Relatedness and Innovation: The Role Local and External Knowledge
Preliminary Version*

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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. Firms' product space evolution is characterised by strong cognitive path and place dependence. Technologically related intra-regional knowledge spillovers and firm internal capabilities appear as the only important drivers of new products additions vis-à-vis extra-regional knowledge spilling from imported inputs and foreign firms. However, when focusing on new products never produced before in the region, that is regional "discoveries", external related knowledge spurring from foreign firms active in the same location as the innovating firm significantly matters. We interpret this finding as dependent on the higher level of product complexity which characterises regional "discoveries" with respect to goods already produced in the region. Finally, when we account for the level of complexity of new products, we find that technologically related capabilities accruing from foreign firms active in the local market are fundamental in fostering the introduction of new products with a high complexity level whereas low complexity goods are spurred by proximity to domestic and firms' internal knowledge. Production capabilities transferred by foreign firms have, then, contributed to further stimulate production diversification and upgrading in some core regions, but at the same time they have also represented a key element for a possible structural break in less developed regions, even if Eastern regions are mainly excluded from this process. ***JEL: F11, F14, D22, D80, N30***
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1 Introduction

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 knowledge 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 technological transfers from advanced to developing economies are increasingly eased by rapid spur and advances in information and communication technologies, the crucial difference between information and knowledge persists (Gertler, 2003; Howells, 2012). In an era of widespread access to codified knowledge, the flow of tacit knowledge emerges as an increasingly important element for developing and preserving successful firm routines at the basis of competitive advantages of countries and regions (Gertler, 2003; Maskell and Malmberg, 1999). Tacit knowledge flows especially matter for the production of complex goods which require a large set of exclusive capabilities (Hausmann and Rodrik, 2003; Hausmann et al., 2007; Hausmann and Hidalgo, 2009).

From this discussion, three main aspects emerge as crucial to 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. Indeed, if knowledge does not freely flows across the borders, path dependence is expected to sharpen the technological divide between the North and the South of the world. Developing economies are often poorly diversified and rest on a few traditional products which only modestly contribute to long run economic growth. 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.

In this paper we investigate the impact of extra-regional related knowledge spurring from local affiliates of foreign firms in the evolution of domestic firms' product space within the Turkish manufacturing sector. Multinational firms are intensive in R&D production and transfer knowledge to their foreign affiliates (UNCTAD, 2003; Arnold and Javorcik, 2009), which, in turn, have a higher propensity to innovate than their indigenous competitors (Brambilla, 2009; Guadalupe et al., 2012). Furthermore, in a developing country framework, where much of the innovation effort is about introducing existing foreign goods that are only new to the local economy, 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, by directly engaging in cost discovery in host economies, multinationals may also stimulate subsequent innovation by domestic rivals (Wang and Wu, 2016; Javorcik, 2008).

As outcome of our empirical analysis we specifically consider a firm's probability to add a new product to its own product basket 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. We define a firm's new products either as those never previously produced 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 FDIs in promoting economic discoveries and the emergence of pioneer domestic firms for more technologically advanced goods in the regional economy. Furthermore, we contrast findings on the impact of relatedness to foreign firms on local firms' discoveries with evidence emerging from a broader definition of new products as those goods not previously produced by the firm, but possibly produced by other firms in the same location region. Finally, we assess whether the importance of technological relatedness for new products' additions - regardless the definition of innovation adopted - is somehow shaped by the extent of complexity of the products to add.

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 matter and of intra-regional knowledge flows conveyed by geographically close domestic firms which, instead, will especially turn to matter for diversification into simpler products.

Our work contributes to the recent literature highlighting the importance of technological relatedness as mediating factor of local knowledge spillovers in shaping economic diversification (Boschma et al., 2012, 2013; Boschma and Iammarino, 2009; Neffke et al., 2011; Breschi et al., 2003; Neffke and Henning, 2013; Poncet and de Waldemar, 2012). Localised knowledge spillovers, indeed, are expected to be effective when the necessary extent of cognitive proximity exists among agents interacting in the geographical space (Nooteboom, 2000; Boschma, 2005). If this is the case, agents' knowledge pools are somehow common and complementary and knowledge can spill. Within this literature, our work is close to the stream of research emphasising an increasing role of spillovers spurring from related extra-regional knowledge flows accruing to a region through international linkages (Boschma and Iammarino, 2009). 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 foreign affiliates acting as external buyers, suppliers or competitors in the local economy. Indeed, literature has shown that localised innovative activities of foreign owned and domestic firms significantly reciprocally facilitate each others' innovation processes and that the extent of diversity of the local 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 inspect, for the first time to our knowledge, the effect of technological relatedness to foreign affiliates active in the local market on domestic firms' probability to develop new products and, especially, to act as local pioneers for some specific productions. We do so by using very detailed firm-product level data for the Turkish manufacturing firms.

