New and Improved: Does FDI Boost Production Complexity in Host Countries?

Running Title: Does FDI Boost Production Complexity?

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Abstract

This paper examines the relationship between the presence of foreign affiliates and product upgrading by Turkish manufacturing firms. The analysis suggests that Turkish firms in sectors and regions more likely to supply foreign affiliates tend to introduce more complex products, where complexity is captured using a measure developed by Hausmann and Hidalgo (2009). This finding is robust to controlling for omitted variables, sample selection and potential simultaneity bias. It is also in line with the view that inflows of foreign direct investment stimulate upgrading of indigenous production capabilities in host countries.

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The academic debate on the process of economic development has recently focused on whether countries' specialisation matters for their future growth pattern (Lucas, 1988; Hausmann *et al.*, 2007). Although a large literature has investigated the drivers of the national production structure at the macro level, little is known about the determinants of product upgrading at the micro level. As aggregate production is the result of micro-level choices and behaviours of individual firms, it is important to understand what allows firms to upgrade their production by introducing more sophisticated products or improving the existing ones.

Innovation and product upgrading in developing countries may be hindered by appropriability issues. In an influential paper, Hausmann and Rodrik (2003) argued that a firm that attempts to introduce a new product into the country faces uncertainty about the underlying cost structure of the economy. If the project is successful, other firms learn that the product in question can be profitably produced and follow the incumbent's footsteps. In this way, the returns to the pioneer investor's cost discovery become socialised. If the incumbent fails, the losses remain private. This knowledge externality means that investment levels in cost discovery are suboptimal.

This paper argues that inflows of foreign direct investment (FDI) may stimulate product upgrading in the host country. Multinational enterprises (MNEs) are creators of innovation, being responsible for the majority of global R&D spending (UNCTAD, 2003). The vast experience gathered from operating around the globe may mean that MNEs possess superior knowledge on the suitability of the host country as the production location for a particular product. Moreover, there is evidence suggesting that MNEs transfer knowledge to their foreign affiliates (Arnold and Javorcik, 2009) and that foreign affiliates are more likely to introduce new products than their indigenous competitors (Brambilla, 2009; Guadalupe *et al.*, 2012). By directly engaging in cost discovery in host countries, MNEs may also stimulate subsequent innovation by domestic rivals.[1] Furthermore, MNEs may provide local producers with better inputs, thus facilitating product innovation. Finally, they might encourage and support their local suppliers' efforts to develop new inputs and to improve the existing ones.[2] By sharing product information and production-related know-how, MNEs may lower the costs of inno-

[1]For instance, in a World Bank survey, 24% of local firms in the Czech Republic and 15% in Latvia reported that they have learned about the availability of new technologies by observing MNEs operating in their country and sector (Javorcik, 2008).

[2]According to the Business Environment and Enterprise Performance Survey conducted jointly by the World Bank and the European Bank for Reconstruction and Development in 25 transition countries, 41.8% of suppliers to MNEs received pressure from their customers to develop new products or services. The corresponding figure for non-suppliers was only 36.8% (Godart and Görg, 2013). According to the same data source, the corresponding figures for the Turkish sample were 90% for domestic suppliers to MNEs and 80% for non-suppliers.

vation and product upgrading on the part of the local suppliers. In sum, inflows of FDI into the same, upstream or downstream sector may facilitate product upgrading by domestic firms.

Our analysis is based on firm-product level data available from the Turkish Statistical Office for the period 2006-2009. We examine the link between the sophistication of new products introduced by Turkish firms and the presence of foreign affiliates in the same industry as well as in the input providing (upstream) and input sourcing (downstream) industries in the same region.

Turkey represents a suitable setting for our analysis. It is one of the few countries that have transformed their productive structure dramatically in the last decades (Hidalgo, 2009). It has also experienced a spectacular surge in FDI inflows during the 2000s. Being an emerging economy, Turkey is likely to have been significantly affected by the knowledge transfer taking place through FDI inflows. Finally, the large size of the country and the availability of information on the location of individual plants belonging to each firm allow us to exploit the geographical dimension of the data.

The object of our analysis is the sophistication level of products newly introduced by Turkish firms. We capture product sophistication using a measure proposed by Hausmann and Hidalgo (2009) who relate the concept of complexity to the extent and exclusivity of capabilities needed to produce a given product. These capabilities, which are neither directly observable nor measurable, are inferred by jointly exploiting information on the prevalence of a given product in the countries' export baskets and export diversification of countries that export it.[3]

The existing literature investigating the determinants of product upgrading tends to equate upgrading with an increase in unit values (Hallak, 2006; Manova and Zhang, 2012; Harding and Javorcik, 2012; Bas and Strauss-Kahn, 2015). Unit values are highly imperfect as (in addition to reflecting quality) they may be capturing production costs, market power, or noise due to both aggregation and measurement error.[4] A notable exception is the work of Khandelwal (2010) and Khandelwal *et al.* (2013) who estimate quality by exploiting information on unit values and quantities, based on the insight that higher quality products are those with higher market shares conditional on price. In all these studies, the concept of quality refers to product differentiation, vertical in the former case and also horizontal in the latter case and is measured within strictly defined products. In contrast, the

[3] In the paper, we use the words "complexity" and "sophistication" interchangeably.

[4] Hallak and Schott (2011) develop a method for decomposing countries' observed export prices into quality versus quality-adjusted components under the assumption that, holding observed export prices constant, countries with trade surpluses offer higher quality than countries running trade deficits. They find that observed unit value ratios can be a poor approximation for relative quality differences.

aim of the Hausmann and Hidalgo (2009) indicator is to rank products according to the sophistication of their production process. Although this measure can still in part capture a higher quality level of products (when higher quality translates into a higher number of capabilities needed in the production process), its scope is wider since it allows to compare products that may be very different in terms of use and cannot be compared in terms of quality in its traditional sense. Moreover, our focus on the complexity indicator is related to our interest in examining the impact of FDI on the development of firms' new and exclusive production skills and their ability to combine them in new and more sophisticated and less ubiquitous goods.

We investigate the impact of FDI in the same, upstream and downstream sectors. However, our main explanatory variable of interest is the presence of multinational firms in the downstream (input sourcing) sectors, since we expect FDI in input-sourcing sectors to serve as the primary channel of knowledge transfer to host countries (see Javorcik, 2004; Havranek and Irsova, 2011). Indeed, FDI in the same and the upstream sectors will never turn out to matter in the analysis. FDI variables are defined at the level of NUTS2 Turkish regions,[5] based on the assumption that physical proximity both increases the likelihood of engaging in contractual relationships and eases the technology and knowledge transfers from foreign affiliates to domestic firms. We control for unobservable heterogeneity by including region-year and industry-year fixed effects.

Our focus on new products means that we need to address the possible selection bias resulting from the fact that only some Turkish producers choose to introduce new products. Our approach thus relies on the estimation of a Heckman selection model. In the selection equation we model the determinants of introduction of a new product, and in the outcome equation we focus on the determinants of the complexity of the newly introduced product(s). As the exclusion restriction, we use the lag of industry concentration at the regional level (excluding the firm in question). We believe that industry concentration should be closely linked to the probability of product innovation, as highlighted by the existing literature (Nickell, 1996; Blundell *et al.*, 1999), but should not affect the sophistication of newly introduced products.

We find that while the presence of foreign affiliates does not affect the likelihood of a new product being introduced, it does affect the complexity of new products. More specifically, sophistication of the products newly introduced by domestic firms is positively correlated with the presence of MNEs

[5]NUTS stands for Nomenclature of Territorial Units for Statistics.

in the downstream sectors (i.e., sectors which the innovating Turkish firms are likely to supply). This finding is consistent with the view that interactions between MNEs and their Turkish suppliers may boost the latter's ability to upgrade their production structure. The existence of a positive relationship between the presence of foreign affiliates and increasing sophistication of Turkish manufacturers in the supplying industries is also corroborated when we investigate the change in the overall complexity of the firm's portfolio of products and account for unobservable firm-level heterogeneity.

