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# Local Discoveries and Technological Relatedness: the Role of Foreign Firms

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# Local Discoveries and Technological Relatedness: the Role of Foreign Firms*

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**Abstract**

We explore the role of local intra- and extra-regional product-specific capabilities in fostering the introduction of new products by firms active in the Turkish manufacturing sector. We model firms' product additions to their product basket as dependent on extra- and intra-regional knowledge. We find that regional "discoveries", that is newly introduced products never produced before in the region, are positively and significantly affected by external related knowledge spurring from foreign firms active in the same location as well as by firm internal capabilities. Technologically related intra-regional knowledge spillovers and extra-regional knowledge spilling from imported inputs do not play a relevant role. The former, however, matter when we extend the analysis to all new products introduced by firms, regardless of their previous presence in the regional production basket. We interpret this evidence as foreign affiliates bringing new and exclusive capabilities which are missing in the region where they locate, thus providing a stimulus for regional production diversification and upgrading. This hypothesis is validated by exploring the heterogeneous role of the different intra- and extra-regional knowledge sources according to products' complexity.

***JEL: F11, F14, D22, D80, N30***
***Keywords: product innovation, relatedness, complexity, regional analysis, turkey***

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# 1 Introduction

Endogenous growth models have highlighted that the invention and production of new goods is a fundamental growth creating engine (Grossman and Helpman, 1991; Aghion and Howitt, 1998). However, the process of discovery of new production opportunities is strictly dependent on prior knowledge. Agents, indeed, tend to recognise those opportunities that are strictly related to capabilities and information they already possess (Shane, 2000). While in a standard neoclassical framework fundamental competencies to produce all existing goods are a common pool for all agents, a large part of knowledge useful in production, indeed, is tacit. Although the rapid spur and advances in information and communication technologies increasingly allow technological transfers from advanced to developing economies, the crucial difference between information and knowledge persists and the flow of tacit knowledge emerges as a key factor for developing and preserving successful firm routines at the basis of competitive advantages of countries and regions (Maskell and Malmberg, 1999; Gertler, 2003; Howells, 2012). Tacit knowledge especially seems to matter for the production of complex goods. This type of products requires a large set of capabilities which can be considered exclusive, as they are only available in a few locations across the world (Hausmann and Rodrik, 2003; Hausmann et al., 2007; Hausmann and Hidalgo, 2009).

From this discussion, three main aspects emerge as crucial for the process of innovation: the existence of a sufficient pool of knowledge, its technological relatedness to the new product to introduce, the activation of interactive *related* learning processes in the local economy which increasingly involve a firm's relationship with local actors outside its own boundaries.

These features of the innovation process imply that developing economies are hardly able to autonomously diversify and upgrade their production structure. Developing economies are often poorly diversified and rest on a few traditional products which only modestly contribute to long run economic growth (Hausmann et al., 2007). Firms active in these economies are usually endowed with a limited pool of simple capabilities which are often technologically distant from those required to produce the newest technology frontier goods. Also, they are embedded in a local economy made up of similarly poorly endowed firms. Then, their diversification opportunities are severely bounded by the local conditions. If knowledge does not freely flow across the borders, path dependence is expected to sharpen the technological divide between the North and the South of the world.

In this paper we investigate the impact of extra-regional related knowledge spurring from local affiliates of foreign firms on the evolution of domestic firms' product space within the Turkish manufacturing sector. Multinational firms are specialised in more skill and knowledge intensive productions and transfer knowledge to their foreign affiliates (UNCTAD, 2003; Arnold and Javorcik, 2009). Furthermore, in a developing country framework, returns to the pioneer investor's cost discovery can be easily socialised and this means that investment levels in cost discovery are suboptimal (Hausmann and Rodrik, 2003). In this respect, by sharing tacit knowledge, foreign affiliates reduce the discovery costs of new production opportunities for their local suppliers and may also stimulate subsequent innovation by domestic competitors (Wang and Wu, 2016; Javorcik, 2008).

As outcome of our empirical analysis we specifically consider a firm's probability to introduce a local discovery, that is to add a new product to the product basket of the region/s where the firm is located, and we model it as dependent on the extent of technological proximity - measured *à la* Hidalgo et al. (2007) - to the product basket of foreign firms active in the region. More specifically, as firm's new products we consider those goods never produced previously in any of the regions where the firm's plants are located. Through the adoption of this definition of innovation, our work aims at shedding light on the role of technologically related extra-regional knowledge transferred by foreign MNEs in promoting economic discoveries and the emergence of pioneer domestic firms in the regional economy. In the same empirical framework we account for the role of extra-regional knowledge embedded in imports accruing to the local economy, which, however, will never turn to affect the introduction of local discoveries, as well as of intra-regional knowledge flows conveyed by geographically close domestic firms which, instead, especially foster domestic firms' diversification into simpler products. As a matter of fact, as a final step of our analysis, we shed light on the drivers of the positive influence of the technological relatedness to foreign affiliates by exploring the role of a product's complexity level. Our evidence supports the view of foreign firms as technological gatekeepers providing locally unavailable important and exclusive capabilities fundamental for the production of highly complex goods.

Our work is close to the recent literature on the importance of technological relatedness as mediating factor of local knowledge spillovers in shaping economic diversification (Breschi et al., 2003; Boschma and Iammarino, 2009; Neffke et al., 2011; Boschma et al., 2012; Poncet and de Waldemar, 2012; Boschma et al., 2013; Neffke and Henning, 2013). In particular, we add to the stream of research emphasising an increasing role of spillovers spurring from related extra-regional knowledge flows transferred to a region through international linkages (Boschma and Iammarino, 2009; Colantone and Crinò, 2014). Rapid technological advances and declining trade costs in last decades have allowed for the growing global integration of local economies, therefore favouring the flow of knowledge across national and sub-national boundaries. This phenomenon is especially relevant for developing and emerging countries, where local firms are increasingly involved in international production networks, either through the expansion of international trade relationships or through linkages with colocated foreign affiliates. Indeed, some works have shown that localised innovative activities of foreign owned and domestic firms significantly reciprocally facilitate each other and that the extent of diversity of the local production environment is an important feature of knowledge creation (Wang and Wu, 2016; Wang and Guo, 2017)

Compared to the existing literature, we provide some original contributions.

First of all, we exploit firm product level data in order to explore the role of localised technologically related knowledge spillovers in fostering firms' introduction of local discoveries. Rather than focusing on firm product exports (Poncet and de Waldemar, 2012), as previous literature Lo Turco and Maggioni (2016), we use firm level production data in order to provide a exact picture of the evolution of a country's product space. However, differently from previous firm level works, we exploit the available fine disaggregation level of our data to precisely identify local discoveries and explore the impact of the local environment composition in favouring their introduction. In particular, we provide an original contribution to the literature by highlighting the role of technological relatedness to foreign affiliates active in the regional market on local firms' probability to act as pioneers for some specific productions. Also, we contribute by considering regional imports as potential source of related knowledge which can foster innovation at firm level. The exclusive knowledge and capabilities needed to produce pioneer goods in a developing economy are likely spurred from foreign firms' activity in the local market and/or from imports accruing to the region. From our data, indeed, discoveries emerge as goods requiring a larger set of exclusive skills and competencies which are often unavailable or insufficiently developed in an emerging country context.

Second, while previous literature has compared and, for the country under scrutiny, has quantified the relative importance of local and firm internal resources for innovation (Pfirrmann, 1994; Sternberg and Arndt, 2001; Beugelsdijk, 2007; Wang and Lin, 2012; Lo Turco and Maggioni, 2016), the relative role of local intra- and extra- regional knowledge for the introduction of new products by firms has never been investigated. More specifically, differently from former contributions which considered local firms as being part of a homogeneous group, we inspect the existence of differences in knowledge externalities spurring from the pool of productive capabilities of local foreign versus domestic firms.

Finally, to the best of our knowledge, this is the first piece of research comparing the importance of related intra- and extra-regional capabilities in shaping firms' product space in Turkey. The focus on the emerging Turkish economy turns to be particularly suitable for our aims for a number of reasons. First, the country's production structure experienced important changes and a relevant restructuring process over the last decades (Hidalgo, 2009). Second, the Turkish economy has sensitively increased its international involvement in global production networks. During the period under analysis, the country has recorded an unprecedented upsurge both in FDI and import flows which could have driven relevant knowledge spillovers into the local economy. Third, relevant territorial disparities characterise the country. A laggard East contrasts with a more developed West, in terms of economic development, production structure, international integration and presence of multinationals' affiliates. Although hosting foreign firms represents an important opportunity for the country, the risk that a selective entry of MNEs' affiliates could sharpen the traditional economic and geographical divide in the country should be taken into account. Compared to advanced western regions, the laggard eastern ones, due to their poor resource endowment, could greatly benefit from new capabilities brought about by foreign affiliates. Nonetheless, less developed areas'access to knowledge spillovers from MNEs could be hampered by these firms' preference to locate in more developed regions.