Second, the data at our disposal, also allow us to examine whether the linkage between technological relatedness and innovation is shaped by the extent of product complexity. By testing whether the level of complexity of new products mediates the effect of local intra- and extra-regional knowledge flows, we aim at providing useful insights for the assessment of aggregate growth perspectives (Hausmann et al., 2007; Hausmann and Hidalgo, 2009). Hausmann and Hidalgo (2009) show that products differ in terms of their capabilities content, and complex goods require a large set of skills and competencies which are pretty exclusive. Although the latter could be insufficiently developed in an emerging country context, they could be instead conveyed by foreign firms and embedded in imports. We then highlight whether the presence of cognitively proximate foreign firms affects the diffusion of innovation and the upgrading of production complexity across the Turkish geographical space.

Third, while previous literature has compared the relative importance of local and firm internal resources for innovation (Pfirrmann, 1994; Sternberg and Arndt, 2001; Beugelsdijk, 2007; Wang and Lin, 2012) and, for the country under scrutiny, has quantified the relative importance of firm and local technological proximity in shaping the evolution of firms' product space (Lo Turco and Maggioni, 2016), the relative importance of local intra- and extra-regional knowledge for the introduction of new products by firms has never been investigated. More specifically, while previous works implicitly 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. Also, we add to the literature by considering the regional level imports as potential source of knowledge which can foster firms' innovation.

Finally, to the best of our knowledge, this is the first piece of research compsring 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 underwent 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 experience 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 foreign owned firms' presence. Although hosting foreign firms represents an important opportunity for the country, the risk is that a selective entry of MNEs's affiliates could sharpen the traditional economic and geographical divide in the country. 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. Our empirical analysis, therefore, aims at developing policy relevant insights to direct cluster policies for the attraction of FDIs in Turkish peripheral areas.

The work is structured as follows. In the next section 2 we review the relevant literature. In Section 3.2 we describe the measure of technological proximity and product complexity and we present the data sources we exploit. Section **??** presents the empirical model and Section 4 discusses the results. In Section 4.3 we assess the contribution of the different sources of knowledge to the evolution of firms' product scope and in particular to its upgrading in terms of complexity content. Section 5 concludes.

2 Technological relatedness, extra-regional knowledge and firm innovation

The rapid advances in ICT have posed the question on the effective relevance of geographical proximity in favouring knowledge spillovers. Indeed, as the innovation process increasingly benefits from *learning by interacting* (Lundvall and Johnson, 1994), the social dimension of innovation gains in importance and social and relational proximity could turn to matter for innovation more than colocation of agents in the same geographical space (Boggs and Rantisi, 2003; Breschi and Lissoni, 2001, 2009). Nonetheless, the economic literature has shown that knowledge externalities, which play a relevant role in economic growth (Arrow, 1962; Romer, 1986b,a; Grossman and Helpman, 1993), are geographically localised (Jaffe et al., 1993) and importantly enhance firm innovation, especially in small and medium size firms (Audretsch and Feldman, 2004). 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) as, in order to learn from the local knowledge pool, firms need to be able to absorb the relevant knowledge and thus need to be cognitively proximate to the local environment (Boschma, 2005). As a consequence, the notions of geographical and cognitive proximities are intertwined (Autant-Bernard, 2001; Baptista and Swann, 1998; Orlando, 2000).

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; Boschma et al., 2013; Neffke et al., 2011) with cognitive proximity across industries being mainly measured on the basis of the the proximity indexes proposed by Hidalgo et al. (2007) or by Neffke and Henning (2008). Concerning the importance of the existence of a pool of related variety knowledge for innovation, with patent data and the citation records for U.S. states,Castaldi et al. (2015) found evidence to illustrate that related variety in a region facilitates innovation because related technologies are more easily recombined into a new technology.

Although the geographically immobile nature of place-specific both tacit and codified knowledge makes of innovation 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, also in this case as for the case of the local pool 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 notion 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. 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 related extra-regional knowledge in shaping the process of regional economic growth. Differently from Boschma and Iammarino (2009), we focus on an emerging economy case, measure relatedness à la Hidalgo et al. (2007) and we inspect the relevance of related extra-regional knowledge for new products additions by manufacturing firms. More importantly, beyond the inspection of extra-regional knowledge embedded in import flows, we explore the importance of extra-regional knowledge brought into the local economy by affiliates of foreign firms.