Although we control for region-year and industry-year fixed effects, it is possible that some unobservables varying at the industry-region-year level could be affecting our findings or that MNEs may anticipate local firms' ability to expand their production into more complex goods and therefore MNEs locate in those areas. To address these possibilities, we show that our results are robust to using the instrumental variable (IV) approach. The starting point for our first instrument is the view that Turkey is an attractive destination for FDI thanks it to its low wages and customs union with the European Union (EU), which means, however, that Turkey is in direct competition for FDI with Eastern European members of the EU, particularly the largest one, Poland. To build our instrument we utilise information on industry-specific FDI stocks found in Poland. Also, anticipating that less developed regions within Turkey may be less attractive to foreign investors, we identify such regions using information on the pre-sample (2005) level of Socio-Economic Development Index from the Turkish State Planning Organization. Our first instrument is, then, an interaction between the logged stock of FDI received by Poland in a given sector in a given year and an indicator variable denoting underdeveloped regions of Turkey in the pre-sample period. This instrument captures two push factors (competition from Poland and regional backwardness), so we expect it to bear a negative sign in the first stage regressions. The second instrument captures the distribution of global supply of FDI across sectors by using the logged stock of outward FDI from OECD countries disaggregated by investor country, sector and year. Since the existing literature has documented the negative effects of information asymmetries on capital flows (Portes *et al.*, 2001; Portes and Rey, 2005; Gelos and Wei, 2005) and has shown that they are particularly strong for FDI (Daude and Fratzscher, 2008), we weight the stock of FDI by newspaper exports from a given Turkish region to a given country in the pre-sample year. Thus, our instrument is the weighted average of outward FDI stocks of OECD countries in a given industry where the weights proxy for the information flows between each Turkish region and a given source country. The IV results confirm the main message of the paper by showing a positive relationship between the presence of foreign affiliates and increasing sophistication of products newly introduced by Turkish firms in the supplying industries.[6]

In the final exercise, we allow for heterogeneous effects on different types of Turkish firms. The analysis suggests that multinational customers represent a convergence force. The most beneficial effects stemming from their presence are absorbed by indigenous innovators that are smaller and endowed with a lower pre-existing sophistication level. This is consistent with the view that MNEs tend to do business with multiple suppliers in order to avoid excessive reliance on a single source of inputs.

Throughout the analysis, we do not find a statistically significant impact of MNE presence in the same or in the input providing industry on product upgrading by Turkish firms. This is consistent with our priors that contacts between MNEs and their local suppliers are the main channel through which knowledge spillovers from FDI take place. As expected, such spillovers are associated with FDI inflows from high income countries rather than FDI inflows in general.

As for the other possible margins of adjustments, we do not find a statistically significant effect of foreign presence on entry or exit rates of Turkish firms in the same, upstream or downstream industries. Also, Turkish firms that do not introduce new products do not seem to disproportionately expand the production volume of their relatively more complex existing products as a result of FDI inflows. All of this evidence suggests that FDI inflows stimulate upgrading of the host country's production structure primarily by encouraging product upgrading among innovating firms in the supplying sectors.

Our work is related to two strands of the economic literature. First, we contribute to the literature investigating the role of FDI in stimulating economic growth (Borensztein *et al.*, 1998; Alfaro *et al.*, 2004) and transformation of the production and export structure. Recent work has shown that multinationals' activity affects the quality and the sophistication of exports in the host countries (Harding and Javorcik, 2012; Swenson and Chen, 2014), though other studies (Wang and Wei, 2010) have failed to find such a relationship. However, the exact channel through which this phenomenon may be taking place still needs to be investigated in detail. On the one hand, multinationals could themselves produce more technology- and knowledge-intensive goods and could initiate production of goods

[6] Our results are robust to using alternative instruments which we describe in detail in section 3.3.

that have not been produced before in host countries, thus directly contributing to the sophistication of the country's production structure. On the other hand, their presence could encourage local firms to introduce more sophisticated goods. Knowing which channel is at work matters hugely for policy. Our results give support to the latter channel.[7]

Second, we contribute to the extensive literature on FDI spillovers. To date, this literature has almost exclusively focused on the link between the presence of foreign affiliates and the total factor productivity of domestic firms (Aitken and Harrison, 1999; Javorcik, 2004; Goerg and Greenaway, 2004; Havranek and Irsova, 2011).[8] By considering another outcome, the sophistication of newly introduced products, we help shed light on the complex ways through which FDI inflows affect the host economy.

Our findings matter for policy. Rodrik (2006a) states that enhancing an economy's productive capabilities over an increasing range of manufactured goods is an integral part of economic development. As he puts it "The first order of business in development is to learn how to do new things, not to focus on what one already does well." (p. 5). Based on the findings of Hausmann *et al.* (2007), he further argues that countries promoting exports of more sophisticated goods grow faster. He concludes that, although the sophistication of a country's exports is determined in part by its overall productive capacity and its human capital endowment at a point in time, policy also matters. Viewed from this perspective, the results of our study suggest that attracting FDI inflows can stimulate economic growth by facilitating upgrading of the country's productive capabilities. And, thus, they suggest there is room for investment promotion activities, an inexpensive policy that is quite effective in a developing country context (see Harding and Javorcik, 2011).[9]

This paper is structured as follows: the next section introduces the background for our analysis and briefly discusses anecdotal evidence related to our research question; section 2 presents the data sources and discusses measurement issues; section 3 lays out the empirical model and discusses estimation issues; section 4 summarises the conclusions.

[7]The former channel is not the focus of our study, though we do include some descriptive evidence suggesting superior product sophistication of foreign affiliates relative to Turkish firms.

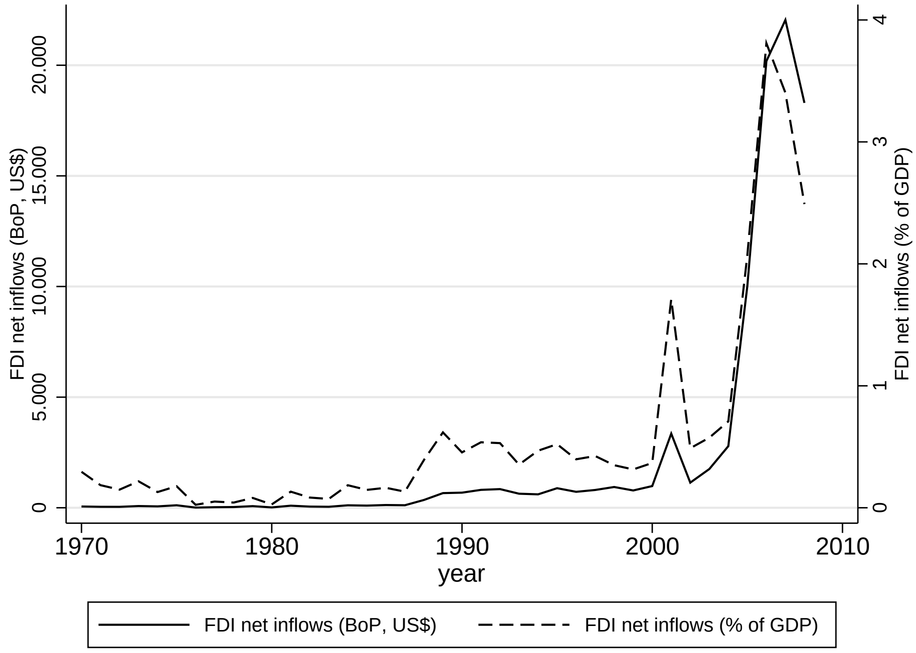
[8]The notable exceptions include the work of Branstetter (2006) who focused on knowledge flows reflected in patent citations, and the work of Griffith *et al.* (2006) who focused on inventors working for a firm's foreign subsidiaries as a conduit of knowledge transfer.

[9]Under some circumstances, inflows of FDI may have a negative impact on the host country welfare. For instance, a theoretical contribution by Lin and Saggi (2007) shows that exclusivity contracts preventing MNE suppliers to supply the domestic rivals of MNEs will result in a welfare loss for the host country. Similarly, Carluccio and Fally (2013) show that technological incompatibilities between foreign and domestic technologies limit the welfare gains from FDI inflows but this negative effect can be compensated by domestic technology adoption.