The particular geographical setting of our empirical analysis allows us to provide policy relevant insights from our evidence. More specifically, our results suggest that, in order to activate a process of product diversification and upgrading in Turkish peripheral areas, cluster policies aimed at attracting FDI can be an effective tool. In this direction, supporting the creation of joint ventures between local and foreign firms could enlarge the country's knowledge endowment and foster the diversification of its production structure.

The work is structured as follows. In the next section 2 we review the relevant literature. In Section 3 we present our empirical model and describe the data and measures. Section 4 discusses the results and Section 5 concludes.

## 2 Technological relatedness, extra-regional knowledge and firm innovation

The economic literature has shown that knowledge externalities - fundamental engine of economic growth (Arrow, 1962; Romer, 1986b,a; Grossman and Helpman, 1993) - are geographically localised (Jaffe et al., 1993). As the innovation process increasingly benefits from *learning by interacting* (Lundvall and Johnson, 1994), spatial clustering, then, matters, as the sharing of social, cultural, and institutional contexts eases reciprocal understanding and the flow of tacit knowledge among diverse agents (Gertler, 2003; Howells, 2012; Shefer and Frenkel, 1998; Rodríguez-Pose and Comptour, 2012; Poon et al., 2013). However, geographical proximity is neither a necessary nor a sufficient condition for spurring innovation across firms (Boschma, 2005). 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). Cognitive proximity, then, complements the geographical one (Autant-Bernard, 2001; Baptista and Swann, 1998; Orlando, 2000). Localised knowledge spillovers, indeed, are expected to be effective only when the necessary extent of cognitive proximity exists among agents interacting in the geographical space (Nooteboom, 2000; Boschma, 2005). In this case, agents' knowledge pools are somehow common and complementary and knowledge can spill.

In this line, recent empirical work has explored the importance of the existence of a variety of related industries for regional growth and diversification into new industries (Boschma et al., 2012; Porter, 2003; Neffke et al., 2011; Boschma et al., 2013; Castaldi et al., 2015). In particular, for the country of our analysis, Lo Turco and Maggioni (2016) have investigated the relative importance of firm- and local product-specific capabilities in fostering the introduction of new products in the manufacturing sector and have highlighted that strong cognitive path dependence is importantly relaxed by a firm's international exposure.

Accordingly, although the geographically immobile nature of place-specific - tacit and codified - knowledge reinforces the view of innovation as a geographically bounded phenomenon, the literature has shown that knowledge accruing from the outside world to firms active in a specific location can also be crucial for innovation (Asheim and Isaksen, 2002). However, as for the local pool of cognitive capabilities, the inflow of extra-regional knowledge is not per se a sufficient condition for affecting growth and innovation of regions and firms and the complementary role of technological proximity again turns relevant.

Following this line of enquiry, Boschma and Iammarino (2009) look at the effect of technologically related extra-regional knowledge flows on regional economic growth in Italian provinces for the period 1995-2003.[1] The relatedness indicator adopted in the study 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). The authors find an important effect of extra-regional related knowledge - namely related knowledge embedded in regional imports - in shaping the process of regional economic growth. Differently from them, we measure relatedness à la Hidalgo et al. (2007) and inspect the relevance of related extra-regional knowledge for local product discoveries developed by manufacturing firms in the context of an emerging economy. More importantly, beyond the inspection of extra-regional knowledge embedded in import flows, we focus on the role of extra-regional knowledge brought into the local economy by affiliates of foreign firms. Regional diversification requires the presence of locally available technologically related industries. This is, however, only a necessary but not sufficient condition. Departing from path dependence and creating new industries often requires original knowledge and this is particularly valid for pioneer goods whose content of sophisticated capabilities is often very high (Boschma and Frenken, 2011).

In this respect, as for the local economy knowledge spilling from foreign firms is newly created and available, we therefore consider it as extra-regional. As a matter of fact, it spurs from entities - MNEs' affiliates - which, although active in the local economy, belong to large international production networks and can, therefore, source capabilities and skills from their parent company's country and from all the countries where other affiliates are located.

We believe, then, that knowledge spillovers from foreign firms substantially differ from those spurring from other colocated domestic firms. Extant work has shown that, among co-located firms, technological gatekeepers emerge as having stronger technological capabilities and intensive connections with firms outside the cluster and tend to drive and dominate localized knowledge spillover (Giuliani, 2011; Munari et al., 2012). In this direction, Javorcik et al. (2017) have shown that foreign affiliates when acting as customers of domestic firms favour the complexity upgrading of domestic firms through the introduction of more complex goods. In this respect, affiliates of multinationals located in a region can be considered as technological gatekeepers, as they are endowed with a large pool of exclusive and technologically advanced capabilities that they bring into the local economy. Especially in the context of an emerging economy, they can be considered as responsible of the spreading of extra-regional knowledge created in MNEs' headquarters into the local economy. In this framework, cognitive proximity to foreign owned firms' core products can turn into a relevant advantage for domestic producers localised in the same region. However, colocation and technological relatedness, although necessary, are not sufficient conditions to absorb and enjoy knowledge spilling from foreign owned firms. The latter could be reluctant

[1] In a similar vein Colantone and Crinò (2014) look at the effect of imports of new inputs on the innovation propensity of EU countries' manufacturing sectors and find that new imported inputs have a strong positive effect on product creation in Europe as they allow countries to benefit from both wider and better sets of intermediate products.

to share their knowledge, local domestic firms could lack the needed absorptive capacity to grasp knowledge transfers or an wide cultural distance between domestic and foreign owned firms could hamper cooperation and interaction between the two types of firms. Then, it is an empirical matter to ascertain to what extent local product discoveries are fostered by the presence of technologically related productions of foreign firms.

In this direction, Wang and Wu (2016), investigate the impact of innovation activity performed by foreign owned firms on innovation by domestic firms. They analyse 5026 domestic firms in the Chinese electronics industry in 2009 and find that localized innovative activities of foreign firms, measured as foreign firms' output share of new products in a county, exert positive and significant influences on the output share of new products added by domestic firms. More specifically, they inspect FDI horizontal and vertical spillovers and find that they reinforce each other, although the former is more valuable than the latter in affecting innovation of domestic firms. Also, inter-sector knowledge spillovers is positive and significant but intra-sector spillover is not significant. The authors interpret the findings as diverse knowledge from other sectors located in the region is beneficial for product innovation of domestic firms.[2]

Finally, for the case of Turkey, Javorcik et al. (2017) analyse the role of horizontal and vertical spillovers from FDIs in the upgrading of new product complexity, where complexity is captured using a measure developed by Hausmann and Hidalgo (2009). They find that Turkish firms in sectors and regions more likely to supply foreign affiliates tend to introduce more complex products, however they find no significant effect of spillovers from multinationals on firms' innovation activities.

Although we share a similar research question as Wang and Wu (2016) and we run our empirical analysis on the same economic context as Javorcik et al. (2017), our work substantially differs from the previous studies in a number of ways. First, for the first time to our knowledge, we look at the role of local FDI in the introduction of local product discoveries by domestic firms and, more in general, at their choice on which product to add to their product basket. Second, we extend previous analysis based on traditional spillover measures by considering a product level measure of technological relatedness. Hence, we measure in detail the extent of cognitive proximity between products produced by foreign and domestic firms beyond the traditional input-output linkages. Third, we consider the activity of foreign firms in its whole, as important innovation inputs and stimulus for domestic firms could simply spur by the normal operativeness of foreign affiliates in the local market, rather than from their innovation activity only. Finally, rather than analysing a single industry as in Wang and Wu (2016), we focus on the whole manufacturing sector thereby providing a systematic and comprehensive analysis of the impact of technological relatedness to foreign firms in an emerging economy's manufacturing.

