process. Firm growth, indeed, can be viewed as a process of exploitation of productive opportunities (Penrose, 1959). Firms are 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 good.[1] Thus, product-specific capabilities can constitute an important knowledge base allowing firms to explore new production fields and diversify into technologically related products (Danneels, 2002). In this respect, on a sample of US, Italian, French, UK, German, and Japanese firms patenting to the European Patent Office from 1982 to 1993, Breschi et al. (2003) show that knowledge relatedness, measured on the basis of

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

the co-classification codes contained in patent documents, is a major determinant of firm diversification, measured as a firm's probability to be simultaneously active in a further 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 do play a role in the evolution of firms' production structure, firms' internal product-specific abilities are undoubtedly a key driver of their choice of new productions.

Actually, part of the literature on firm innovation has called into question the existence of a regional environment effect *tout-court*. By comparing the relative importance of firm and local resources and capabilities, Pfirrmann (1994) for a sample of Small and Medium Enterprises 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 firm-specific resources are generally more important than a firm's regional environment for any kind of product innovation. Although this literature casts a shadow on the relevance of inter-firm interactions within bounded territories for firm growth and diversification processes, in our view, the concept of technological relatedness can redeem the absolute and relative contribution of local knowledge by shedding light on the circumstances under which and to what extent a regional environment can matter for product innovation.

In this article, we, therefore, test and compare the impact of firm and local *product*-specific capabilities on the process of firm introduction of new products in the context of the Turkish emerging economy.

We expect both firm and local technological relatedness to drive a firm's choice over new product additions, nonetheless we believe that initial regional disparities could affect the relative importance of these two factors. As evolutionary economic geographers have argued, when starting brand new sectors/products, firms need to develop by themselves those *product/sector-specific* capabilities that cannot be retrieved in their location regions, which, instead, only provide general knowledge and skills (Boschma and Lambooy, 1999; Boschma and Frenken, 2006). This implies that firms' own knowledge is fundamental in all those cases where a relevant gap exists between the new products' requirements and the local supply of product-specific factors. Hence, conditionally on observing new product additions, we expect firm capabilities to represent the main driver of the product space evolution in Turkish laggard and peripheral regions. Owing to these areas' tiny product base, firms are less likely to retrieve locally the necessary specific resources. On the contrary, the relative contribution of regional product-specific factors should be higher in developed regions, which are endowed with a larger and diversified production structure and, as a consequence, knowledge base.

As a further step of our analysis, we inspect the role of firm heterogeneity in affecting the dependence of firms' product portfolio choices on the firm internal and local *product*-specific capabilities. On the one hand, a minor role of the environment should be recorded for large, internationalised, high Research & Development (R&D) intensive and high complexity firms. On the other hand, we expect firms' own knowledge to particularly affect product additions of the less complex firms. The latter, indeed, are more likely to introduce products whose knowledge base rests on a few competencies, which are already available within a firm's own boundaries.

3. Data and measurement issues

3.1. Data sources and estimation sample

Our firm product-level data set originates from the matching of the Turkish Annual Industrial Product Statistics (AIPS), Structural Business Statistics (SBS) and Foreign Trade Statistics (FTS).[2] AIPS convey information that an all 10-digit PRODTR goods—volume and value of production and sales—produced by Turkish firms with more than 20 persons are employed in either section C (mining and quarrying) or section D (manufacturing) of NACE Rev 1.1 in the 2005–2009 time span. For firms in AIPS, SBS provides information on firms' output, input costs, employment, foreign ownership, and NUTS 3 region of location. FTS reports then on firms' import and export activities.

The investigation of the role of both local and firm product-specific competencies called for the construction of the relevant product space. While from AIPS, we could directly observe the firms' product mix, we retrieved the provincial product baskets by aggregating data from firm to province level. In particular, in the computation of 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 good produced by each plant is proportional to its declared turnover. In order to split the production of multi-product multi-plant firms across plants located in different NUTS 3 regions, we assumed, instead, that each plant produces the same products and we attributed the production value to each plant in proportion to its turnover.[3]

Finally, in order to measure technological proximity and, thus, to compute the firm and local product density indicators (Hidalgo et al., 2007), we use BACI (Gaulier and Zignago, 2010) trade data at country-product level. BACI data are recorded according to the 1996 HS classification. Production data, instead, are recorded according to the PRODTR classification system, whose first six digits correspond to the CPA. In order to match firm product-level production data with the proximity indicator computed on the basis of 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 1297 products of which 1030 are actually produced in Turkey. Hereafter, product code refers to HCPA classification.