1 Background and Anecdotal Evidence

In the 1980s, after about 20 years of import substitution, Turkey moved to an outward-oriented development strategy based on liberalising capital account, attracting FDI and promoting exports. Liberalisation policies and important investments in telecommunications infrastructure created a more favourable environment for FDI throughout the 1980s. Nevertheless, as shown in Figure 1, a decisive change in the pace of FDI inflows occurred only after the entry into force of the new Foreign Capital Law in 2003, which removed several important restrictions on operations of foreign affiliates.

Figure 1: *Turkish Inward FDI Flows, 1970-2010*



Source: World Development Indicators 2012.

Foreign affiliates operating in Turkey have recently become quite reliant on the local supplier base. According to the World Bank Enterprise Survey, 65% of total inputs used by foreign affiliates located in Turkey were of domestic origin in 2002. By 2008, this share increased to 76%. The surge in FDI inflows and the increase in the reliance of foreign affiliates on local sourcing have coincided with an increasing sophistication of the Turkish production structure (Hidalgo, 2009).[10]

Anecdotal evidence suggests that the two phenomena may be related, thus supporting the view that buyer-supplier relationships between MNEs and their Turkish suppliers may have stimulated the

[10]To the best of our knowledge, during the period under study there were no changes in regulations pertaining to the treatment of foreign firms or to international trade that would encourage local sourcing by foreign affiliates.

transformation of the Turkish manufacturing sector. Consider the case of Indesit Turkey.[11] Indesit is an Italian white good producer - recently acquired by Whirlpool - active in Turkey since the 1990s. Its plant located in Manisa produces refrigerators. Although initially Indesit entered Turkey primarily to save on labour costs, over time Indesit has increased its reliance on the Turkish supplier base. In the beginning of its operations in Turkey, Indesit imported most of the components needed for production of the final products. Now Indesit sources locally almost all of the main components, and more than half of its supplier base is currently located in Turkey, mostly in the same industrial district as its Manisa plant. Geographical proximity to suppliers is indeed crucial for keeping down the transport costs and allowing for a more efficacious collaboration with the suppliers. Indesit regularly conducts audits of its suppliers. It also helps suppliers with starting production. The vast pool of engineering know-how and experience stemming from previous experiences of working with local suppliers in other parts of the world is shared with Turkish business partners.

Indesit's relationship with a stainless steel sheet pressing (SSSP) company located in Manisa is an example of how foreign affiliates stimulate upgrading of production complexity in their local suppliers.[12] In 2012, Indesit built a new plant producing washing machines. To become a supplier of this new plant, the SSSP company purchased new presses and automated its production process. This allowed it to start producing a new and more sophisticated product, increase efficiency and the production volume. The SSSP company became the only Turkish supplier of Indesit capable of producing a flange of a washing machine basket which is a steel component with deep drawing illustrated in Figure A.1 in the online Appendix. The flange is not a new component for Indesit. Indesit sources flanges from Italy and Poland for its plants in Italy, Poland and Russia. However, this type of a flange had not been previously sourced by Indesit from Turkey.

The complexity of steel components with deep drawing is not uniform and strictly depends on their aesthetic and physical characteristics.[13] Stainless steel components like a flange need to be produced with no aesthetic defects by 800-1000 tons presses. The component's drawings are statistically controlled to allow for a correct assembly with the rest of the washing machine basket. They also need to withstand a 1000-1400 revolutions per minute stress while remaining within a certain range

[11] This information is based on the interview one of the authors conducted with the company's Sourcing Manager on December 3, 2014.

[12] The name of the company has been omitted during the interview because of confidentiality reasons.

[13] As illustrated in Figure A.1, the flange of a washing machine basket is a much more complex product than a sink. The sink's complexity in turn exceeds that of a pot scourer.

of vibration and noisiness.

Besides investing in automation, the SSSP company introduced new control and maintenance tools and processes. It is also currently collaborating with Indesit on a system to improve the primary input usage by employing scraps. Indesit has shared essential tacit knowledge, information processes, instructions and control procedures with the SSSP company, thus stimulating and supporting the supplier's complexity upgrading.

Similar anecdotal evidence can be found in other sectors.[14] For instance, Pfizer, a pharmaceutical company active in Turkey since the late 1950s, has also developed a large network of local suppliers. Two years ago a Turkish logistics company, which is a partner of Pfizer, invested into new cold-chain logistics systems in order to increase the volume of its business with Pfizer. Thanks to this additional investment and to the know-how it had received from Pfizer on the cold-chain logistic requirements needed to comply with the Pfizer Quality Management system, the supplier has widened its portfolio of services and has been able to strengthen and stabilise its contractual relationship with Pfizer.

Another example is represented by an on-going Pfizer's project aiming to upgrade a product it uses in its transportation system. The current supplier cannot meet the additional requirements but another Turkish firm is willing to make the necessary investment in highly complex machines in order to become a Pfizer's supplier. This investment is very costly, especially when compared to the supplier's regular operational equipment.

Motivated by this anecdotal evidence, in what follows we formally examine the relationship between the presence of foreign affiliates and the complexity of products newly introduced by Turkish firms in the supplying industries. Although we also test for the link between the presence of FDI in the same and the upstream sector, these will turn out not to play a statistically significant role.

The focus on product innovation in Turkey is motivated by our interest in shedding light on the country's manufacturing evolution. It is supported by Figure A.2 in the online Appendix. Here, Panel A shows the spatial distribution of industrial production in Turkey in the year 2005 and documents an important divide between the laggard Eastern regions and the industrial Western ones, in line with the evidence from Table A.1. More noteworthy, Panel B and C in the figure reveal that new products are an important driver of regional industrial growth, especially in the laggard Eastern regions. These

[14] This information has been obtained by means of email interviews conducted by one of the authors with a Pfizer manager in October/November 2014.

patterns are in line with the view that new products represent an important factor behind the industrial evolution of Turkey.

2 Data Sources and Measurement Issues

2.1 *Data Sources*

Our sample covers all manufacturing firms with more than 20 employees operating in Turkey in the period 2006-2009. It was created by merging the Structural Business Statistics (SBS) with the Turkish Annual Industrial Product Statistics (AIPS). Both data sources are available from the Turkish National Statistical Office. The former source provides information on a wide number of firm characteristics, while the latter allows for the identification of each firm's product scope and newly introduced products.

We use the SBS to retrieve information on firms' output, input costs, employment and foreign ownership. Turkstat provides information on foreign ownership from 2006 onwards. We follow the OECD definition and classify as domestic those firms whose foreign capital asset share is lower than 10% (OECD, 2008). Unlike many similar data sources from other countries, the SBS contains information on a firm's plants, including the number of plants, location of each plant (NUTS2 region), its employment, turnover and NACE sector.[15] We use the SBS to build proxies for the presence of foreign affiliates in each region-sector combination.

From the AIPS we get information on firms' products 10-digit PRODTR classification).[16] For each product, we know its code, volume of production, value of production and sales for the years 2006-2009 for all manufacturing firms with more than 20 employees. We identify new products starting from 2006 on the basis of firms' product baskets. Our analysis is performed on the sample of domestically owned manufacturing firms.[17]

Tables A.1 and A.2 in the online Appendix describe the sectoral and regional distributions of all

[15] NACE is the statistical classification of economic activities in the European Union.

[16] The PRODTR is a national product classification whose first 6 digits correspond to CPA (Classification of Products by Activity) codes and which includes about 3,700 different products.

[17] We exclude from our analysis firms operating in NACE sector 16 (Manufacture of tobacco products) and 23 (Manufacture of coke, refined petroleum products and nuclear fuel) because of the nature of the activities they perform. We also drop sector 25 "Rubber and Plastics" because of suspected mis-measurement of foreign presence. This sector represents less than 5% of the original sample. Including this sector in the analysis would not affect the significance of the results and the main insights of the analysis. We trim the top and the bottom percentile of the size and the productivity distributions, though not doing so would not affect the conclusions of our study.

firms and of innovators (i.e., firms introducing new products) in our sample. In terms of the sectoral distribution, firms are mainly concentrated in traditional comparative advantage sectors, such as, Food (NACE 15), Textiles (NACE 17), and Apparel (NACE 18). They are also well represented in Non-Metallic Mineral Products (NACE 26), Metal Products (NACE 28), and Machinery and Equipment (NACE 29). As for the geographical distribution (Table A.1), we find that Istanbul accounts for about 43% of all firms in our sample and Izmir, Bursa and Ankara account for a further 23% of the total number of firms. This is consistent with the country's development stage and indicates that the relatively recently developed manufacturing sector is quite concentrated in a few regions. Turning to the importance of product innovators, as visible in the tables, they constitute a non-negligible share of firms across all regions and sectors, and their distribution across both dimensions mimics the distribution observed for the full sample.