# 3 Empirical Strategy

## 3.1 Empirical Model

In order to explore whether and how local discoveries depend on the extent of cognitive proximity to foreign firms active in the region and, more generally, to the other sources of extra- and intra-regional knowledge, we estimate the following linear probability model (LPM):

[2] Wang and Guo (2017), instead explore the opposite linkage and find that localized innovation and knowledge spillover of domestic firms favour the innovation performance of foreign firms operating in China ICT industry, especially when there is a low local market concentration, but related variety fails to positively affect innovation performance of foreign firms.

$$I_{ip\,t}^{NUTS3} = \begin{array}{l} \alpha + \beta_1 \phi_{lp\,t-1}^{for} + \beta_2 \phi_{lp\,t-1}^{imp} + \beta_3 \phi_{lp\,t-1}^{dom} + \beta_4 \phi_{ip\,t-1}^{firm} \\ +\beta_5 RCA_{lp\,t-1} + \gamma' X_{i\,t-1} + \eta_i + \chi_p + \lambda_t + \epsilon_{ipt} \end{array} \tag{1}$$

where $I_{ip\,t}^{NUTS3}$ is a dummy denoting the introduction of a product discovery $p$ by firm $i$ at time $t$. The dummy is equal to one if firm $i$ at time $t$ starts producing a product $p$ which was not previously produced in any of the NUTS3 regions where firm $i$ is active with one of its plants. On the contrary, the dummy takes the value of zero for those products representing potential discoveries, that is goods which the firm could have introduced, but that, actually, it has never introduced in any of the NUTS3 region either at time $t$ or before. To attribute the zero values it is then fundamental to define the set of all possible goods that firms could introduce in a given year. The set, then, should include the whole set of producible products available in the product level classification scheme. However, to keep the empirical analysis computationally feasible, for each firm we build a sub-set of potential products including all goods belonging to any of the 2digit NACE sectors where the firm was active in $t-1$, denoted as $P_{it}^{2d\,t-1}$, which were never produced in the region. So, while the one values of $I_{ipt}^{NUTS3}$ are observed, we set $I_{ipt}^{NUTS3}$ to zero for all products belonging to the set $P_i^{2d\,t-1}$ which the firm and all the other firms located in the firm's location region(s) do not produce.[3] As we can see from Table 1, local discoveries are rare, as just a small percentage of potentially new products in the region.

Table 1: Distribution of $I_{ip\,t}^{NUTS3}$

| | $I_{ip\,t}$ | Frequency | Cumulative |
|---|---|---|---|
| 0 | 326,608 | 99.31 | 99.31 |
| 1 | 2,259 | 0.69 | 100 |
| Total | 328,867 | 100 | |

$I_{ip\,t}^{NUTS3}$ is a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which had never been produced before in any of the NUTS3 regions where the firm is active with one of its plants. The dummy variable takes value 0 for all those products that are never produced by firm $i$ either at time $t$ or before and which are classified within any of the 2-digit NACE industries where the firm records non zero production flows.

The main variable of interest in model 1 is $\phi_{lp\,t-1}^{for}$ which measures cognitive proximity between product $p$ and the pool of productive capabilities embedded in the local production attributable to foreign firms at time $t-1$. Similarly, $\phi_{ip\,t-1}^{imp}$ accounts for related extra-regional knowledge accruing to the local economy through imports. Similarly, $\phi_{lp\,t-1}^{dom}$ measures intra-regional knowledge spurring from production activities of domestic neighbouring firms and, finally, $\phi_{ip\,t-1}^{firm}$ captures the proximity between the new potential products $p$ and firm's own internal capabilities proxied by its production bundle in the previous year. We then add a variable capturing the local specialisation in product $p$, which is measured as the average of

[3]This strategy is in line with the existing literature which suggests that firms tend to diversify in their sector of activity (Frenken et al., 2007; Neffke and Henning, 2013). However, it partially limits the extent of application of the measure of technological relatedness which highlights the cognitive and knowledge linkages across products by overcoming the standard sector classification. However, by focusing on wide sectors - 2digit NACE sectors-of activities we believe to exploit the advantages of using technological relatedness indicators by keeping, at the same time, the analysis computationally feasible. In a robustness check we test the robustness of our results when extending a firm's set of new potential products to all existing products.

the RCA indicator in product $p$ across all provinces $l$ where a firm $i$ is active ($RCA_{lp}$). All the above mentioned indicators of technological proximity between product pairs are measured according to the indicator proposed by Hidalgo et al. (2007) which hinges on information gathered from the world trade network on the co-occurrence of products in countries' export baskets. According to their approach a higher probability of co-occurrence of two goods in countries' export baskets would hint to a higher overlapping of the cognitive content required for their production. Due to its sensible logic, the measure has been widely adopted in several recent empirical works focusing on the key role of technological relatedness for diversification of countries and regions (Boschma et al., 2012, 2013; Poncet and de Waldemar, 2012). A detailed description of the measure of technological relatedness and of the calculation of our main variables is included in subsection 3.3 below.

Our empirical model further includes a number of time-varying firm level controls $X_{i\,t-1}$ which are firm size ($lab$), labour productivity ($lp$), export ($exp$), import ($imp$), foreign ownership status[4] ($foreign$) and a dummy for multi-plant firms ($multiplant$). Finally, the model also includes firm fixed effects, product fixed effects and year dummies. All regressors appear at time $t-1$ in order to mitigate simultaneity concerns. Since some firms are active in different provinces, the measures of production proximity at the product level - $\phi^{dom}_{lp\,t-1}$, $\phi^{for}_{lp\,t-1}$, $\phi^{imp}_{lp\,t-1}$ - are averaged across firms' regions of location (for multi-region firms) and then vary by firm. As a consequence, we cluster standard errors at firm level.[5] Descriptive statistics for the variables of interest are shown in Table A1 in Appendix C.

### 3.2 Sample and Data Sources

Our sample is made up of Turkish manufacturing firms with more than 20 persons employed - including employees and the firm's owner(s) - introducing a local product discovery between year 2006 and 2009. The sample originates from the merging of the Turkish Annual Industrial Product Statistics (AIPS), Structural Business Statistics (SBS) and Foreign Trade Statistics (FTS) all available from the Turkish Statistical Office (TurkStat). AIPS informs on all 10-digit PRODCOM goods produced by Turkish firms with more than 20 persons employed active in section D (Manufacturing) of NACE Rev 1.1 over the period 2005-2009. By observing firms' product scope over time we are then able to identify newly introduced product discoveries, which are defined as the ones firms produce at time $t$ and which were not produced before in any of the regions where the firm operates with one of its plants.[6] Furthermore, SBS convey information on a bunch of firm level characteristics, such as NUTS3 location province - Turkey has 81 NUTS3 regions - , size, labour productivity, wage and, importantly for our aims, foreign ownership. We define foreign firms as those ones which present a foreign capital share equal or higher than 10% (OECD, 2008), all other firms are instead defined as domestic. AIPS and SBS allow to retrieve the domestic and foreign production structure at province level. This entails the need to deal with the presence of firms with plants located in different provinces. For multi-province single-product firms we assumed that the value of

[4]It is worth mentioning that foreign firms in our sample ofinnovators account for about 3% of observations and do not drive the empirical evidence shown below. However, in a robustness check we will exclude them from the sample.

[5]In the robustness checks we will show that results are not affected when we cluster standard errors at the most conservative province level. Also results do not change when proximity measures refer to the main province of location.

[6]It is worth mentioning that a firm introduces a new product when a new HCPA code appears in its product basket. However to realise whether this new product is a local discovery, we check, at the more disaggregated 10-digit PRODTR level, whether the good had been already introduced by other firms or not. As a matter of fact, we could observe the same HCPA - corresponding to a new product for the firm - being produced by other colocated firms. Nonetheless this HCPA code could correspond to a different PRODTR than the one introduced by the firm. In this case, then, the firm is introducing a local discovery even if the same HCPA is already present in the region(s) where the firm is active.

the single good produced by each plant was proportional to its declared turnover. Similarly, the production of multi-province multi-product firms is split among their plants located in different provinces by assuming that each plant produces all products and attributing their production value in proportion to each plant's turnover. The same procedure is applied to both the sample of domestic firms and the sample of foreign firms in order to gather the provincial structure of the domestic and foreign production. The latter is then exploited to compute the technological relatedness between each firm's potential new product and products produced by foreign and domestic peers active in the same province(s) as the firm.[7]

Finally, FTS allow to identify the importer and exporter status of firms as well as the set of imported products in each Turkish province.

### 3.3 Measuring Technological Relatedness

Hinging on the definition of the Revealed Comparative Advantage (RCA) index (Balassa, 1965) which measures the extent of a country $c$'s trade specialisation in product $p$ vis-à-vis the rest of the world, we build the dummy $dRCA_{cp}$ which is equal to one if country $c$ enjoys a comparative advantage in product $p$ and zero otherwise.[8] The indicator of technological proximity is then obtained as:

$$\phi_{pj} = min\{P(dRCA_p|dRCA_j), P(dRCA_j|dRCA_p)\}$$

$\phi_{pj}$, thus, gives a measure of the overlap between the pool of production capabilities required by the goods $p$ and $j$ as 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 underlying idea is that, if products $j$ and $p$ require a similar pool of skills and knowledge they will be, indeed, more likely to be simultaneously present in the export basket of a higher number of country pairs.