Our estimation sample is made up of all Turkish manufacturing and mining[4] firms with more than 20 persons employed introducing a new product in the 2006–2009 time span. As we aim at highlighting how local and firm product technological relatedness affect a firm's decision over new product additions, our empirical results are conditional on a firm's product innovation status.

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[2] All sources are available from the Turkish National Statistical Office.

[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 four-digit NACE sector declared as the plant's main activity. The two territorial distributions of production are rather close. Descriptive evidence is not shown for the sake of brevity and is available upon request.

[4] The following empirical analysis is unchanged when the very few mining sector firms are removed from the sample. Results are not shown for the sake of brevity, nonetheless they are available from the authors upon request.

3.2. Measuring product innovation and product relatedness

3.2.1. Product innovation

To model a firm's decision over which new good to produce, we need to define the set of all possible product additions for each firm *i*. Allowing a firm to choose among any of the existing HCPA 1297 products not previously produced would make the analysis computationally unfeasible, due to the very high number—roughly 13 millions—of firm–product combinations. We, thus, restrict product addition possibilities to those products that, in a way, may be technically related according to a firm's sector code (Frenken et al., 2007) and define the set of all possible product additions for each firm *i* as the set $S2d$ including all products belonging to one of the two-digit NACE codes where the firm was actually active in the year preceding the product addition, that is at time $t-1$. Our dependent variable $I_{ip\,t}$ is, therefore, a dummy taking value 1 for any product *p,* firm *i* starts to produce at time *t*, and 0 for any product $p \in S2d$ that firm *i* does not add to its product portfolio.

In our sample period, the share of new products with respect to all potential products belonging to one of the two-digit codes within which a firm was active in the previous year is on average 1.78% and this percentage remains substantially unchanged during the period of our analysis. It follows that product addition is, indeed, a rare activity.

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 A1 in the Appendix, Panel A documents the unequal distribution of industrial production between eastern and western regions at the beginning of our sample period, while Panels 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.

3.2.2. Product relatedness

In order to calculate the extent of cognitive 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] We calculate this index 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, in our view, is a more comprehensive and superior proxy of technological and cognitive relatedness across products compared with

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[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.

[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).

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 with the product/sector definition is shown in Table 1. Proximity decreases when considering more aggregate sector codes; however the mean and median proximities of goods belonging to the same four, three and two digits are quite close. Also, although the average proximity values between couples of products belonging to different sectors are lower than within sectors, the maximum values recorded within and across sectors are pretty similar, thus hinting at the fact that product proximity is a concept that goes beyond the conventional sector classification.

In order to measure the relatedness between firms' and provinces' capabilities endowment, 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:

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

where d_{ij} is a dummy equal to 1 when product *j* is produced by the firm and is 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

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

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

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[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.

Table 1. 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 two digits	0.223	0.212	0.119	0	0.864
Among different two digits	0.169	0.156	0.102	0	0.797
Within the same three digits	0.237	0.222	0.135	0	0.864
Among different three digits	0.171	0.159	0.103	0	0.797
Within the same four digits	0.245	0.231	0.142	0	0.864
Among different four digits	0.172	0.160	0.104	0	0.851

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

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_{il} 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 across all provinces where the firm has at least one plant.

Our aim in the present article is, thus, to highlight whether 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 2 where t-tests reveal that newly introduced product–firm combinations systematically present higher firm and local densities.

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):

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

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 local and firm density at time $t-1$ around a firm's potential new product p. Owing 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, foreign ownership status and a dummy for multi-plant firms.

Table 2. The *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

The authors' elaborations on AIPS and SBS data and BACI dataset. $dens^l$ and *dens* captures local and firm product relatedness measured by resting on the Hidalgo et al.'s (2007) density indicator.

η_i, χ_p and λ_t, respectively denote firm, product and time fixed effects, while ϵ_{ipt} represents an idiosyncratic error term.

Table A1 in the Appendix contains a detailed description of all the right-hand side variables included in the various specifications of model 3.

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 centre 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 0 and 1. Nevertheless, in the robustness checks, we adopt alternative non-linear models to test the robustness of our findings based on the LPM.

4.2. Baseline results

Table 3 shows results for a baseline specification of model 3. In columns 1–6, 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 that are technologically proximate to those required for the new product positively affect its introduction. The inclusion of fixed effects increases the coefficient of local density that 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.

We control for further variables that are expected to affect a firm's product innovation activity: firm size and productivity levels, importer, exporter, foreign ownership and multi-plant 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 A1 in the Appendix.