To create a measure of product sophistication we apply the Hausmann and Hidalgo (2009) approach to the BACI database compiled by CEPII (Gaulier and Zignago, 2010). This database includes bilateral export flows at the 6-digit Harmonised System (HS) level (1996 version). We use the information for year 2002. To match firm-product-level production data from Turkstat with the product-level information obtained from BACI, we first converted 6-digit HS codes into the CPA classification codes by means of the HS-CPA correspondence table provided by the Eurostat. Then, we constructed a harmonised classification that is slightly more aggregated than the CPA classification (we refer to it as HCPA). Although the CPA classifies 1,390 distinct products, the HCPA classification contains 1,297 products of which 1,030 are actually produced in Turkey. Hereafter, a product code refers to a product as defined in the HCPA classification.

2.2 *Measuring Product Complexity*

We measure the sophistication of Turkish firms' production by means of the complexity indicator proposed by Hausmann and Hidalgo (2009). Before we explain the measure in detail, it is helpful to illustrate it with an analogy mentioned by Hausmann and Hidalgo (2009) and Felipe *et al.* (2012).

Imagine that a country is represented by a bucket of Lego pieces with each piece representing the capabilities available in the country. The set of products (i.e., Lego models) a country can produce depends on the kind, diversity, and exclusiveness of the Lego pieces in the bucket. A Lego bucket that contains pieces that can only be used to build a toy bicycle probably does not contain the pieces to create a toy car. However, a Lego bucket that contains pieces that can build a toy car may also have the necessary pieces needed to build a toy bicycle.

While two Lego buckets may be capable of building the same number of models, these may be completely different sets of models. Thus, determining the complexity of an economy by looking at the products it produces amounts to determining the "diversity and exclusivity" of the pieces in a Lego bucket by simply looking at the Lego models it can build.

Hausmann and Hidalgo (2009) start from the assumption that the bipartite - country-product - network of world trade originates from a larger tripartite network. This tripartite network links countries to the capabilities they are endowed with and products to the capabilities they require in their production process. Hence, capabilities are the unobserved network nodes connecting countries to products they produce. Using the information retrieved from the world trade data, they first define *diversification* as the number of products in which a country has a revealed comparative advantage (RCA), and *ubiquity* as the number of countries with a RCA in that product.[18] These can be considered the simplest measures of complexity of a country and a product, respectively, and are calculated as:

$$\begin{aligned} Diversification:\ K_{c,0} &= \sum_p dRCA_{cp} \\ Ubiquity:\ K_{p,0} &= \sum_c dRCA_{cp} \end{aligned} \quad (1)$$

where $dRCA_{cp}$ is an indicator variable denoting whether country c has a comparative advantage in product p. In the Lego analogy, the former measure is expected to represent the number of models a Lego bucket can create, while the latter should reflect the commonness (or the inverse of exclusivity) of the Lego pieces in the bucket. The intuition is that a less ubiquitous product requires more exclusive capabilities. Nonetheless, the extent of diversification and ubiquity are only imprecise measures of complexity, as not only the availability and usage of a wide variety of capabilities, but also the level of their exclusivity is important in the definition of sophistication of countries and products. Therefore, Hausmann and Hidalgo (2009) apply the Method of Reflections which consists of refining these rough complexity indicators by calculating jointly and iteratively the average value of the measure

[18] The index of revealed comparative advantage is defined as the ratio of the export share of a given product in the country's export basket to the share of the product in the world's exports. A country is considered to have a RCA in a given product if the value of the ratio exceeds one.

computed in the preceding iteration. After *n* iterations, these are given by:

$$K_{c,n} = \frac{1}{K_{c,0}} \sum_p dRCA_{cp} * K_{p,n-1} \tag{2}$$

$$K_{p,n} = \frac{1}{K_{p,0}} \sum_c dRCA_{cp} * K_{c,n-1}$$

Thus, the two indicators iteratively identify a country's complexity by means of its specialisation in products that are not only less ubiquitous but also exported by complex countries. Complex countries are defined as those exporting a larger number of less ubiquitous products. And a product's complexity is defined based on its presence in the export basket of fewer complex countries. Iterations stop when no more information can be drawn from the world trade map, that is, there is a perfect rank correlation between iterations *n* and *n+1*. Even numbered iterations for $K_{c,n}$ give measures of countries' diversification, while odd numbered iterations for $K_{p,n}$ give measures of products' complexity.

As in our analysis we are interested in products' complexity we focus on $K_{p,n}$ and we stop iterations at $n = 13$. Thus, we employ the $K_{p,13}$ index. We standardise the complexity indicator for each product p, $K_{p,13}$, by subtracting its mean and dividing it by its standard deviation. It is worth stressing that the iteration procedure provides a more detailed and more precise ranking of products in terms of their complexity. This can be illustrated by comparing the product ranking based on the simple ubiquity measure, $K_{p,0}$, to the one based on our complexity measure $K_{p,13}$. While $K_{p,0}$ is able to identify only 73 different rank positions, $K_{p,13}$ ranks differently each of the 1,297 goods in the HCPA classification. For example, in 2002 the HCPA products "Spacecraft (including satellites) and spacecraft launch vehicles" (35.30.40) and "Tin tubes, pipes and tube or pipe fittings" (27.43.29) share the same ranking in terms of product ubiquity, $K_{p,0}$, that is they share the 69th position as only seven countries have a RCA in exporting them. According to the refined product complexity indicator $K_{p,13}$, the former product is ranked 29th and the latter 848th, which is clearly a more intuitive ranking.[19]

Furthermore, the complexity indicator is highly correlated (correlation of 0.74) with another so-

[19]The number of exporters with RCA in a given product ranges from 3 to 97 with a median value of 23 and the first and last deciles of 12 and 43.

phistication indicator used in literature, the $PRODY$ index (Hausmann *et al.*, 2007). The latter relates a product's complexity to the average income level of its exporters, by weighing each country's income with its RCA index in the product. Indeed, after removing the information on per capita income, $PRODY$ collapses to $K_{p,1}$. This implies that the $PRODY$ indicator relies more on the structure of the network connecting countries to the products they export than on the income of countries. This suggests that the explanatory power that this measure of sophistication and its country level counterpart, $EXPY$, have demonstrated (Rodrik, 2006b; Hausmann *et al.*, 2007) stems from the information on the diversification of countries and on the ubiquity of products (Hidalgo, 2009). Both diversification and ubiquity are exploited in our product complexity indicator.

Finally, going back to our anecdotal evidence, it is interesting to notice that the washing machine component (flange), which corresponds to the HCPA 29.54.42, has a complexity level of $K_{p,13} = 1.034$, which is higher than the complexity level of another - relatively simpler - steel product with deep drawing, namely a sink (HCPA 28.75.11) whose complexity level is $K_{p,13} = 0.529$. Finally, both products are more complex than other stainless steel products which do not require deep drawing, such as pot scourers (HCPA 28.75.12) whose complexity level is $K_{p,13} = -0.197$. See Figure A.1 in the online Appendix.