While existing literature has adopted further approaches in order to measure the technological relatedness across products (Teece et al., 1994; Fan and Lang, 2000; Porter, 2003; Neffke and Henning, 2008; Bryce and Winter, 2009), the indicator developed by Hidalgo et al. (2007) is very intuitive and allows us to exploit information at a very disaggregated level as well as to add to the existing and growing strand of literature which adopts this measure (among others Poncet and de Waldemar, 2012; Felipe et al., 2012; Lo Turco and Maggioni, 2016).

In order to investigate and dissect the effect of the different local sources of knowledge on a firm's likelihood to introduce a new product, we compute the technological proximity of each product $p$ with the foreign, domestic and imported goods' production structure. We then obtain the following indicators:

[7]Even if we do not observe production information for the whole population of firms, we are confident in the goodness of our measure of province-product level production. In the period of our analysis, according to official Turkstat data, the manufacturing production value generated by firms with more than 20 employees accounted for about 88/89% of the total production value. Furthermore, production data at our disposal refer to the population of firms with more than 20 persons employed, thus the measures we gather are likely to capture the quasi totality of the Turkish manufacturing production.

[8]The RCA index of country $c$ in product $p$ is calculated as

$$RCA_{cp} = \frac{\frac{country\ c's\ exports\ of\ product\ p}{total\ country\ c's\ exports}}{\frac{world\ exports\ of\ product\ p}{world\ total\ exports}}\ with\ 0 \leq RCA < \infty$$

Hence, country $c$ exports product $p$ with RCA if the RCA index for the product is higher than 1.

$$\phi_{lp}^{for} = \sum_{j \in S_l^{for}, j \neq p} \phi_{pj} * \frac{prod_{lj}^{for}}{\sum_{j \in RCA_l^{for}} prod_{lj}^{for}}$$

$$\phi_{lp}^{imp} = \sum_{j \in S_l^{imp}, j \neq p} \phi_{pj} * \frac{imports_{lj}}{\sum_{j \in DRCA_l^{imp}} imports_{lj}}$$

$$\phi_{lp}^{dom} = \sum_{j \in S_l^{dom}, j \neq p} \phi_{pj} * \frac{prod_{lj}^{dom}}{\sum_{j \in RCA_l^{dom}} prod_{lj}^{dom}}$$

where $S_l^{for}$ and $S_l^{dom}$ are the sets of comparative advantage products corresponding to the province foreign and domestic production,[9] while , $S_l^{imp}$ is the set of province de-specialisation goods.[10] We, thus, measure the cognitive proximity of each product $p$ with the domestic, foreign and imported production of the region, by focusing on the set of goods for which the province $l$ enjoys a comparative advantage - disadvantage for imports - in the domestic, foreign and imported product basket, respectively.[11]

For those firms active in more than one province, we will average the above proximity indicators across all provinces where they have a plant, by weighting each provincial indicator by the firms' output share produced in that province.

Finally, as we acknowledge the importance of internal product specific capabilities in affecting the process of firms' own diversification (Breschi et al., 2003; Neffke and Henning, 2013; Lo Turco and Maggioni, 2016), in our baseline specification we control for the cognitive proximity with a firm's existing pool of productive capabilities which is reflected in the existing product scope:

$$\phi_{ip}^{firm} = \sum_{j \in I_i, j \neq p} \phi_{pj} * \frac{prod_{ij}}{\sum_{j \in I_i} prod_{ij}}$$

[9] The RCA indicator for products produced by foreign/domestic firms is calculated as the share of product *j* in total foreign/domestic production over the total share of product *j* in Turkish aggregate manufacturing production. The set of products with RCA is made up of products whose corresponding RCA is higher than 1.

[10] The $S_l^{imp}$ indicator is calculated as the share or product *j*'s imports in total provincial imports over the share of product *j* in world imports. In this respect it is rather a de-specialisation indicator as the indicator is higher than 1 when the product share in the provincial imports is higher than the normal share represented by the world one. In a robustness check, we will show that results do not substantially change when we remove the constraint $j \neq p$ from the above equations and therefore include the values $\phi_{pp} = 1$ in the computation of the above indicators.

[11] Two important issues are worth mentioning. First, by focusing on the set of (de)specialisation goods we purge the proximity measures by scale factors dependent on the size of a single province economy. Results, however, are robust if we consider all products regardless of their corresponding RCA indicator value. Second, Hidalgo et al. (2007) propose to normalise proximity between a new potential product *j* and a country's current productive capability space indicated by its own RCAs, by dividing the proximity indicator by the available world product space for product $j$, that is by the total proximity between product $j$ and any other product $i$, regardless of its inclusion in the specific country's set of RCA goods. Hence, our proximity indicators in equations 2, 2, 2 and 2 reflect absolute rather than relative distances between product $j$ and the products produced by foreign/domestic firm and/ or imported. This choice follows from the fact that, due to the presence of product fixed effects in the model, the normalised measures - all bearing the same denominator - are highly correlated and the identification of their single contribution is, therefore,impossible. Hence, as we preferred to maintain product fixed effects in the model, we opted for the use of absolute proximity measures, yet controlling for each good's total product space extension by means of product fixed effects. While this approach is equivalent to using normalised proximity measures in the absence of product fixed effects, it is more conservative as the latter purge our estimates from further unobserved time-invariant heterogeneity at the product level.

# 4 Results

## 4.1 Baseline

Table 2 reports the results of the estimation of equation 1. It is interesting to notice that related knowledge spilling from foreign firms is positively and significantly associated to local firms' probability of starting producing a new good never produced before in the NUTS3 region(s) of their activity. This result is robust to the inclusion of the remaining proximity variables and the coefficient in column [5] implies that one standard deviation increase - 0.074, from Table A1 - in proximity to foreign firms' production bundles enhances a firm's probability to introduce a specific product by 0.13 percentage points. By comparing this effect to the average firm probability of adding a product in our sample - 0.7%, from Table A1 - we can conclude that the effect of cognitive proximity to foreign firms is not only significant but also economically meaningful. Contrarily to this finding, cognitively related knowledge embedded in import flows does not play any role for the introduction of product discoveries, and the same is true for the knowledge spilling from local domestic firms. The only other significant related knowledge is the one pertaining to a firm's own internal resources. According to results in the Table an increase by one standard deviation in firm own technological relatedness increases a firm's probability to add a new product by 0.52 percentage points. This suggests that the high relevance of firms' internal resources for innovation which has widely been acknowledged by the literature. As a firm's expansion can be viewed as a process of exploitation of productive opportunities (Penrose, 1959), firms' endowments of product-specific *capabilities* constitute an important knowledge base to explore new production fields and can be exploited by firms to diversify into technologically related products (Danneels, 2002; Breschi et al., 2003; Neffke and Henning, 2013; Lo Turco and Maggioni, 2016). On the contrary, extra-regional knowledge contained in imports or intra-regional competencies embedded in local firms production bundles do not significantly drive the introduction of brand new products in the local economy. The lack of contribution of the local domestic environment for the introduction of brand new products and sectors can depend on the large distance between the existing pool of capabilities and the requirements of the new products on the one side and its environment on the other (Boschma and Frenken, 2006).

From this set of results, we then conclude that, beyond firm level internal production capabilities, external sources of knowledge in the form of cognitively proximate capabilities transferred by foreign firms in the local economy are fundamental in explaining the introduction of products that are new both to the firm and to the local economy and, as such, represent a structural break with respect to the local production specialisation. In this respect, foreign firms emerge as important players of regions' economic development perspectives. Figure 1, indeed, corroborates this view. The figure provides the territorial distribution of the contribution of foreign relatedness to local discoveries over the total contribution of related foreign and firm knowledge - namely ($\frac{\hat{\beta}*\phi^{for}_{lp\ t-1}}{\hat{\beta}*\phi^{for}_{lp\ t-1}+\hat{\iota}*\phi^{firm}_{ip\ t-1}}$) from our empirical model - as the only significant sources of related capabilities and shows that some Eastern less developed regions appear in the top part of this distribution. Also, it appears that the contribution of foreign related knowledge to the spread of product discoveries has been especially high in some of the so-called Anatolian Tigers: Gaziantep, Kayseri, Ordu, Bursa, Kocaeli, Malatya. A particular case is represented by Malatya, an Eastern province, which is recognised as one of the most prominent Tiger. Although the presence of MNEs is not very spread, the existence of closer cognitive proximity between foreign and domestic firms has possibly played a beneficial impact on its product diversification.