In this respect, we consider knowledge spilling from foreign firms as extra-regional because we believe that it is different from knowledge spurring from other 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 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. In addition, especially in the context of an emerging economy, they can be considered as responsible for having extra-regional knowledge created in MNEs' headquarters spill over 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. Indeed, the latter could be reluctant to share their knowledge or the cultural distance between domestic and foreign owned firms could be too large. Then it is an empirical matter to ascertain to what extent innovation activity by domestic firms is spurred 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 by performing an analysis on 5026 domestic firms in the Chinese electronics industry in 2009. They measure domestic firms' innovation as the share of turnover generated by new products and spillovers from foreign firms as the output value share of new products generated by foreign-invested firms in a county-level region. They found that localized innovative activities of foreign firms exert positive and significant influences on product innovation of domestic firms. More specifically, FDI horizontal and vertical spillover reinforce each other although the former is more valuable than the latter to affect innovation of domestic firms. Also, inter-sector knowledge source is positive and significant but intra-sector spillover is illustrated insignificant. Therefore diverse knowledge from other sectors is beneficial to product innovation of domestic firms.[1]

Although we share a similar research question and a similar economic context with the latter work, our empirical analysis substantially differs from it in a number of ways. First, rather than focusing on the share of new products in total output, we look at domestic firms' choice on which product to add to their product basket. We, then, investigate the exact sources of product diversification at the firm level. Second, the extent of cognitive proximity is only limitedly addressed in the mentioned study, as only traditional measures of intra/horizontal and inter-sectoral/vertical spillovers are considered. By considering the product level measure of technological relatedness, instead, we measure in detail the extent of cognitive proximity between products produced by foreign and domestic firms and test whether the impact of foreign firms' presence is mediated in a continuous manner by the extent of technological proximity. Third, while the mentioned study focuses on spillovers from innovative activity of foreign firms 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. Finally, rather than analysing a single industry, 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 the impact of intra- and extra-regional knowledge spillovers on firms' choices over the new goods to produce we estimate the following linear probability model (LPM):

$$\begin{aligned} I_{ip\,t} = \;& \alpha + \beta\phi^{for}_{lp\,t-1} + \mu\phi^{imp}_{lp\,t-1} + \delta\phi^{dom}_{lp\,t-1} + \iota\phi^{firm}_{ip\,t-1} \\ & + \Gamma' X_{i\,t-1} + \eta_i + \chi_p + \lambda_t + \epsilon_{ipt} \end{aligned} \quad (1)$$

where $I_{ip\,t}$ is a dummy denoting the introduction of the product p by firm i at time t, which is equal to one if firm i at time t produces the product p which was not previously produced in any of the NUTS3 regions where firm i is active with one of its plants, and zero for those products which firms never produces either at time t or before. To keep the empirical analysis computationally feasible, for each firm, instead of considering the whole set of producible products available in the product level classification scheme, we build a sub-set of potential products which effectively the firm could introduce, P_{it}. This sub-set includes all products belonging to one of the 2digit NACE sectors where the firm was active in $t-1$. So, while the one values of I_{ipt} are observed, we set I_{ipt} to zero for all products which the firms does not produce and belonging to the set $P_i^{2d\,t-1}$.[2] As we can see from Table 3 just a small percentage

[1] 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.

[2] This strategy is in line with the existing literature which suggests that firms tend to diversify in their sector of

of products are actually introduced. Our analysis is aimed at exploring whether the exclusive product capabilities brought by foreign firms into the local economy generate knowledge externalities affecting the product space evolution of domestic firms.

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 NACE 2-digit industries where the firm records non zero production flows.

The main variable of interest in model 1 is $\phi_{lp\,t-1}^{for}$ which measure cognitive proximity between product p and the pool of productive capabilities embedded in the local production attributable foreign firms at time $t-1$. $\phi_{ip\,t-1}^{imp}$ accounts for related extra-regional knowledge accruing to the local economy through imports, $\phi_{lp\,t-1}^{dom}$ 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. In all cases, technological proximity between product pairs is 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 section 3.3 in the Appendix.

Finally, in our empirical model, we control for a number of time-varying firm level covariates $X_{i\,t-1}$ which are firm size (lab), labour productivity (lp), export (exp), import (imp), foreign ownership status[3] ($foreign$) and a dummy for multi-plant firms ($multiplant$). We then add a variable capturing the local specialisation in product p, which is measured as the average of the RCA indicator in product p across all provinces l where a firm i is active (RCA_{lp}). Finally, the model also includes firm fixed effects, product fixed effect and year dummies. All regressors appear at time $t-1$ in order to mitigate simultaneity concerns. Since some firms

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.