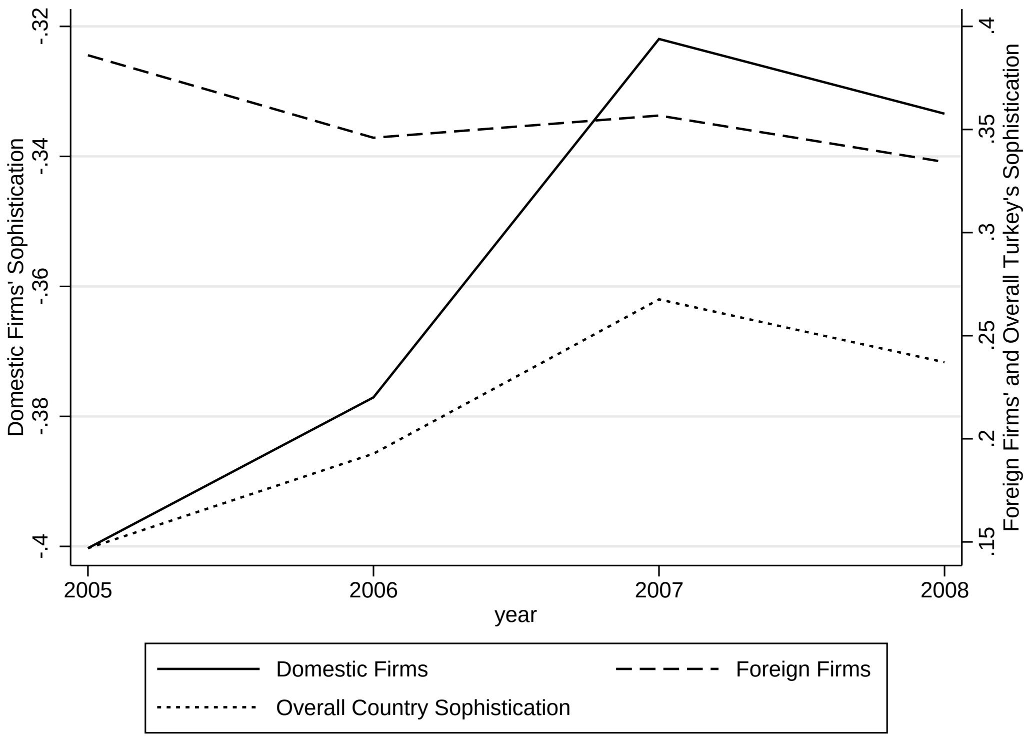
Figure 2 contrasts the evolution of Turkish firms' average production complexity (left axis) with the path of foreign firms' average complexity (right axis) and with the overall production sophistication in Turkish manufacturing (right axis).[20] More specifically, we aggregate production of domestic firms at the product level. We do the same for foreign firms. Then, we calculate the weighted average of the complexity of products produced by domestic and foreign firms, respectively. The country-level complexity indicator is computed on the basis of aggregate trade flows. The picture shows the superior product sophistication level of foreign firms vis-à-vis the domestic ones. The latter, nonetheless, experience a significant upgrading of their product sophistication which drives the overall pattern observed for the Turkish manufacturing sector.

Figure A.3 in the online Appendix contrasts the evolution of country-level complexity measures for Turkey, the US and the EU15 during 2004-8 (defined as described in footnote 20). The upper panel of the figure plots Turkey's complexity relative to that of the US and the EU and shows that Turkey's

[20] Country level production complexity for Turkey refer to $K_{c,20}$, which is computed on the basis of equation 2 by exploiting BACI trade data. We stop iterations at n = 20, when no more information can be gathered from the world trade network, that is there is a perfect rank correlation between iterations 20 and 21.

production complexity is converging to the levels found in the advanced economies. The lower panel, showing absolute complexity levels, suggests that this converging trend is attributable to the steadily increasing, albeit lower, level of product complexity in the Turkish economy. The same patterns can be found when we consider individual sectors from which we have drawn our anecdotal evidence (Metal Products, Chemicals and Pharmaceuticals) as well as Machinery & Equipment and Transport Equipment (see figures A.4-A.7 in the online Appendix).

Figure 2: *Evolution of Product Sophistication in Turkey*



Sources: BACI and TurkStat SBS. Own Calculations.
The left axis measures product sophistication of domestically-owned manufacturing firms, while right axis measures product sophistication of foreign firms operating in Turkish manufacturing and the country level complexity computed on the basis of aggregate world trade flows.

Since the aim of our analysis is to shed light on determinants of product upgrading, for each firm i in our sample we calculate the weighted average, K_{it}^{New}, of the complexity level of new products introduced by the firm at time t as:

$$K_{it}^{New} = \sum_{p=1}^{P_{it}^{New}} K_{p,13} * \frac{Y_{ipt}}{\sum_{p=1}^{P_{it}^{New}} Y_{ipt}} \quad (3)$$

where P_{it}^{New} is the number of new goods introduced by firm i at time t, while Y_{ipt} is its production value of good p.[21] Similarly, by considering all products produced by the firm in year t we obtain the weighted average of the complexity level of the firm's product basket, K_{it}^{All}.

2.3 *Measuring FDI Spillovers*

To capture the impact of foreign firms' presence on the sophistication of products newly introduced by Turkish firms, we use the standard proxies for horizontal and vertical spillovers employed by the literature (see, e.g., Javorcik (2004)). We compute these proxies at the region-sector-year level, thus exploiting both regional and cross-industry variation in the presence of foreign owned firms over time. Regions are defined at the NUTS2 level, with a total of 26 regions, whereas sectors are defined at the 2-digit NACE level, with a total of 19 manufacturing sectors.

Our spillovers proxies are compiled based on the information on foreign owned firms with more than 20 employees, their sector of activity, location and output available from the SBS.[22] A proxy for horizontal (intra-industry) spillovers in sector j and region r at time t is defined as the average foreign equity share, $ForeignShare$, in firms in the sector-region cell weighted by each firm $i's$ share in the cell's output in a given year:

$$Horizontal\ FDI_{jrt} = \frac{\sum_{i=1}^{N_{jrt}} Y_{it} * ForeignShare_{it}}{\sum_{i=1}^{N_{jrt}} Y_{it}} \tag{4}$$

with N_{jrt} indicating the number of firms in region r which are active in sector j and year t, and Y_{it} denotes the output of firm i in year t. Since we consider the regional dimension, in order to build our spillover indicator we employ plant-level information on output and we attribute to each foreign plant the corresponding foreign equity share declared at the firm level.[23]

To create a proxy for the foreign presence in downstream (input sourcing) and upstream (input supplying) sectors, and thus investigate potential vertical spillovers, we combine the $Horizontal\ FDI$ indicator in equation 4 with the national Input-Output table (for domestic production) for Turkey

[21] Our baseline results are robust to using a simple average or the maximum level of complexity.

[22] Since the SBS collect information for just a rotating sample of firms with fewer than 20 employees, we focus on the population of firms with more than 20 employees. We believe that the exclusion of small firms from the calculation does not represent a severe problem due to the small share of output accounted for by this part of firms' population and due to the evidence that most of foreign owned firms are large.

[23] We also compute weights on the basis of firms' employment shares and we test the robustness of our findings to the use of spillover measures based on employment.

in the year 2002. We, then, build the following proxies for spillovers through backward and forward linkages, respectively:

$$Downstream\ FDI_{jrt} = \frac{\sum_{s=1,s\neq j}^{S} HorizontalFDI_{srt} * Sales_{js}}{\sum_{s=1}^{T} Sales_{js}} \tag{5}$$

$$Upstream\ FDI_{jrt} = \frac{\sum_{s=1,s\neq j}^{S} HorizontalFDI_{srt} * Purchases_{js}}{\sum_{s=1}^{T} Purchases_{js}} \tag{6}$$

where $Sales_{js}$ and $Purchases_{js}$ are respectively the total sales and purchases of sector j to/from a manufacturing sector s. $1, .., S$ denote the manufacturing sectors, while $S, .., T$ denote the remaining non-manufacturing sectors. Sector j is a firm's main sector of activity. Note that in order to separate intra-industry and inter-industry effects, we exclude sourcing and supplying relationships taking place within the sector.

Figures A.8 and A.9 in the online Appendix show the evolution of $Horizontal\ FDI$, $Downstream\ FDI$ and $Upstream\ FDI$ variables by region and sector, respectively. We can observe the existence of a large variation across regions, across sectors and across time in the presence of foreign multinationals. Although the highest shares of foreign output are recorded in the country's most industrialised regions, e.g. Istanbul, Ankara, Izmir and Manisa, foreign presence is also non-negligible in less developed Eastern regions, such as Malatya and Mardin. Foreign firms are responsible for a significant share of output (more than 10%) in Chemicals (24), Metal Products (28), Electrical Appliances (31) and Motor Vehicles (34). Their presence is also considerable (7% of total output) in more traditional sectors, where Turkey enjoys comparative advantage, such as Food (15) and Clothing (18). Significant variation is also visible, albeit to a lesser extent, in the presence of foreign firms in upstream and downstream industries.