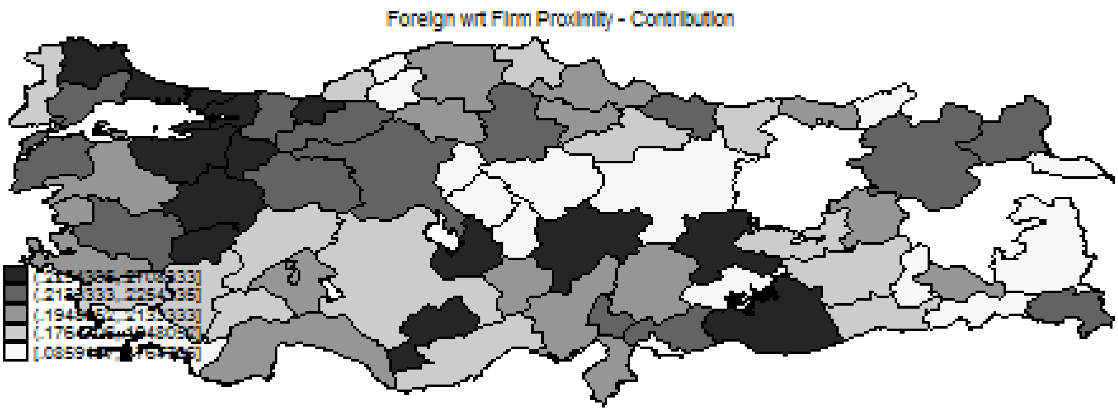
## Table 2: Results I

| | Product Discoveries in the NUTS 3 - $I_{ip\,t}^{NUTS3}$ | | | | |
|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] |
| $\phi_{lp}^{for}$ | 0.019*** | | | | 0.018*** |
| | [0.005] | | | | [0.005] |
| $\phi_{lp}^{dom}$ | | 0.011 | | | -0.007 |
| | | [0.009] | | | [0.010] |
| $\phi_{lp}^{imp}$ | | | 0.013 | | 0.003 |
| | | | [0.008] | | [0.008] |
| $\phi_{ip}$ | | | | 0.051*** | 0.051*** |
| | | | | [0.004] | [0.004] |
| $RCA_{lp}$ | 0.033*** | 0.033*** | 0.033*** | 0.033*** | 0.033*** |
| | [0.004] | [0.004] | [0.004] | [0.004] | [0.004] |
| $lab$ | 0.002 | 0.002* | 0.002* | 0.002* | 0.002* |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $lp$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $foreign$ | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 |
| | [0.003] | [0.003] | [0.003] | [0.003] | [0.003] |
| $exp$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $imp$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $multiplant$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| Observations | 328867 | 328867 | 328867 | 328867 | 328867 |
| $R^2$ | 0.148 | 0.148 | 0.148 | 0.149 | 0.15 |
| FE | | | | | |
| Firm | Yes | Yes | Yes | Yes | Yes |
| Product | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes |

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Robust standard errors clustered at the firm level are shown in brackets.
The dependent variable is $I_{ip\,t}^{NUTS3}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which had never been produced before in any of the NUTS3 regions where the firm is active with one of its plants. The dummy variable takes value 0 for all those products that are never produced by firm $i$ either at time $t$ or before and which are classified within any of the NACE 2-digit industries where the firm records non zero production flows.

## Figure 1: Relative Contribution of Foreign Related Knowledge to Local Discoveries

### Foreign over Firm and Foreign Relatedness




*Notes:*
*Source:* TurkStat SBS and AIPS. Own calculations.

**Robustness** The above evidence is robust to a number of sensitivity checks that are shown in Table 3. First, we show that results do not substantially change when we exclude foreign firms from the sample in order to isolate the impact of extra- and intra-regional knowledge for domestic firms only. As it is evident from Column [1] of the Table, our baseline evidence is not driven by the inclusion of foreign firms in the original sample. Second, our results persist when in Column [2] we account for the local production scale of product $p$ by including its local production value of product, $prod\_value_{lp}$. Third, to ascertain that our results actually identify the role of technological relatedness rather than just the presence of foreign firms in the local market for product $p$, in Column [3] we include the local production share of foreign firms in product $p$, $prod\_sh_{lp}^{for}$, together with the local share of imports on total product $p$'s production, $prod\_sh_{lp}^{imp}$, to capture import exposure *tout-court*. Results remain unaffected and the same happens when we replace these two controls with the total production share of foreign firms, $prod\_sh_{l}^{for}$, and with the total share of imports on manufacturing production in region $l$, $prod\_sh_{l}^{imp}$, (Column [4]). By the same token, results are robust when, in Column [5], we add the number of products produced by the firm, $Nprod_i$, the number of products imported/ produced by domestic/foreign firms for which location $l$ has a revealed comparative advantage (respectively, $Nrca_l^{imp}$, $Nrca_l^{dom}$, $Nrca_l^{for}$). Furthermore, we show that the standard errors cluster level does not really affect our insights, as from Columns [6] where we cluster standard errors at the more conservative province level.[12] In Column [7], our baseline evidence is maintained when we enlarge the sample and consider as potential new products all products regardless of their belonging to one of the 2digit NACE sectors where the firm was active in $t-1$. In this case, as the sample becomes sensitively larger, in order to implement a computationally feasible analysis, we randomly select 10% of all zeros. Finally, our evidence is robust to alternative ways of calculating the technological proximity indicator: i) by considering proximity to products produced only in the firm's main province; ii) by including 1 values, that is removing the restriction $j \neq p$ in equations 2, 2 and 2, therefore, adding to the above formulas proximity between firm's product $p$ and the same product produced by local and foreign firms.[13] All in all, our evidence calls into question the treatment of firms colocated in a geographical space as a homogeneous group and highlights the importance of affiliates of foreign firms as technology gate-keeper able to affect local firms' innovation and production paths (Giuliani, 2011; Munari et al., 2012; Wang and Wu, 2016).

**Adopting a broad definition of innovation** In Table 4 we extend our analysis and show results relative to a more general definition of innovation. Rather than considering local product discoveries only, we define product innovations as those products that are new to the firm but that are not necessarily so for the region(s) where the firm is active. Therefore, the left hand side variable is $I_{ip\,t}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which it was not producing at time $t-1$. The dummy variable takes value 0 for all those products that are not produced by firm $i$ either at time $t$ or at time $t-1$ and which are classified within any of the 2-digit NACE industries where the firm records non zero production flows. This outcome represents a broader definition of a new product, as the latter could be only new to the firm and not to the neighbouring local firms. It is interesting to notice that the alternative definition of the dependent variable delivers results that point at different knowledge sources as being relevant for different types of firm inno-

[12] We further clustered standard errors at the product and firm-product level and, again, results are unaffected. Results are available upon request.

[13] Also, results are corroborated when we consider the whole set of products in the proximity calculation, regardless of the comparative advantage pattern. We ran further controls that we do not show here for the sake of brevity. In particular, our evidence is robust to the inclusion of non innovators in the sample, to the control for the firm's past innovation activity and to the adoption of alternative modelling strategies, i.e. the ReLogit and the Clogit model.