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

Table 3. Results: firm and local capabilities in product innovation

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
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]	
Logdens^l										0.005***
										[0.001]
Logdens										0.008***
										[0.001]
Size							0.002	0.001	0.001	0.001
							[0.001]	[0.001]	[0.001]	[0.001]
LP							0.000	0.000	0.000	0.000
							[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]
Exporter							−0.001	−0.001	−0.001	−0.001
							[0.001]	[0.001]	[0.001]	[0.001]
Foreign							0.008**	0.008*	0.010**	0.009***
							[0.003]	[0.004]	[0.004]	[0.003]
Multi-plant							0.002	0.001	0.002	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]
FE:										
Year	y	y	y	y	y	y	y	y	y	y
Product	n	n	n	y	y	y	y	y	y	y
Firm	n	n	n	y	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	895,823
R^2	0.001	0.008	0.008	0.079	0.079	0.079	0.081	0.082	0.082	0.082

$^*p < 0.10$;$^{**}p < 0.05$;$^{***}p < 0.01$. Dependent variable: firm probability to introduce new product p. Standard errors are clustered by firm. All regressors included in the estimation are lagged to one year. *dens*^{l} and *dens* capture local and firm 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}. Column 10 tests for the logarithmic transformation of the density indicators.

Larger firms are more likely to invest in R&D and to gather the necessary financial resources, 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, closely 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, 2014). On the other hand, exporters may dramatically be pushed to innovate by their own foreign customers (Egan and Mody, 1992; Goh, 2005; Salomon and Shaver, 2005; Baldwin and von Hippel, 2011; Hahn and Park, 2011; Bratti and Felice, 2012; Lo Turco and Maggioni, 2015). 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). Besides this set of firm-level controls, 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, 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 2 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—1.78%—and hint at the possible higher responsiveness of firms' new product choice to firm internal product-specific resources rather than to the local ones. In column 10 of Table 3, 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 displayed in Figure A2 in the Appendix, which shows the relative importance of firm density compared with the total—firm and local—technological proximity in explaining the spatial distribution of firms' introduction of new products.[10] The comparison of Figures A1 and A2 suggests that firm product-specific capabilities could have led the dynamics of industrial production and innovation experienced by laggard eastern regions—such as Ağri, Iğdir, 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,

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[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 α_1 and α_2 taken from Column 9 of Table 3.

Istanbul, Manisa, Bursa and Konya. To further inspect whether the traditional Turkish territorial divide somehow shapes the working of firm and local product-specific capabilities, we ran the above analysis by sub-samples of western and eastern firm–product observations.[11] Results are shown in column 1 of Table 4 and point at firm-level product-specific competencies having a statistically significant higher impact on eastern regions compared with the western ones. By the same token, when in column 2 we focus on the split between regions with value—averaged over our sample time span, 2006–2009—of new product introduction, I_{ip}, above and below the median, again we find that both local and, in particular, firm capabilities emerge as significant and relevant elements in the catching up process of less-innovative areas. These findings are in line with a firm's need to develop suitable internal resources and organisation routines for the introduction of a new product, when a relevant gap exists between the local pool of competencies and those required by the new product. As a matter of fact, peripheral areas are characterised by a scant and poorly diversified set of economic activities and the local environment can support product innovation to a very limited extent. A firm's own product-related knowledge and experience are instead fundamental for its ability to innovate and, therefore, represent an important driver of structural change in the local product space.

4.3. Robustness checks

To check the robustness of the baseline findings, we run a number of checks.

Firstly, we use alternative density indicators and results are shown in Table 5. In column 1, 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, instead of on the Turkish production share in the good. This is to account for a possible mis-measurement of provinces' RCA indexes due to the use of Turkish industrial structure as the benchmark for the comparison of each province production structure. In column 2, 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 3, 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 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 4, we substitute average local and firm proximity for firm and local densities.[12] In column 5, 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.

Secondly, we allow for alternative sampling strategies and further firm and local level controls in Table 6. In order to account for the possible selection bias in our estimates

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[11] Western NUTS 3 provinces are all the ones belonging to the following NUTS 1 regions: Istanbul, Bat i Marmara (Western Marmara), Ege (Egean region), Doğu Marmara (Eastern Marmara), Bat i Anadolu (Western Anatolia) and Akdeniz (Mediterranean region). The remaining provinces belong to the East area.

[12] Instead of computing a density indicator, we average the proximity indicator between the potential product p, on the one hand, and each product produced by firm i and products in which the province enjoys an RCA, on the other hand.