To get a sense of the correlation between the spillover variables and the firms' sophistication level of new products, K^{New}, as well as of the existing ones, K^{All}, Table 1 reports the value of complexity indicators by quartile of spillovers' measures. As firms may have plants in more than one region, for each firm we take the simple average of the above spillover proxies across all regions of operation.

Thus, in the remainder of the paper, spillover measures will vary by firm and year. It is straightforward to notice that firms more exposed to the presence of foreign firms in the same sector or in upstream or downstream sectors tend, in general, to produce and to introduce goods characterised by a higher sophistication level, though the relationship is not monotonic. The pattern is, however, particularly striking when the presence of MNEs in downstream sectors is considered.[24]

Table 1: *Sophistication of Newly Introduced Products and FDI Presence*

Quartile	K^{New}	K^{All}
$Horizontal\ FDI$		
$q1$	-0.344	-0.397
$q2$	-1.015	-1.122
$q3$	-0.485	-0.555
$q4$	0.244	0.273
$Downstream\ FDI$		
$q1$	-0.997	-1.088
$q2$	-0.743	-0.799
$q3$	0.114	0.086
$q4$	0.075	0.054
$Upstream\ FDI$		
$q1$	-0.328	-0.309
$q2$	-1.178	-1.327
$q3$	-0.100	-0.130
$q4$	0.061	0.023

Sources: TurkStat AIPS and SBS. Own calculations on 5674 total observations.

3 Empirical Strategy and Results

3.1 *Baseline Specification*

As our analysis aims to investigate the complexity of newly introduced products, we need to deal with the selection issue. Not all firms introduce new products, and it may not be random which firms do so. We address this issue by estimating a Heckman selection model by maximum likelihood. To model the probability of innovation we use the extent of competition faced by domestic firms in the region-industry cell as an exclusion restriction. The level of competition is proxied by the Herfindahl index computed based on the total output in the region-industry cell (excluding the firm in question). In other words, we argue that innovation activity is affected by the extent of competition (Nickell, 1996; Blundell *et al.*, 1999) but that the extent of competition has no effect on the complexity level of newly introduced goods.[25]

[24] t-tests show that firms that operate in sector-region cells where the presence of potential foreign competitors, suppliers and customers exceeds the median value introduce products that are significantly more complex than the ones introduced by firms located in other sector-region cells. This piece of evidence is not shown here for the sake of brevity, but it is available upon request.

[25] We tested directly the latter assumption and could not reject it in our data.

We then examine the impact of foreign firms' presence on the complexity of products newly introduced by domestic firms by estimating the following specification:

$$\begin{aligned} K_{it}^{New} = \alpha_1 Downstream\ FDI_{it-1} + \alpha_2 Upstream\ FDI_{it-1} + \\ + \alpha_3 Horizontal\ FDI_{it-1} + \boldsymbol{\beta}' \boldsymbol{x}_{it-1} + \hat{\lambda}_{it} + \gamma_{jt} + \delta_{rt} + \epsilon_{it} \end{aligned} \tag{7}$$

where K_{it}^{New} represents the product complexity across all new goods introduced in year t by firm i which is located in region r and whose main sector of activity is sector j. All the explanatory variables enter the specification with a one-year lag in order to mitigate simultaneity issues. As a consequence, our dependent variable is observed in years 2007-2009 and our explanatory variables pertain to years 2006-2008. The impact of foreign firms operating in the same sector j and the same region is captured by $Horizontal\ FDI$. To further mitigate endogeneity concerns, we compute the $Horizontal\ FDI$ variable excluding the output of firm i from the denominator of equation 4.[26] The effect of foreign presence in upstream sectors in the same region is captured by $Upstream\ FDI$, while $Downstream\ FDI$ captures the regional presence of foreign firms in downstream sectors and represents our main variable of interest. As mentioned above, since firms may have plants in more than one region, for each firm we take the simple average of the above proxies across all regions of operation. Thus, spillover measures vary at the firm level and hence we cluster standard errors at the firm level.[27]

In our empirical model, we control for a number of relevant firm-level characteristics (x_{it-1}). This set includes the average complexity of the firm's product basket in the previous period K_{it-1}^{All}. We expect that firms that produced more sophisticated products in the past have the resources and capabilities to introduce new products with a higher level of complexity. We also control for other potential determinants of the complexity level of new products: firm size ($Size_{it-1}$) measured as the log of the number of employees, labour productivity ($Labour\ Productivity_{it-1}$) defined as the log value-added per worker, the share of employees engaged in R&D activities ($R\&D\ Employment\ Share_{it-1}$) and the firm's average wage ($Wage_{it-1}$). $\hat{\lambda}$ represents the inverse Mills ratio. Finally, we add 2 digit NACE sector-year, γ_{jt}, and NUTS 2 region-year, δ_{rt}, fixed effects. We, thus, account for the possibility that

[26] However, results are very similar when this correction is not implemented.

[27] We have also experimented with a weighted average where the regional output shares were used as weights. Using this alternative approach does not change the main findings of this paper. Furthermore, the same insights emerge when we consider only the main region of activity. Finally, we will show later that our results are robust to alternative standard errors clustering.

multinationals choose specific sectors and specific regions when entering Turkey because of their attractiveness. Sector-year and region-year fixed effects also account for time-varying shocks such as regional and sectoral demand shocks. Table A.3 in the online Appendix presents the descriptive statistics for our complexity measures and explanatory variables.

Before we implement the above model, we want to establish a benchmark by estimating an OLS version of specification (7) (ignoring the the inverse Mills ratio $\hat{\lambda}$) on the subsample of innovating firms. This will give us some basis against which we will compare our findings from the selection model. The estimation results are presented in Table 2. The proxies for FDI presence first enter one by one and then all together. The results suggest a positive relationship between the foreign presence in the downstream sectors and the complexity of new products introduced by Turkish firms. This is true when $Downstream\ FDI$ enters the specification by itself as well as in the full specification. This finding is consistent with Turkish firms benefiting from their relationships with multinational customers and these benefits manifesting themselves in the sophistication of their new products. Foreign presence in the same or the upstream sectors does not appear to be significantly related to the complexity of new products introduced by Turkish firms. Among firm-level controls, only the past sophistication of the production structure and the firms' average wage appear to be statistically significant. As expected, both variables are positively correlated with the complexity of new products.[28]

The main message emerging from the OLS estimates is confirmed by the results of the Heckman selection model presented in Table 3. In the first step, we model the probability of introducing a new product, while the second step focuses on the factors determining the sophistication of newly introduced products. The estimated coefficients of interest and their significance levels remain virtually unchanged relative to the OLS. The selection term, $\hat{\lambda}$, is never statistically significant. Thus, the results suggest that selection bias does not seem to be a serious issue in our model. As far as the exclusion restriction is concerned, the concentration level in the region-sector bears a negative and statistically significant coefficient, thus corroborating part of the literature suggesting a positive impact of competition on innovation (Nickell, 1996; Blundell *et al.*, 1999).

We find that, while the presence of foreign affiliates in the downstream (input buying) sectors is positively correlated with the sophistication of new products, it does not seem to affect the firm's

[28]Note that past sophistication pertains to all products produced by the firm in $t-1$, while the dependent variable pertains only to the newly introduced products.

propensity to introduce a new product. This is true in both specifications presented. The link between the FDI presence in downstream sectors and new product complexity is statistically significant at the one percent level in both specifications. FDI presence in the same or the upstream sector does not seem to matter in either stage.

Moving on to the firm level controls, new products tend to be introduced by firms with a less complex production structure, smaller firms and firms paying lower wages. The past firm complexity turns out to be very relevant in driving the level of complexity of new products, while labour productivity does not seem to affect the sophistication of new products. Higher wages are also positively associated with the complexity of newly introduced goods. In other words, we confirm the evidence from the OLS estimation.