[3]It is worth mentioning that foreign firms in our sample 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.

are active in different provinces, the measures of production proximity at the product level - $\phi^{dom}_{lp\,t-1}$, $\phi^{for}_{lp\,t-1}$, $\phi^{imp}_{lp\,t-1}$ - also vary by firm. We, thus, cluster standard errors at firm level. We will check the robustness of our results by clustering standard errors at product, province and product-province level. Descriptive statistics for the variables of interest ar shown in Table A1 in Appendix **??**.

3.2 Sample and Data Sources

Our sample is made up of Turkish manufacturing firms with more than 20 persons employed introducing a product 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 products, which are defined as the ones firms produce at time t and which did not produce before in any of the regions where the firm operates with one of its plants. 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 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 product and products produced by foreign and domestic firms active in the same province as the firm.[4]

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 the 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.[5] The indicator of technological

[4]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.

[5]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 or equal to 1.

proximity is then obtained as:

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

ϕ_{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 are, indeed, more likely to be simultaneously present in the export basket of a higher number of countries.[6]

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 (Poncet and de Waldemar, 2012; Felipe et al., 2012; Lo Turco and Maggioni, 2016).

In order to investigate the role of the different local external sources of knowledge for a firm's ability to introduce new products, we compute the technological proximity of each product p with the domestic production structure, the foreign production structure and the province level set of imported goods. We then obtain the following indicators:

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

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

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

where RCA_l^{dom}, RCA_l^{for}, and RCA_l^{imp} are the sets of comparative advantage products in provincial domestic production, foreign production and imports. 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 in the domestic, foreign and imported product basket, respectively.

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 weighing each provicial indicator by the firms' output share produced in that province.

By resting on the existing literature highlighting the (Breschi et al., 2003; Neffke and Henning, 2013) importance of internal product specific capabilities in affecting the process of firms' own diversification, we control for the cognitive proximity with a firm's existing pool of productive capabilities which is reflected in the existing product scope:

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

[6] We show in a robustness check that results do not change when including the values $phi_{pp} = 1$ in the computation of the above indicators does not lead to significantly different results.

4 Results

4.1 Baseline

Table **??** reports the estimated results of equation 1 in Columns [1]-[5]. It is interesting to notice that our main variable of interest is positively and significantly related to local firms' probability of starting producing a new good never produced before in the same NUTS3 region 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 increases a firm's probability to introduce a specific product by 0.13% 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. 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%. This points at 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). 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 firms/products on the one side and its environment on the other (Boschma and Frenken, 2006).

This 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).

In Columns [6]-[10] of the Table we adopt an alternative definition of innovation. Here 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 NACE 2-digit 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 in this case results are different, as 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 on 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.

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 brought 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.

Robustness The above evidence is robust to a number of robustness checks that are shown in Tables **??** and **??** for the two contrasting definition of innovations. First, we show that results do not substantially change when we exclude of 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 both Tables, 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 account for 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 of the total share of imports on manufacturing production in region l, $prod_sh_l^{for}$, (Column [4] in both Tables). By the same token, results are robust when, in Column [5], we account for 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.[7] From Column [7], our baseline evidence is maintained when we enlarge the sample and consider as potential new products all products regardless of their inclusion in the set of all products belonging to one of the 2digit NACE sectors where the firm was active in $t-1$. Finally, our evidence is robust to alternative ways of calculating the technological proximity indicator: i) by considering proximity to products produces only in the firm's main province; ii) by including 1 values, that is proximity between firm's product p and the same product produced by local and foreign firms.[8] It is worth noticing that when the latter definition of relatedness is adopted the coefficient on proximity to foreign firms' product basket turns negative and significant in Table **??**. This implies 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.[9]

4.2 Extension: does product complexity moderates the effects of technological relatedness?

In this section we explore whether and how a product complexity level moderates the impact of technological relatedness to foreign, local and firm product capabilities. This line of enquiry emerges from the fact that, if foreign firms are technological gatekeepers and help the introduction of pioneer goods and technologies in the region, it must be more so for those products requiring a vast set of exclusive capabilities, usually scarce in a developing economy context. Extant evidence on the country of our analysis, indeed, points at spillovers from foreign firms increasing the complexity level of new products (Javorcik et al.). We therefore extend the above model 1 by including the interactions between the technological proximity measures and a product's complexity, K_p, measured $\grave{a}$ la Hidalgo (2009):[10]

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

[8] Also results are corroborated when we consider the whole set of products in the proximity calculation, regardless of the specialisation pattern.