# Table 3: Robustness - Local Discoveries

| | Excluding foreign firms | Adding Local Production | Adding Foreign and Imported Production Shares | | Adding # products | cluster Province | By considering all Products Selection 10% of 0s | Main Province | By including $\phi_{pp}$ |
|---|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] |
| $\phi_{lp}^{for}$ | 0.017*** | 0.012** | 0.018*** | 0.018*** | 0.018*** | 0.018*** | 0.011*** | 0.017*** | 0.018*** |
| | [0.005] | [0.005] | [0.005] | [0.005] | [0.005] | [0.006] | [0.004] | [0.005] | [0.005] |
| $\phi_{lp}^{dom}$ | -0.005 | -0.008 | -0.001 | -0.007 | -0.003 | -0.007 | 0.005 | -0.01 | -0.001 |
| | [0.010] | [0.010] | [0.010] | [0.010] | [0.010] | [0.014] | [0.010] | [0.009] | [0.010] |
| $\phi_{lp}^{imp}$ | 0.003 | 0.01 | 0.01 | 0.003 | 0.003 | 0.003 | 0.006 | 0.004 | 0.002 |
| | [0.008] | [0.008] | [0.008] | [0.008] | [0.008] | [0.008] | [0.006] | [0.008] | [0.008] |
| $\phi_{ip}$ | 0.051*** | 0.045*** | 0.050*** | 0.051*** | 0.053*** | 0.051*** | 0.129*** | 0.052*** | 0.050*** |
| | [0.004] | [0.004] | [0.004] | [0.004] | [0.004] | [0.007] | [0.004] | [0.004] | [0.004] |
| $RCA_{lp}$ | 0.033*** | 0.011*** | 0.032*** | 0.033*** | 0.033*** | 0.033*** | 0.024*** | 0.002*** | 0.033*** |
| | [0.004] | [0.003] | [0.004] | [0.004] | [0.004] | [0.005] | [0.003] | [0.000] | [0.004] |
| $lab$ | 0.002* | 0.003* | 0.002 | 0.002* | 0.003** | 0.002* | 0 | 0.002 | 0.002* |
| | [0.001] | [0.002] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $lp$ | 0 | -0.001 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.000] | [0.000] | [0.001] | [0.001] |
| $foreign$ | | -0.018 | 0.003 | 0.004 | 0.003 | 0.004** | 0.034 | 0.005 | 0.004 |
| | | [0.013] | [0.002] | [0.003] | [0.003] | [0.002] | [0.024] | [0.003] | [0.003] |
| $exp$ | 0 | 0.002 | -0.001 | 0 | 0 | 0 | 0.001 | -0.001 | 0 |
| | [0.001] | [0.003] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $imp$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0 | 0.001 | 0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $multiplant$ | 0 | -0.008*** | -0.001 | 0 | 0 | 0 | 0.001 | 0 | 0 |
| | [0.001] | [0.003] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $prod\_value_{lp}$ | | 0.023*** | | | | | | | |
| | | [0.002] | | | | | | | |
| $prod_sh_{lp}^{for}$ | | | 0.057*** | | | | | | |
| | | | [0.008] | | | | | | |
| $prod_sh_{lp}^{imp}$ | | | -0.014*** | | | | | | |
| | | | [0.001] | | | | | | |
| $prod_sh_{l}^{for}$ | | | | -0.002 | | | | | |
| | | | | [0.006] | | | | | |
| $prod_sh_{l}^{imp}$ | | | | -0.001 | | | | | |
| | | | | [0.003] | | | | | |
| $Nprod_i$ | | | | | -0.006*** | | | | |
| | | | | | [0.001] | | | | |
| $Nrca_l^{for}$ | | | | | 0.001 | | | | |
| | | | | | [0.001] | | | | |
| $Nrca_l^{dom}$ | | | | | -0.004 | | | | |
| | | | | | [0.003] | | | | |
| $Nrca_l^{imp}$ | | | | | 0.003 | | | | |
| | | | | | [0.003] | | | | |
| FE | | | | | | | | | |
| Firm | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Product | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster | Firm | firm | firm | firm | Product-Prov | Prov | Firm | Firm | Firm |
| Observations | 319712 | 328867 | 328867 | 328867 | 328867 | 328867 | 345414 | 328031 | 328867 |
| R-squared | 0.15 | 0.253 | 0.154 | 0.15 | 0.15 | 0.15 | 0.105 | 0.128 | 0.15 |

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Robust standard errors clustered at the firm level are shown in brackets.
The dependent variable is $I_{ip\,t}^{NUTS3}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which had never been produced before in any of the NUTS3 regions where the firm is active with one of its plants. The dummy variable takes value 0 for all those products that are never produced by firm $i$ either at time $t$ or before and which are classified within any of the NACE 2-digit industries where the firm records non zero production flows.

vation. As a matter of fact, in Column [1] relatedness to the production basket of foreign firms in the region is not relevant anymore, while domestic technological relatedness turns to be significant and positively associated to the probability of introducing a new product. Local domestic resources, then, turn to matter when the introduction of new products do not exclusively concern pioneer goods in the local economy. Findings from column [1] on this broader definition of innovation are robust across all the robustness checks presented in Columns [2]-[10]. Worthy of note is the evidence emerging from column [10] when we include 1 values in the relatedness indicators, thereby removing the restriction $j \neq p$ in equations 2, 2 and 2. When this definition of relatedness is adopted the coefficient on proximity to foreign firms' product basket turns negative and significant. This suggests that local firms introducing a product that is new to them but not necessarily to the local market suffer from competition of foreign firms and, therefore, they are less likely to introduce a product which is too close or even equal to goods realised by foreign firms in the local market.

## Table 4: Robustness - Broad Definition of Innovation

| | Baseline | Excluding foreign firms | Adding Local Production | Adding Foreign and Imported Production Shares | | Adding # products | cluster Province | By considering all Products Selection 10% of 0s | Main Province | By including $\phi_{pp}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] |
| $\phi_{lp}^{for}$ | -0.004 | -0.003 | -0.007 | -0.005 | -0.004 | -0.005 | -0.004 | -0.018*** | -0.005 | -0.013*** |
| | [0.005] | [0.005] | [0.005] | [0.005] | [0.005] | [0.005] | [0.011] | [0.005] | [0.005] | [0.005] |
| $\phi_{lp}^{dom}$ | 0.059*** | 0.060*** | 0.056*** | 0.056*** | 0.058*** | 0.057*** | 0.059** | 0.108*** | 0.059*** | 0.113*** |
| | [0.010] | [0.010] | [0.009] | [0.009] | [0.009] | [0.009] | [0.027] | [0.010] | [0.009] | [0.011] |
| $\phi_{lp}^{imp}$ | -0.002 | -0.004 | -0.001 | 0.006 | -0.001 | 0.001 | -0.002 | -0.028*** | 0.001 | -0.011 |
| | [0.008] | [0.008] | [0.008] | [0.008] | [0.008] | [0.008] | [0.015] | [0.007] | [0.008] | [0.008] |
| $\phi_{ip}$ | 0.152*** | 0.152*** | 0.152*** | 0.152*** | 0.152*** | 0.150*** | 0.152*** | 0.363*** | 0.151*** | 0.151*** |
| | [0.004] | [0.004] | [0.004] | [0.004] | [0.004] | [0.004] | [0.013] | [0.004] | [0.004] | [0.004] |
| $RCA_{lp}$ | 0.001*** | 0.001*** | 0.001*** | 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] | [0.000] | [0.000] |
| $lab$ | 0.002 | 0.002 | 0.002 | 0.001 | 0.002 | 0.003*** | 0.002 | 0.001 | 0.001 | 0.002 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $lp$ | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.000] | [0.000] | [0.001] | [0.001] |
| $foreign$ | 0.008** | | 0.008*** | 0.008** | 0.008*** | -0.001 | 0.008*** | 0.011*** | 0.009*** | 0.009*** |
| | [0.003] | | [0.003] | [0.004] | [0.003] | [0.001] | [0.001] | [0.003] | [0.003] | [0.003] |
| $exp$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | 0 | -0.001 | 0 | -0.001 | -0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $imp$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | 0.007* | -0.001 | 0 | -0.001 | 0 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.004] | [0.001] | [0.001] | [0.001] | [0.001] |
| $multiplant$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001* | 0.001 | 0.001 | 0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $prod\_value_{lp}$ | | | 0.000*** | | | | | | | |
| | | | [0.000] | | | | | | | |
| $prod_sh_{lp}^{for}$ | | | | 0 | | | | | | |
| | | | | [0.001] | | | | | | |
| $prod_sh_{lp}^{imp}$ | | | | -0.009*** | | | | | | |
| | | | | [0.000] | | | | | | |
| $prod_sh_{l}^{for}$ | | | | | -0.002 | | | | | |
| | | | | | [0.005] | | | | | |
| $prod_sh_{l}^{imp}$ | | | | | 0.006** | | | | | |
| | | | | | [0.003] | | | | | |
| $Nprod_i$ | | | | | | -0.016*** | | | | |
| | | | | | | [0.001] | | | | |
| $Nrca_l^{for}$ | | | | | | 0.001 | | | | |
| | | | | | | [0.001] | | | | |
| $Nrca_l^{dom}$ | | | | | | 0.004 | | | | |
| | | | | | | [0.002] | | | | |
| $Nrca_l^{imp}$ | | | | | | -0.007** | | | | |
| | | | | | | [0.003] | | | | |
| FE | | | | | | | | | | |
| Firm | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Product | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 895659 | 867765 | 895659 | 895659 | 895659 | 892693 | 895659 | 1031153 | 893855 | 895661 |
| R-squared | 0.088 | 0.088 | 0.088 | 0.088 | 0.088 | 0.089 | 0.088 | 0.154 | 0.089 | 0.088 |

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Robust standard errors are shown in brackets and are clustered at the firm level in all specifications with the exception of column [7] where they are clustered at the Province level.
The dependent variable is $I_{ip\ t}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which it was not producing at time $t-1$. The dummy variable takes value 0 for all those products that are not produced by firm $i$ either at time $t$ or at time $t-1$ and which are classified within any of the NACE 2-digit industries where the firm records non zero production flows.