Table 4. Results: regional divide and catching up

	[1]		[2]	
	A Western regions	B Eastern regions	A Above P50	B NUTS 3 average of I $_{ip}$ Below P50
$dens^L$	0.037***	0.088*	0.024***	0.069*
	[0.008]	[0.051]	[0.008]	[0.036]
dens	1.756***	4.007***	1.766***	3.025***
	[0.208]	[1.103]	[0.219]	[0.540]
Size	0.001	−0.006	0.001	−0.002
	[0.001]	[0.004]	[0.002]	[0.002]
LP	0	−0.001	0	−0.001
	[0.001]	[0.002]	[0.001]	[0.001]
Exporter	−0.001	0.004	−0.001	−0.001
	[0.001]	[0.003]	[0.002]	[0.002]
Importer	−0.001	−0.002	−0.002	0
	[0.001]	[0.004]	[0.002]	[0.002]
Foreign	0.010**	0	0.010**	0
	[0.004]	[0.000]	[0.004]	[0.000]
Multi-plant	0.002	0.001	0.002	−0.002
	[0.001]	[0.004]	[0.002]	[0.003]
RCA^L	0.001***	0.001***	0.002***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
FE:				
Year	y	y	y	y
Product	y	y	y	y
Firm	y	y	y	y
Observations	836,538	60,806	677856	219488
R^2	0.084	0.109	0.088	0.078
Tests:				
$\alpha_1^A = \alpha_1^B$		1.006		1.512
p-value		0.316		0.219
$\alpha_2^A = \alpha_2^B$		4.019		4.668
p-value		0.045		0.031

$^*p < 0.10$;$^{**}p < 0.05$;$^{***}p < 0.01$. Dependent variable: firm probability to introduce a new product. Standard errors are clustered by firm. All regressors included in the estimation are 1-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 NUTS 3 characteristics: Western versus Eastern NUTS 3 regions, NUTS 3 regions above and below the median of the average introduction of new products.

stemming from the exclusion of firm product observations for non-innovating firms, we randomly select 20% of them from the same two-digit codes where non-innovating firms in our sample are active and attribute to them the local and firm density measures around the products they could potentially introduce. Results are shown in column 1 and are rather close to the baseline ones. The inclusion of non-innovators in the sample allows for the identification of the impact of previous innovation activities on a firm's probability to add a specific product (Cefis and Orseningo, 2001; Cefis, 2003).

Table 5. Robustness: alternative density indicators

	[1] RCA based on world product shares	[2] Different RCA threshold	[3] Normalised density	[4] Proximity	[5] NUTS 2 Local unit
$dens$	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]		
$dens^{Norm}$			37.530***		
			[0.906]		
ϕ^{l}				0.049***	
				[0.008]	
ϕ				0.153***	
				[0.004]	
$dens^{R}$					0.045***
					[0.008]
Size	0.001	0.001	0.002	0.001	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
LP	0	0	0	0	0
	[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]
Exporter	−0.001	−0.001	−0.001	−0.001	−0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Foreign	0.009**	0.010**	0.008***	0.009***	0.010**
	[0.004]	[0.004]	[0.003]	[0.003]	[0.004]
Multi-plant	0.001	0.001	0.001	0.001	0.002
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
RCA^{l}		0.001***	0.001***	0.001***	
		[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
Product	y	y	y	y	y
Firm	y	y	y	y	y
Observations	897,344	897,344	897,344	897,344	897,344
R^2	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 new product p. Standard errors are clustered by firm. All regressors included in the estimation are 1-year lags of the corresponding variables.

Columns 1 and 2 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 3, 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 4 explores the role of firm and local proximity indicators. In Column 5, 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] Inclusion of randomly selected 20% of non-innovators	[2] Inclusion of randomly selected 20% of non-innovators and state dependence in innovation	[3] Exclusion of Istanbul	[4] Drop of provinces with less than 20 firms in AIPS	[5] No. of products in firm and province	[6] Local production value	[7] Further firm controls
$dens^l$	0.012***	0.017***	0.055**	0.042***	0.077***	0.030***	0.037***
	[0.003]	[0.004]	[0.025]	[0.008]	[0.010]	[0.008]	[0.008]
dens	1.037***	1.296***	2.327***	1.861***	3.703***	1.851***	2.287***
	[0.142]	[0.186]	[0.419]	[0.206]	[0.202]	[0.205]	[0.204]
$inno_{t-1}$		0.003***					
		[0.001]					
Size	0	−0.001	0.003	0.001	0.004***	0.001	0.003*
	[0.000]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]
LP	0	0.000	0	0	0	0	0
	[0.000]	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Importer	0	0.000	0	−0.001	0	−0.001	−0.001
	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Exporter	0	0.000	0.001	0	−0.001	−0.001	0
	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Foreign	0	0.002	0	0.010**	0.007	0.010**	0.013***
	[0.002]	[0.002]	[0.000]	[0.004]	[0.005]	[0.004]	[0.005]
Multi-plant	0	0.000	0.001	0.002	0.002*	0.001	0.002
	[0.000]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]
RCA^L	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	[0.000]	[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	y
Product	y	y	y	y	y	y	y
Firm	y	y	y	y	y	y	y
Observations	1,642,911	1,046,698	415,209	891,101	897,344	897,344	897,344
R^2	0.059	0.062	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 new product p. Standard errors are clustered by firm. All regressors included in the estimation are 1-year lags of the corresponding variables.