[9] 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.

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

Table 2: Results I

	New Potential Products in the NUTS 3 - $I^{NUTS3}_{ip\ t}$					**All New Potential Products in the Firm's Product Basket - $I_{ip\ t}$**				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ϕ^{for}_{lp}	0.019***				0.018***	0.001				-0.004
	[0.005]				[0.005]	[0.005]				[0.005]
ϕ^{dom}_{lp}		0.011			-0.007		0.102***			0.059***
		[0.009]			[0.010]		[0.010]			[0.010]
ϕ^{imp}_{lp}			0.013		0.003			0.035***		-0.002
			[0.008]		[0.008]			[0.008]		[0.008]
ϕ_{ip}				0.051***	0.051***				0.153***	0.152***
				[0.004]	[0.004]				[0.004]	[0.004]
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**	0.008**
	[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]
Observations	328867	328867	328867	328867	328867	895659	895659	895659	895659	895659
R^2	0.148	0.148	0.148	0.149	0.15	0.081	0.081	0.081	0.088	0.088
Fixed effects:										
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 $I^{NUTS3}_{ip\ t}$, 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.

$$
\begin{aligned}
I_{ip\,t}^{NUTS3} = \; & \alpha + \beta_0 \phi_{lp\,t-1}^{dom} + \beta_1 \phi_{lp\,t-1}^{dom} * K_p + \mu_0 \phi_{lp\,t-1}^{for} + \mu_1 \phi_{lp\,t-1}^{for} * K_p + \delta_0 \phi_{lp\,t-1}^{imp} \\
& + \delta_1 \phi_{lp\,t-1}^{imp} * K_p + \iota_0 \phi_{ip\,t-1}^{firm} + \iota_1 \phi_{ip\,t-1}^{firm} * K_p + \Gamma' X_{i\,t-1} + \eta_i + \chi_p + \lambda_t + \epsilon_{ipt}
\end{aligned} \tag{2}
$$

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 **??**. 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 concerning firms' own capabilities turns significant but negative. Therefore from this set of results it would emerge that the contribution of both foreign and local capabilities increases while the contribution of firms' related knowledge declines with the extent of product complexity. As the contribution of technological relatedness is significantly shaped by product complexity, we report in Table 4 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.

Turning to results on the broader definition of innovation shown in Columns [6]-[10] of Table **??**, it is interesting to notice that, 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 **??** 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.

4.3 Foreign Firms and the evolution of the product space over the geographical space

To Be Done

5 Concluding Remarks

To Be Done

Table 3: Results II - The moderating role of product complexity

	New Potential Products in the NUTS 3 - $I_{ip\ t}^{NUTS3}$					All New Potential Products in the Firm's Product Basket - $I_{ip\ t}$				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
ϕ_{lp}^{for}	0.019***				0.018***	0.003				0.002
	[0.005]				[0.005]	[0.005]				[0.005]
ϕ_{lp}^{for}*K_p	0.007*				0.005	0.028***				0.022***
	[0.004]				[0.004]	[0.005]				[0.005]
ϕ_{lp}^{dom}		0.014			-0.004		0.099***			0.049***
		[0.009]			[0.010]		[0.009]			[0.009]
ϕ_{lp}^{dom}*K_p		0.024***			0.023***		-0.014			-0.023**
		[0.008]			[0.008]		[0.010]			[0.009]
ϕ_{lp}^{imp}			0.013		0.004			0.034***		-0.004
			[0.008]		[0.008]			[0.008]		[0.009]
ϕ_{lp}^{imp}*K_p			0		-0.004			0.005		0.016**
			[0.006]		[0.006]			[0.008]		[0.008]
ϕ_{ip}				0.053***	0.053***				0.144***	0.143***
				[0.004]	[0.004]				[0.003]	[0.003]
ϕ_{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.

Table 4: Results II - The moderating role of product complexity

K_p	ϕ_{lp}^{for}	ϕ_{lp}^{dom}	ϕ_{lp}^{imp}	ϕ_{ip}
	New Potential Products in the NUTS 3			
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 products			
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.

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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
ϕ_{lp}^{for}	328867	0.171	0.074	0	0.615
ϕ_{lp}^{dom}	328867	0.161	0.060	0.002	0.510
ϕ_{lp}^{imp}	328867	0.165	0.054	0.003	0.511
ϕ_{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