## 4.2 In search of the drivers: do foreign firms bring new and exclusive capabilities?

In this section we explore the mechanism behind the positive impact of related knowledge spilling from foreign firms on local product discoveries. If foreign firms are technological gatekeepers and help the introduction of pioneer goods and technologies in the region, they possibly provide some exclusive and new capabilities unavailable locally which can be exploited to enlarge the scope of domestic production. In this perspective, foreign firms are expected to play a fundamental role for the introduction of complex products especially, as their production process requires a large pool of exclusive capabilities (Hausmann and Hidalgo, 2009). Extant evidence on the country of our analysis, indeed, points at spillovers from foreign firms in downstream industries as fostering the complexity level of new products (Javorcik et al., 2017). This suggests that foreign firms are endowed with exclusive capabilities that they transfer to their suppliers. Hence, if technological proximity to foreign firms positively affects the introduction of local discoveries only, this could possibly depend on the higher sophistication level of these goods compared to the extant products in the local economy. A simple t-test for the difference in the mean complexity level between product discoveries and the rest of new products reveals that the former are significantly and sensitively more complex than the latter.[14] Then building on the evidence by (Javorcik et al., 2017) and on the one shown above, we expect technological proximity to foreign firms to matter more for higher complexity goods.

We therefore extend the above model 1 by including the interactions between all the technological proximity measures and a product's complexity, $K_p$, measured $\grave{a}$ la Hausmann and Hidalgo (2009):[15]

$$
\begin{aligned}
I_{ip\,t}^{NUTS3} = \alpha + \beta_1 \phi_{lp\,t-1}^{for} \quad & + \delta_1 \phi_{lp\,t-1}^{for} * K_p + \beta_2 \phi_{lp\,t-1}^{imp} + \delta_2 \phi_{lp\,t-1}^{imp} * K_p + \beta_3 \phi_{lp\,t-1}^{dom} + \delta_3 \phi_{lp\,t-1}^{dom} * K_p \\
+ \beta_4 \phi_{ip\,t-1}^{firm} + \delta_4 \phi_{ip\,t-1}^{firm} * K_p \quad & + \beta_5 RCA_{lp\,t-1} + \gamma' X_{i\,t-1} + \eta_i + \chi_p + \lambda_t + \epsilon_{ipt}
\end{aligned} \tag{2}
$$

where $K_p$ is the measure of product complexity while the remaining variables are the same as in equation 1. Corresponding results are shown in Table A2 in the Appendix. Column [1] shows a positive coefficient on the interaction between product complexity and relatedness to foreign firms' product basket which, nonetheless turns non significant in column [5] when the complete specification is estimated. Here, the interaction of product complexity with technological proximity to neighbouring domestic firms' product basket is also positive and significant while the interaction term with firms' own capabilities turns significant but negative. However, In order to understand how proximity indicators shape the probability to introduce a new product along the distribution of product complexity, in Table 5 we report the marginal effects of all of the technological relatedness indicators in our model by different percentiles of the distribution of the complexity indicator. From the top panel in the Table we can observe that while the higher the complexity level of products the higher the contribution of related capabilities flowing from foreign firms active in the local market, the contribution of technological relatedness to local domestic firms is hardly relevant for the introduction of pioneer products in the local economy. On the contrary, although declining, the role of firm own related knowledge is relevant all along the distribution of product complexity.

Of particular interest are the results gathered by exploiting the broader definition of in-

[14]According to the standardised version of the Hidalgo's 2009 complexity indicator which ranges from -2.6 up to 2.6, local discoveries have an average complexity level of 0.084 while the remaining new products have an average complexity level of -0.590 and the T-statistics for the difference in means is equal to 71.7. Detailed results from the t-test are available upon request.

[15]For the computation of the complexity indicator, please, see details in Appendix A.

novation shown in Columns [6]-[10] of Table A2. Compared to results on pioneer new goods, relatedness to foreign firms is significantly and positively moderated by product complexity which also moderates, although in an inverse manner, the impact of relatedness to domestic neighbours. Indeed, the lower panel of Table 5 corroborates the view of related capabilities brought by foreign firms into the local economy as fundamental for introducing new products embedding a higher complexity level. At the same time the importance of local and firm internal knowledge declines as the complexity level of products increases.

The above evidence and the analysis presented in this sub-section all suggest that local discoveries, which are relatively more complexity than the remaining new products in the region, call for capabilities which are not available in the local context, and which can just be provided by external knowledge sources, namely foreign affiliates. This feature, therefore, highlights the fundamental role of extra-regional knowledge brought by foreign firms into the local economy for their introduction and, more, in general for regions' development perspectives.

Table 5: Results II - The moderating role of product complexity

| $K_p$ | $\phi_{lp}^{for}$ | $\phi_{lp}^{dom}$ | $\phi_{lp}^{imp}$ | $\phi_{ip}$ |
|---|---|---|---|---|
| | **Local Discoveries - $I_{ip\ t}^{NUTS3}$** | | | |
| 10th percentile | 0.01 | -0.038** | 0.01 | 0.079*** |
| | [0.008] | [0.015] | [0.014] | [0.007] |
| 25th percentile | 0.014** | -0.022* | 0.007 | 0.067*** |
| | [0.006] | [0.011] | [0.010] | [0.005] |
| Median | 0.018*** | -0.003 | 0.003 | 0.053*** |
| | [0.005] | [0.010] | [0.008] | [0.004] |
| Mean | 0.018*** | -0.005 | 0.004 | 0.054*** |
| | [0.005] | [0.010] | [0.008] | [0.004] |
| 75th percentile | 0.022*** | 0.013 | 0 | 0.040*** |
| | [0.006] | [0.012] | [0.009] | [0.004] |
| 90th percentile | 0.025*** | 0.024 | -0.002 | 0.031*** |
| | [0.007] | [0.015] | [0.010] | [0.005] |
| | **All New Products - $I_{ip\ t}$** | | | |
| 10th percentile | -0.031*** | 0.084*** | -0.028* | 0.275*** |
| | [0.009] | [0.018] | [0.017] | [0.007] |
| 25th percentile | -0.015** | 0.067*** | -0.017 | 0.212*** |
| | [0.007] | [0.012] | [0.012] | [0.005] |
| Median | 0.002 | 0.049*** | -0.004 | 0.141*** |
| | [0.005] | [0.009] | [0.009] | [0.003] |
| Mean | 0.001 | 0.050*** | -0.005 | 0.146*** |
| | [0.005] | [0.009] | [0.009] | [0.003] |
| 75th percentile | 0.018*** | 0.032*** | 0.008 | 0.077*** |
| | [0.005] | [0.011] | [0.009] | [0.003] |
| 90th percentile | 0.028*** | 0.02 | 0.015 | 0.034*** |
| | [0.007] | [0.014] | [0.011] | [0.004] |

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

# 5 Conclusions

Within the literature on the causes of the development of countries' production structure, in this paper we have explored a new line of enquiry. We have investigated whether the presence of technologically close foreign firms acts as an escape from path dependence for local firms active in laggard territories. Our empirical evidence on Turkish firms' product space evolution corroborates this hypothesis: firms' probability to introduce a local discovery is significantly favoured by its technological relatedness to foreign firms, so as measured by the indicator proposed by Hidalgo et al. (2007).

Furthermore, we have compared the role of extra-regional related knowledge spurred by MNEs' affiliates to the contribution of extra-regional related knowledge embedded in imports. Our data reveal the absolute prominence of the former on the latter which, contrarily to findings by extant literature on countries' and regions' product baskets in advanced economies (Boschma and Iammarino, 2009; Colantone and Crinò, 2014), never significantly affects firms probability to introduce local discoveries. Also, for the introduction of pioneer goods, cognitive proximity to foreign firms dominates on spillovers stemming from colocated technologically proximate domestic firms, while firms' own internal resources are of fundamental importance. The territorial distribution of the relative contribution of relatedness to foreign firms vis-à-vis firms' own capabilities endowments reveals that in our sample period foreign firms actively spur innovation across some less developed Eastern regions and that they have possibly played a role in the recent success of the some of the so-called Anatolian Tigers. The relative importance of extra-regional - spurring from foreign firms - and intra-regional - spurring from domestic firms - is reversed when we look at the introduction of goods that may be new only to the firm and not to the region. In this case the role of relatedness to foreign firms fades away while capabilities stemming from the local domestic product space gain in importance.

From our evidence, spillovers from cognitive proximate foreign(domestic) firms increase(decrease) in importance when new goods are highly complex and require a large set of exclusive skills and competencies, as it is the case for product discoveries especially. Firms' own internal resources emerge from our analysis as the fundamental knowledge pool for their entry into new products regardless of their complexity level. Nonetheless, the higher the sophistication level of the product to introduce, the lower the contribution of firms' related capabilities.

Our evidence points at cognitive proximate knowledge brought by MNEs' affiliates into the region as a path dependence breaking tool for laggard regions and for the potential removal of ancestral lock in processes. Policy makers concerned by the persistent disparities across Turkish regions should then favour foreign firms' entry in the poorer areas of the country. They should target foreign investors able to convey the general and product specific knowledge, that is locally unavailable, needed for the introduction and diffusion of product discoveries in order to open new production paths and favour the process of regional diversification.