In Column 1, a randomly selected sample of 20% of innovators is included in the estimation. In Column 2, we add a dummy for product innovators at time t – 1. In Columns 3 and 4, 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 5 controls for the number of products produced by the firm, N, and the number of local RCA products, $N^{RCA\,L}$. Column 6 controls for the local value of production in the product, y_l. Column 7 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*.

Therefore, in column 2, we account for state dependence in innovation by including a dummy variable, $inno_{t-1}$ taking value 1 for firms that introduced a new product in year $t-1$ and zero otherwise.[13] Accounting for past innovation compelled us to exclude year 2006, thus retaining in the sample only those firms for which we have the information on production data for at least 3 consecutive years. Nonetheless, results on the significance and relative importance of the two density measures are unaffected. In column 3, 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. In column 4, 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.

Furthermore, in order to ensure that our firm and local density indicators are not capturing any generic effect of agglomeration economies, rather than the availability of cognitively proximate firm and local capabilities, we include, in column 5, the log of the number of products produced by the firm and the log of the number of products in which its province(s) has a revealed comparative advantage.[14] Also, in column 6, we include the local value of production in the product. On the one hand, the resulting findings imply that Jacobs diversification economies positively operate only if technologically related. Indeed, a higher number of local RCA bears a negative and significant coefficient. On the other hand, although a higher local production of the good has a positive impact on a firm's probability to introduce it, local density around the product still matters, thus witnessing that a large existing local production scale is not a necessary condition to develop new products in a region. We include further observable firm characteristics at our disposal to check that our evidence is not driven by the omission of other important time-varying firm-level characteristics possibly driving a firm's choice of products to add to its product basket. We, thus, introduce 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.

Thirdly, we tested the robustness of our findings to alternative sample compositions and modelling choices and results are shown in Tables A2 and A3 in the Appendix. The first table shows findings stemming from different sample selection rules.

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[13] To further control for both sample selection and state dependence in innovation activity, we have implemented a two-step empirical analysis. In the first step we estimated, by means of system GMM, a dynamic linear probability model of a firm's probability to introduce a new product. We, therefore, included as explanatory variables, the lagged innovation status and a large set of firm-level covariates. From this first step analysis where we specifically control for state dependence, we retrieved the residual and, in a second step, we include it as regressor in the estimations of the probability to introduce a specific product p on the sample of innovators. The first-step regression reveals the importance of state dependence. Also, the residual is statistically significant, thus proving the existence of a sample selection bias, and bears a positive coefficient, thus revealing that innovators at time $t-1$ are more likely to introduce a new product p at time t. Our findings on the role of firm and local product-specific capabilities stay unchanged. Results are not shown for the sake of brevity, nonetheless they are readily available from the authors upon request.

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

In columns 1–3, we differently select our sample within our basic *conservative* definition of new product, where zero values are attributed to those HSCPA products that are not introduced by the firm and belong to any of the two digits where the firm was previously active. First, we 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 (column 1).[15] Second, we discard those products whose production was actually initiated, but whose NACE code falls outside any of the firm's two-digit NACE code (column 2), thus having a homogeneous definition of both the 1 and 0 values. Third, we focus on the sample of new potential products belonging to any two-digit NACE code where the firm was active, but which do not belong to any four-digit NACE code where the firm was already producing (column 3). In all these cases, we adopt a narrower diversification definition and, nevertheless, our main findings are unchanged. In columns 4–8, instead, we relax the definition of diversification possibilities and expand the number of possible product choices by considering all of the 1297 possible HCPA products present in our classification as new potential products. In this respect, we also include those goods belonging to those two-digit codes where the firm was not active in $t-1$ in firms' addition possibilities set (Neffke and Henning, 2013). Thereby, we consider a more radical definition of innovation. However, this choice substantially increases the number of potential firm–product combinations to include in our analysis. Owing to computational constraints, we implement this analysis by year and by selecting the 10% of zero combinations. Finally, in Table A3 in the Appendix, we present estimates of non-linear 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 1–4. In columns 5–7, we use logit, rare event logit[16] and probit models.