Is the estimated effect economically meaningful? Taking as a reference point the results from column 7 of Table 3, our evidence implies that a 10 percentage point increase in foreign presence in downstream sectors is associated with an increase in the average complexity of newly introduced products by 0.297. This corresponds to about 30% of the standard deviation in our sample. Continuing with the example of steel components, this estimate implies moving about half of the way from the production of pot scourers to producing stainless steel products with deep drawing, such as stainless sinks. An increase of about 17 percentage points in FDI in downstream sectors, instead, would be necessary in order to move from the production of stainless sinks to the production of the washing machine flanges.

3.2 *Robustness Checks*

We subject our findings to a plethora of robustness checks. First, we show that our results are not affected by using a different definition of the dependent variable. In columns 1-2 of Panel A of Table 4, we replace our complexity measure with the well-known measure called PRODY developed by Hausmann *et al.* (2007) and confirm our main conclusions. This is not surprising because our preferred measure and PRODY are highly correlated and lead to a similar ranking of products (as explained in subsection 2.2), even if the iteration procedure used to create the preferred measure is more convincing. In columns 3-4 of Panel A, we use the skilled-labour-intensity of the newly introduced products ($SkillInt^{New}$). This measure was developed by Ma *et al.* (2014) and available from one of the authors'

Table 2: *Baseline Results - OLS*

	K^{New}			
	[1]	[2]	[3]	[4]
$Downstream^{FDI}_{t-1}$	**2.951*** **			**2.965*** **
	[0.766]			[0.765]
$Upstream^{FDI}_{t-1}$		-0,465		-0,493
		[0.809]		[0.816]
$Horizontal^{FDI}_{t-1}$			0,082	0,101
			[0.102]	[0.102]
K^{F}_{t-1}	0.271***	0.272***	0.271***	0.270***
	[0.018]	[0.018]	[0.018]	[0.018]
$Size_{t-1}$	-0,017	-0,017	-0,017	-0,017
	[0.010]	[0.010]	[0.010]	[0.010]
$Labour\_Productivity_{t-1}$	-0,006	-0,005	-0,005	-0,005
	[0.013]	[0.013]	[0.013]	[0.013]
$R\&D\_Employment\_Share_{t-1}$	0,003	0,003	0,003	0,003
	[0.003]	[0.003]	[0.003]	[0.003]
$Wage_{t-1}$	0.099***	0.103***	0.103***	0.099***
	[0.025]	[0.025]	[0.025]	[0.025]
Fixed effects				
Sector*Year	y	y	y	y
Region*Year	y	y	y	y
Observations	5674	5674	5674	5674
R-squared	0,702	0,701	0,701	0,702

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Robust standard errors, clustered by firm, are displayed in brackets.
The dependent variable K^{New} is defined as the weighted average of product complexity calculated across new product(s) introduced by firm i in year t where production shares are used as weights.

Table 3: *Baseline Results - Selection Model*

	2^{nd} Step K^{New}	1^{st} Step $Innovation$	2^{nd} Step K^{New}	1^{st} Step $Innovation$	2^{nd} Step K^{New}	1^{st} Step $Innovation$	2^{nd} Step K^{New}	1^{st} Step $Innovation$
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
$Downstream^{FDI}_{t-1}$	**2.957*** **	0,605					**2.971*** **	0,622
	[0.758]	[0.772]					[0.756]	[0.772]
$Upstream^{FDI}_{t-1}$			-0,472	-0,682			-0,5	-0,717
			[0.800]	[0.790]			[0.807]	[0.793]
$Horizontal^{FDI}_{t-1}$					0,083	0,033	0,101	0,046
					[0.100]	[0.111]	[0.101]	[0.111]
K^{F}_{t-1}	0.270***	-0.071***	0.271***	-0.071***	0.271***	-0.072***	0.269***	-0.071***
	[0.018]	[0.017]	[0.018]	[0.017]	[0.018]	[0.017]	[0.018]	[0.017]
$Size_{t-1}$	-0.017*	-0.048***	-0.017*	-0.048***	-0.018*	-0.048***	-0.018*	-0.048***
	[0.010]	[0.012]	[0.010]	[0.012]	[0.010]	[0.012]	[0.010]	[0.012]
$Labour\_Productivity_{t-1}$	-0,005	0.034**	-0,005	0.035**	-0,005	0.035**	-0,005	0.034**
	[0.013]	[0.015]	[0.013]	[0.015]	[0.013]	[0.015]	[0.013]	[0.015]
$R\&D\_Employment\_Share_{t-1}$	0,003	0	0,003	0	0,003	0	0,003	0
	[0.003]	[0.001]	[0.003]	[0.001]	[0.003]	[0.001]	[0.003]	[0.001]
$Wage_{t-1}$	0.098***	-0.168***	0.102***	-0.167***	0.102***	-0.168***	0.097***	-0.168***
	[0.025]	[0.028]	[0.025]	[0.028]	[0.025]	[0.028]	[0.025]	[0.028]
$Herfindhal_{Reg2d}$		-0.405**		-0.407**		-0.418**		-0.405**
		[0.181]		[0.180]		[0.182]		[0.183]
$\hat{\lambda}$	0,011		0,011		0,011		0,011	
	[0.011]		[0.011]		[0.011]		[0.011]	
Fixed effects								
Sector*Year	y	y	y	y	y	y	y	y
Region*Year	y	y	y	y	y	y	y	y
Observations	5674	36633	5674	36633	5674	36633	5674	36633

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Robust standard errors, clustered by firm, are displayed in brackets.
In columns [1], [3], [5] and [7] the dependent variable is K^{New}, defined as the weighted average of product complexity calculated across new product(s) introduced by firm i in year t where production shares are used as weights.
In columns [1], [3], [5] and [7], $\hat{\lambda}$ represents the inverse Mills ratio generated from the first step selection equations in columns [2], [4], [6] and [8], where the dependent variable, $Innovation$, is a dummy taking the value of one for firms introducing new products in a given year, and 0 otherwise.

web page.[29] It is defined as the share of employees holding at least a high school degree averaged across firms exporting a given product from China. Again, we confirm that the presence of foreign firms in downstream sectors is positively related to the introduction of more complex goods by Turkish producers.

Second, we define the dependent variable in the second stage in relative terms. In columns 5-6 of Panel A, our second step outcome is the firm's production share accounted for by newly introduced products whose complexity level is higher than that of all the goods produced in $t-1$ by the firm. In columns 1-2 of Panel B of Table 4, the second stage outcome is the difference between the complexity of the new products and the complexity of the firm's product basket in the previous period. In both cases, we confirm the robustness of the relationship between the presence of FDI and the complexity of products introduced by the Turkish firms in the supplying industries.

Third, we focus on unobservable firm level heterogeneity. Although our data set is a panel, it has a very short time span - just four years. The need for having a baseline year, relative to which we identify new products, and the need for lagging explanatory variables, leave us with only three usable years of data. Due to the irregular nature of innovation, the outcome variable in the second step is rarely available for three years and infrequently available for two years. As a consequence, it impossible to include firm fixed effects. Therefore, to take into account unobservable firm level heterogeneity we consider all firms - regardless of their innovative activity - in all years in which firms are observed and focus on the change in the overall complexity of the firm's product portfolio as the outcome of interest. More specifically, our dependent variable is defined as (i) an indicator variable taking on the value of 1 if the firm-level production complexity has increased (i.e., $\Delta\ K^{All}\ > 0$) between $t-1$ and t, and 0 otherwise; (ii) a continuous variable $\Delta\ K^{All}$ which measures the absolute change in the complexity level between $t-1$ and t. This alternative exercise, then, allows us to control for firm fixed effects. For comparison purposes, we also present the corresponding OLS specifications.

The results, shown in columns 3-6 of Panel B, confirm our baseline findings.[30] We find a positive and statistically significant relationship between the presence of MNEs in downstream sectors and the increasing complexity of the production structure of Turkish firms in the supplying industries. This

[29] $http://www.hwtang.com/data.html$

[30] To avoid the inconsistency of the Fixed Effects estimator due to the presence of the lagged dependent variable among the regressors we exclude K^{All} from the right hand side variables and take the more conservative approach of defining the left hand side variables in terms of difference in product complexity.

relationship is statistically significant in all specifications, both in the OLS and the fixed effects model. Thus these robustness checks confirm our baseline findings, while taking into account unobservable firm heterogeneity.