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# A Measuring Product Complexity

The sophistication content of a good's production process is captured by means of the measure of product complexity proposed by Hausmann and Hidalgo (2009). The concept of product complexity is linked to the width and exclusivity of capabilities required by the production process. The intuition behind the Hausmann and Hidalgo (2009)'s metrics for product complexity is strictly related to the approach proposed by Hidalgo et al. (2007) to assess the technological proximity across products explained above. As technological proximity is related to the overlapping of the pool of capabilities required by products, product complexity depends on the composition of this pool. Being capabilities unobservable, Hausmann and Hidalgo (2009) suggest to infer them from the world trade network. We then rest on the idea that countries' export basket can reveal their endowment of capabilities as well the frequency of the presence of goods in countries' export baskets can hint the capabilities' requirement for their production. A country which enjoys a comparative advantage in a wide and exclusive set of productions is likely to be endowed with a larger set of exclusive capabilities. Similarly, goods which are presents in the basket of just few exporters are likely to require more exclusive capabilities, and, thus, to present a higher level of complexity.

In order to recover information on product and country complexity within this setting, we start by defining two basic indicators, which are the country diversification, $K_{c,0}$, as the number of products a country $c$ exports with comparative advantage, and the product ubiquity, $K_{p,0}$, as the number of countries exporting a product $p$ with comparative advantage. We then compute:

$$K_{c,0} = \sum_{p} dRCA_{cp} \tag{3}$$

$$K_{p,0} = \sum_{c} dRCA_{cp} \tag{4}$$

that is, summing over products and countries, respectively, the RCA dummy, $dRCA$.

Hausmann and Hidalgo (2009) then suggest to refine these rough measures by applying the so-called *Method of Reflections* which consists in an iterative procedure aimed at combining information on products' ubiquity and countries' diversification. Hence, $K_{c,0}$ and $K_{p,0}$ are combined in a number of succeeding iterations and after *n* iterations, one gathers:

$$K_{c,n} = \frac{1}{K_{c,0}} \sum_{p} d_{RCA\ cp} * K_{p,n-1}$$

$$K_{p,n} = \frac{1}{K_{p,0}} \sum_{c} d_{RCA\ cp} * K_{c,n-1}$$

Odd numbered iterations for $K_{p,n}$ give measures of a product's complexity, and denote a product's presence in the export basket of a small number of countries whose production is diversified in low ubiquity products. Similarly, even numbered iterations for $K_{c,n}$ give measures of a country's diversification, and they reveal that a country is specialised in a fairly large set of complex products, which are characterised by a low degree of ubiquity.

In our empirical exercise, we measure product complexity by means of the $K_{p,13}$ indicator gathered after 13 iterations.

## B Data Sources for Computation of Proximity and Complexity

In order to compute the measures of product proximity and complexity, we exploit the CEPII's BACI (Gaulier and Zignago, 2010) database which contain all bilateral trade flows at HS96 product level. This database allows us to build the world trade network which is at the basis of the computation of both product technological relatedness and complexity measures. While BACI data are recorded according to the 1996-HS classification, Turkish production data are recorded according to the PRODTR classification system, whose first 6 digits correspond to the CPA classification. In order to build product level measures which can be matched with Turkish product level production (and trade) data, we first converted 1996-HS codes 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, and our analysis will be implemented at this aggregation level of product.

## C Additional Tables and Figures

Table A1: Descriptive statistics

| Variable | Observations | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| $I_{ip}^{NUTS3}$ | 328867 | 0.007 | 0.083 | 0 | 1 |
| $\phi_{lp}^{for}$ | 328867 | 0.171 | 0.074 | 0 | 0.615 |
| $\phi_{lp}^{dom}$ | 328867 | 0.161 | 0.060 | 0.002 | 0.510 |
| $\phi_{lp}^{imp}$ | 328867 | 0.165 | 0.054 | 0.003 | 0.511 |
| $\phi_{ip}$ | 328867 | 0.213 | 0.105 | 0 | 0.851 |
| $lab$ | 328867 | 3.873 | 0.921 | 0 | 9.708 |
| $lp$ | 328867 | 9.458 | 0.875 | 1.930 | 13.697 |
| $exp$ | 328867 | 0.581 | 0.493 | 0 | 1 |
| $imp$ | 328867 | 0.575 | 0.494 | 0 | 1 |
| $foreign$ | 328867 | 0.028 | 0.164 | 0 | 1 |
| $multiplant$ | 328867 | 0.283 | 0.451 | 0 | 1 |
| $RCA_{lp}$ | 328867 | 0.017 | 0.472 | 0 | 79.724 |

Table A2: Results II - The moderating role of product complexity

| | **Local Discoveries - $I_{ip\ t}^{NUTS3}$** | | | | | **All New Products - $I_{ip\ t}$** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] | [7] | [8] | [9] | [10] |
| $\phi_{lp}^{for}$ | 0.019*** | | | | 0.018*** | 0.003 | | | | 0.002 |
| | [0.005] | | | | [0.005] | [0.005] | | | | [0.005] |
| $\phi_{lp}^{for} * K_p$ | 0.007* | | | | 0.005 | 0.028*** | | | | 0.022*** |
| | [0.004] | | | | [0.004] | [0.005] | | | | [0.005] |
| $\phi_{lp}^{dom}$ | | 0.014 | | | -0.004 | | 0.099*** | | | 0.049*** |
| | | [0.009] | | | [0.010] | | [0.009] | | | [0.009] |
| $\phi_{lp}^{dom} * K_p$ | | 0.024*** | | | 0.023*** | | -0.014 | | | -0.023** |
| | | [0.008] | | | [0.008] | | [0.010] | | | [0.009] |
| $\phi_{lp}^{imp}$ | | | 0.013 | | 0.004 | | | 0.034*** | | -0.004 |
| | | | [0.008] | | [0.008] | | | [0.008] | | [0.009] |
| $\phi_{lp}^{imp} * K_p$ | | | 0 | | -0.004 | | | 0.005 | | 0.016** |
| | | | [0.006] | | [0.006] | | | [0.008] | | [0.008] |
| $\phi_{ip}$ | | | | 0.053*** | 0.053*** | | | | 0.144*** | 0.143*** |
| | | | | [0.004] | [0.004] | | | | [0.003] | [0.003] |
| $\phi_{ip} * K_p$ | | | | -0.017*** | -0.017*** | | | | -0.088*** | -0.088*** |
| | | | | [0.003] | [0.003] | | | | [0.003] | [0.003] |
| $RCA_{lp}$ | 0.033*** | 0.033*** | 0.033*** | 0.033*** | 0.033*** | 0.002*** | 0.001*** | 0.002*** | 0.001*** | 0.001*** |
| | [0.004] | [0.004] | [0.004] | [0.004] | [0.004] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| $lab$ | 0.002 | 0.002* | 0.002* | 0.002* | 0.002* | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $lp$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $foreign$ | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 | 0.005 | 0.005 | 0.005 | 0.008** | 0.007** |
| | [0.003] | [0.003] | [0.003] | [0.003] | [0.003] | [0.004] | [0.004] | [0.004] | [0.003] | [0.003] |
| $exp$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $imp$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| $multiplant$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| yr1 | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.006*** | 0.006*** | 0.006*** | 0.005*** | 0.005*** |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| yr2 | 0.001 | 0.001 | 0 | 0 | 0.001 | 0.004*** | 0.003*** | 0.004*** | 0.004*** | 0.003*** |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| yr3 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.003*** | 0.002*** | 0.003*** | 0.003*** | 0.002*** |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| Observations | 328867 | 328867 | 328867 | 328867 | 328867 | 895659 | 895659 | 895659 | 895659 | 895659 |
| $R^2$ | 0.148 | 0.148 | 0.148 | 0.15 | 0.15 | 0.081 | 0.081 | 0.081 | 0.09 | 0.09 |
| FE | | | | | | | | | | |
| Firm | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Product | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Robust standard errors clustered at the firm level are shown in brackets.

The dependent variable of Columns [1] to [5] is $I_{ip\ t}^{NUTS3}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which had never been produced before in any of the NUTS3 regions where the firm is active with one of its plants. The dummy variable takes value 0 for all those products that are never produced by firm $i$ either at time $t$ or before and which are classified within any of the NACE 2-digit industries where the firm records non zero production flows.

The dependent variable of Columns [6] to [10] is $I_{ip\ t}$, a dummy variable taking value 1 if firm $i$ at time $t$ introduces the new product $p$ which it was not producing at time $t-1$. The dummy variable takes value 0 for all those products that are not produced by firm $i$ either at time $t$ or at time $t-1$ and which are classified within any of the NACE 2-digit industries where the firm records non zero production flows.