All of this further robustness checks confirm the relevance of firm and local technological relatedness for the introduction of new products.

4.4. Does firm heterogeneity shape the role of capabilities?

Results from the tables mentioned above 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 due to 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 dimensions act as mediating factors of local and firm product-specific capabilities absorption. The existing set of local capabilities around a product could play a heterogeneous role in orienting the firms' production choices 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

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[15] We also tested for different shares of zero observations.

[16] The ReLogit STATA command has been used.

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 are, indeed, 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 (3) for different groups of firms and we compare small versus large firms, high- versus low-productivity firms, high- versus low-product sophistication firms and high versus low *R&D* employment share firms. Product sophistication is measured *à la* Hausmann et al. (2007) by means of the *Prody* indicator, which measures the income content of the product. Finally, to account for heterogeneous environmental exposure of firms, we compare multi- versus single plant firms, exporters versus non-exporters, *regular* exporters versus non-*regular* exporters, importers versus non-importers and foreign-owned versus domestic firms.

Results are shown in Tables 7 and 8. The last four rows of these tables present the Wald test for equality of the density coefficients of the two groups that are compared, group A and group B.[17] Table 7 focusses on heterogeneous effects according to different levels of some specific *internal* firm-level characteristics. From the estimations, it emerges that the local set of product-specific capabilities play a major role for the product introduction in smaller than in larger firms. Among the remaining firm 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, thus disclosing that, when a firm is endowed with a small set of capabilities, as revealed by its simple productions, its flexibility in production shrinks, and the product-specific knowledge acquires a fundamental role for the innovation. 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 basis 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 small number of firms hiring R&D workers in our sample, the differences between the two sets of coefficients are not statistically significant.

In Table 8, instead, we inspect the importance of the firm's business network in magnifying/reducing the impact of firm and local technological relatedness. We find 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 Table 8, an interesting finding concerns regular exporters. Our data, indeed, allows for the identification of exported products that are actually produced by the firm and exported products that,

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[17] When the variable of interest is not a dichotomous one, 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.

Table 7. Results: heterogeneous internal resources

	[1]		[2]		[3]		[4]	
	A Large	B Small	A High Productivity	B Low Productivity	A High *Prody*	B Low *Prody*	A R&D	B 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^2	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 new product *p*. Standard errors are clustered by firm. All regressors included in the estimation are 1-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.

instead, correspond to a pure trade intermediary activity of the firm. Regular exporters are firms that export at least one of their own produced goods. Estimates imply a higher return from firm capabilities in terms of innovation for this group of firms compared with non-regular exporters. This result could suggest that a deep and direct linkage between the firm own production and export activity enhances the acquisition and accumulation of product-specific knowledge that can be exploited 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 very small number of foreign-owned firms in our sample.

Table 8. Results: heterogeneous environmental resources

	[1]		[2]		[3]		[4]		[5]	
	A Multi-plant	B Single-plant	A Exporters	B Non-exporters	A Regular exporters	B Non-regular exporters	A Importers	B Non-importers	A Foreign	B 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^2	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 new product p. Standard errors are clustered by firm. All regressors included in the estimation are 1-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.

4.4.1. 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.[18] 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.

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[18] For convenience of exposition, we omit calculations for the subgroups of domestic and foreign firms, as no significant difference actually emerged in Table 8.

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

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

With this article, we have contributed to the literature on the relevance of technological relatedness in shaping spatial clusters of economic activities and to the debate over the relative importance of firm and local resources for product innovation. For the first time to our knowledge, we have estimated a model of the impact of firm and local product-specific capabilities on a firm's choice over new products by exploiting a firm product-level sample of innovators from the Turkish economy. We have measured technological relatedness by means of Hidalgo et al.'s (2007) density indicator that defines two products as related on the basis of their co-occurrence in countries' export baskets. Our empirical analysis has conveyed three main findings.

First, a firm's activity of new product introduction shows strong path and place dependence that originates from the availability of firm and local product-specific competencies, cognitively proximate to those needed for the new goods' production. This result holds once accounted for a large number of robustness checks and, in particular, for the effect of local Jacobs and specialisation external economies. This implies two major facts. On the one hand, regional competencies matter for firm innovation when they are cognitively close to the new products. We, thus, corroborate previous evidence which discloses the positive role of existing local diversification in technologically related sectors on the economic performance of regions and firms (Boschma et al., 2009; Neffke et al., 2011; Boschma et al., 2012, 2013). On the other hand, a large existing local production scale is not a necessary condition to develop new products in a region.

Secondly, new product choices are more responsive to firm internal resources than to the local set of available product-specific knowledge. Also, the former represent the main thrust of innovation in laggard and less-innovative areas, due to the relevant gap between the existing scant and poorly diversified local capabilities and the ones needed for the new products. Firms located in these areas, therefore, appear as autonomously developing and adapting their specific abilities and general organisational routines to the new products' requirements. On the contrary, in more advanced regions, the introduction of new products is sustained relatively more by the local availability of a wide and thick pool of diverse technologically related knowledge.

Third, firm heterogeneity acts as a mediating factor of the impact of firm and local product-specific capabilities on product innovation. 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 a firm's regular export activity and low production complexity enhance the effect of firm product competencies for a given level of local product-specific capabilities.

Despite the minor role of space *vis-à-vis* the key role of firm knowledge for product innovation in Turkish peripheral areas, an accurate interpretation of the overall evidence above casts a shadow over the possibility that entrepreneurs could, by themselves, restore and redeem the future of entire territories. As a matter of fact, what matters for development and long-run growth is not the rate of innovation *per se*, but the level of new products' sophistication (Hausmann et al., 2007). In this respect, our findings show that internal resources mainly explain the innovation rate of low complexity firms. Hence, path dependence could doom firms and their location regions to be locked in low-complexity product specialisation and low growth. Product-space sophistication is a challenging task for a single firm, since the introduction of complex goods importantly originates from the accumulation of a pool of technologically related diverse scientific knowledge (Hausmann and Hidalgo, 2009; Heimeriks and Boschma, 2014). Therefore, the required capabilities, when missing, need to be sourced externally. Our work, thereby, contributes to the debate calling into question the existence of a regional environment effect on innovation: by accounting for the product-specific nature of skills and competencies, we, in fact, suggest that the local product space is of primary relevance for the introduction of new complex goods.

Findings in this article suggest that, in order to promote firms' diversification and growth, the process of knowledge creation and acquisition should be enhanced. Therefore, our work conveys two important policy implications for Turkey and for emerging economies.

On the one hand, the evidence on spatial heterogeneity in path and place dependence that characterises the uneven Turkish economic geography calls for crucial actions in favour of laggard regions directed to improve their endowment of generic resources and of factors that are specific to targeted sectors. Investments in infrastructures and human capital would foster the creation of a favourable environment for entrepreneurial activities. Reducing communication costs and improving the quality of local workforce would also enhance the provision of efficient business services that are essential for the performance of manufacturing firms. Nonetheless, to promote diversification in non-traditional sectors, policies could enhance the role of universities as centres of specific knowledge creation and incubators of spin-off firms. In this respect, ongoing support by the Turkish government in favour of cluster policies around traditional low complexity goods (e.g. carpets and wood products) should be complemented by actions directed to the acquisition of specific factors to encourage laggard regions' transition towards *smart specialisation* products.

On the other hand, public interventions in support of firms' international activities would ease their access to extra-regional knowledge pools.

All of these policy efforts would activate a self-reinforcing process of knowledge production that would allow firms and territories to relax the dependence on historical local specialisation and co-evolve towards a larger and more sophisticated industrial base.

These concluding remarks raise some new questions that still remain unanswered and, yet, are crucial to better understand the role of path and place dependence in development. Is the extent of local complexity—meant as the accumulation of a range of diverse product-specific tacit and codified knowledge—a direct driver of a firm's product mix sophistication? Is technological relatedness a mediating factor of such a linkage? Does a firm's embeddedness in the local environment foster the sophistication of its new goods? These issues constitute a relevant future research agenda.

Disclaimer

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Appendix

Table A1. Variables: definition and description

Variable	Description
$dens$	Density indicator described in Equation (1)
$dens^l$	Density indicator described in Equation (2)
$Size$	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
$Multi\text{-}plant$	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
$Multi\text{-}product$	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 $\frac{\frac{y_{pl}}{\sum_{j=1}^{N} y_{jl}}}{\frac{\sum_{l=1}^{L} y_{pl}}{\sum_{l=1}^{L}\sum_{j=1}^{N} y_{jl}}}$ wherein the formula L is the total number of NUTS 3 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 $\frac{\frac{y_{pr}}{\sum_{j=1}^{N} y_{jr}}}{\frac{\sum_{r=1}^{R} y_{pr}}{\sum_{r=1}^{R}\sum_{j=1}^{N} y_{jr}}}$ wherein the formula R is the total number of NUTS 2 regions in the Turkish economy, and y denotes the value of production

Table A2. Robustness: alternative diversification definitions

	[1] Conservative diversification	[2]	[3]	[4] Radical diversification	[5]	[6]	[7]	[8]
	within produced two-digit codes			outside produced two-digit codes				
	Random selection of 10% of zeroes	Exclusion of new two-digit codes	Exclusion of produced four-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	104,256	893,401	762,795	4,531,279	3,109,521	2,499,714	2,795,065	1,190,127
R^2	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 new product *p*.
Standard errors are clustered by firm. All regressors included in the estimation are 1-year lags of the corresponding variables.

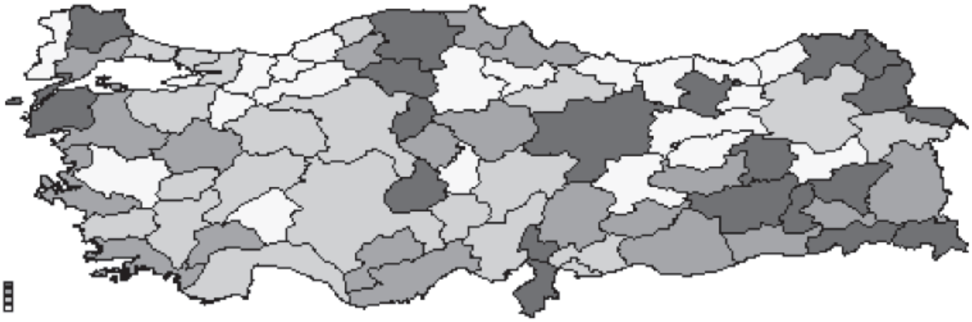
Table A3. Robustness: alternative modelling choice

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
	Conditional logit				Logit	RE Logit	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 1 year. Year fixed effects are included in all specifications.

A - Production Value in 2005

B - Average Production Value Growth 2005/2009



C - Average weight of New Products in Production Value - 2005/2009

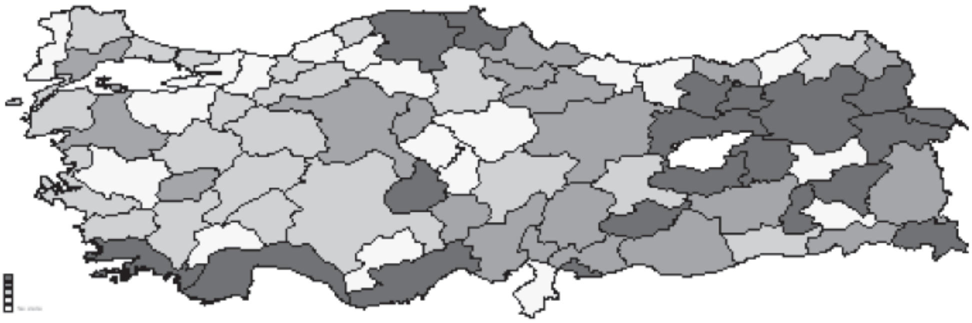


Figure A1. Turkish manufacturing production (2005–2009). (A) Production value in 2005; (B) average production value growth (2005–2009); (C) average weight of new products in production value (2005–2009).

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 NUTS 3 spatial distribution of Turkish manufacturing production value. The middle-panel chart displays the NUTS 3 spatial distribution of Turkish manufacturing production value average growth. The lower-panel chart displays the NUTS 3 spatial distribution of the 2005–2009 average weight of new products in manufacturing production value.

Source: TurkStat SBS and AIPS (own calculations).

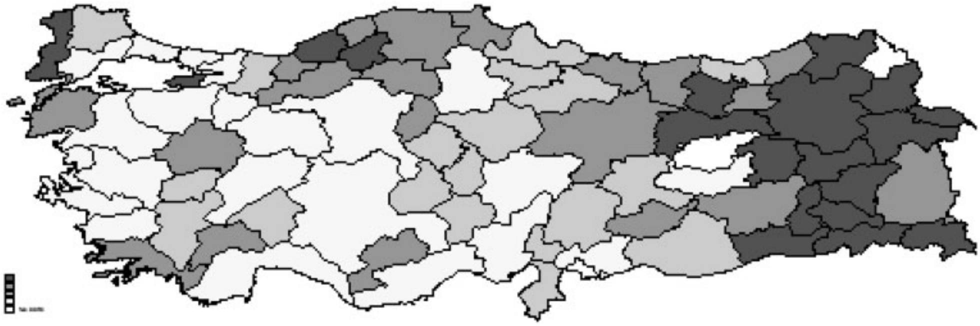


Figure A2. Relative contribution of *dens*

Notes: Quartiles of variables distribution are represented by means of different grey tonalities, with the darker ones identifying upper quartiles.

The map displays the NUTS 3 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).