A further set of robustness checks is presented in Table A.4 in the online Appendix. First, we show that our results are confirmed when we define proxies for FDI presence based on employment (rather than output) shares (column 1). Second, we redefine innovation as introduction of new products which (in total) account for a significant share of the firm's total production. We use the threshold of 3%, which corresponds to approximately the 25th percentile of the distribution. When compared to the original definition of innovators, the new definition excludes relatively large firms that produce many products (column 2). Using this alternative definition does not affect our findings. Next, we present the results from a cross-sectional analysis (column 3). In this exercise, we define the firm's probability of introducing a new product on a 3-year-long interval (2007-2009). The complexity of new products is then measured as an average over the same period. The explanatory variables pertain to the pre-sample year, 2006. Again, we find that the presence of MNEs stimulates product upgrading by Turkish firms in the supplying industries. Further, we consider only single-region firms and use spillover proxies that vary at the region-sector level (column 4) as opposed to the firm-level measures used in the baseline analysis. In this specification, we cluster standard errors at the region-sector level. The estimated coefficient on FDI in downstream sectors is slightly higher, thus hinting at a possible downward bias stemming from averaging spillover measures across a firm's locations.

In the baseline model, we cluster standard errors at the firm level because our spillover proxies are averages across all regions where a firm owns facilities. Thus, the spillover measures are firm specific variables. In columns 5 and 6, we show that our results are robust to clustering standard errors at the region-sector level. When we do so, the variable of interest remains statistically significant at the one percent level. Furthermore, we show that our results are robust to the inclusion of additional covariates which vary at the region-sector-time level, such as value added (VA_{rjt-1}), labour productivity (LP_{rjt-1}), output ($Output_{rjt-1}$), and employment (Emp_{rjt-1}) (columns 7-10). Finally, our results remain unchanged if we control for the firm being an importer, $Importer_{it-1}$, or an exporter, $Exporter_{it-1}$, at t-1 (column 11).

Table 4: *Selection Model - Robustness Checks*

Panel A	Prody		Skill Intensity		Share of Higher Complexity New Products	
	2^{nd} Step $Prody^{New}$	1^{st} Step $Innovation$	2^{nd} Step $SkillInt^{New}$	1^{st} Step $Innovation$	2^{nd} Step $Share^{New}_{High\ K}$	1^{st} Step $Innovation$
	[1]	[2]	[3]	[4]	[5]	[6]
$Downstream^{FDI}_{t-1}$	1.104***	0,618	0.605***	0,624	1.129***	0,114
	[0.415]	[0.771]	[0.166]	[0.771]	[0.436]	[0.155]
$Upstream^{FDI}_{t-1}$	-0,765	-0,742	0,007	-0,757	-0,519	-0,184
	[0.496]	[0.793]	[0.178]	[0.792]	[0.466]	[0.146]
$Horizontal^{FDI}_{t-1}$	0,078	0,025	0,011	0,022	-0,027	-0,004
	[0.056]	[0.112]	[0.022]	[0.112]	[0.055]	[0.023]
$Size_{t-1}$	-0.012**	-0.047***	-0.006***	-0,035	-0.027**	-0.010***
	[0.006]	[0.012]	[0.002]	[0.098]	[0.012]	[0.003]
$Labour\_Productivity_{t-1}$	0,001	0.034**	0.007**	-0.046***	-0,003	0.008**
	[0.007]	[0.015]	[0.003]	[0.012]	[0.011]	[0.003]
$R\&D\_Employment\_Share_{t-1}$	0.003**	0	0.002***	0.034**	0,001	0
	[0.001]	[0.001]	[0.001]	[0.015]	[0.002]	[0.000]
$Wage_{t-1}$	0,015	-0.168***	0,008	0	-0,03	-0.033***
	[0.014]	[0.028]	[0.006]	[0.001]	[0.037]	[0.006]
K^F_{t-1}	0.106***	-0.070**	0.185***	-0.168***	-0.135***	-0.017***
	[0.021]	[0.029]	[0.025]	[0.028]	[0.019]	[0.004]
$Herfindhal_{Reg2d}$		-0.401**		-0.406**		-0.071**
		[0.182]		[0.184]		[0.033]
λ	0,004		0,003		0,857	
	[0.004]		[0.002]		[1.02]	
FE						
Sector*Year	y	y	y	y	y	y
Region*Year	y	y	y	y	y	y
Observations	5674	36633	5623	36565	5674	36633
Number of firms	4412	15053	4412	15053	4412	15053

Panel B	Relative Complexity of New Products		Probability of Increasing Complexity		Δ Complexity	
	2^{nd} Step K^{New}_{Rel}	1^{st} Step $Innovation$	OLS	FE	OLS	FE
	[1]	[2]	[3]	[4]	[5]	[6]
$Downstream^{FDI}_{t-1}$	2.125**	0,625	0.627***	1.274**	0.069*	0.424*
	[0.895]	[0.771]	[0.190]	[0.634]	[0.039]	[0.240]
$Upstream^{FDI}_{t-1}$	-0,786	-0,754	-0,056	0,354	0,045	-0,095
	[0.989]	[0.792]	[0.197]	[0.487]	[0.038]	[0.132]
$Horizontal^{FDI}_{t-1}$	-0,148	0,021	0,02	0.149**	0,003	0,01
	[0.126]	[0.112]	[0.028]	[0.070]	[0.006]	[0.021]
$Size_{t-1}$	-0,011	-0.046***	0.040***	0,01	-0,001	-0,001
	[0.012]	[0.012]	[0.003]	[0.013]	[0.001]	[0.004]
$Labour\_Productivity_{t-1}$	-0,009	0.034**	0.022***	-0,002	0	-0,002
	[0.016]	[0.015]	[0.004]	[0.007]	[0.001]	[0.002]
$R\&D\_Employment\_Share_{t-1}$	0,004	0	0	0,001	0	0
	[0.004]	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]
$Wage_{t-1}$	0.117***	-0.169***	0.017**	0.026*	0.002*	0,002
	[0.031]	[0.028]	[0.007]	[0.016]	[0.001]	[0.005]
K^F_{t-1}						
$Herfindhal_{Reg2d}$		-0.404**				
		[0.183]				
λ	0,016					
	[0.012]					
Fixed effects						
Sector*Year	y	y	y	y	y	y
Region*Year	y	y	y	y	y	y
Firm	n	n	n	y	n	y
Observations	5674	36633	35855	35855	35855	35855
Number of firms	4412	15053		14935		14935
R-squared			0,046	0,014	0,005	0,024

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Robust standard errors, clustered by firm, are displayed in brackets.
In Panel A, the dependent variable of column [1], $Prody^{New}$, measures the weighted average of the per capita income level associated with new products introduced by the firm. In column [3], $SkillInt^{New}$ measures the weighted average of the skill intensity associated with new products introduced by the firm. In column [5] $Share^{New}_{HighK}$ is the production share of new products with a complexity level higher than the complexity level of the firm's portfolio in the previous period, K^{All}_{t-1}. In Panel B, in column [1] K^{New}_{Rel} measures the difference between new products' complexity, K^{New} and the complexity of the firm's product portfolio at t-1, K^{All}_{t-1}.
Results in Panel B columns [3]-[6] refer to fixed effects estimates on the total sample. The dependent variable of columns [3]-[4] is an indicator variable equal to one for firms increasing complexity in t with respect to $t-1$. The dependent variable of columns [5]-[6] is the difference between firm complexity in t, K^{All}_{t}, and $t-1$, K^{All}_{t-1}.

3.3 *Instrumental Variable Approach*

One may be concerned that the location of foreign affiliates in Turkey is chosen strategically based on future expectations of sourcing options, thus introducing a reverse causality problem. We believe that this is unlikely to be the case in practice as this would require foreign investors to possess very detailed information, they are unlikely to have. Moreover, we believe that this concern is mitigated by the inclusion of region-year and sector-year fixed effects as well as by the use of lagged proxies for MNE presence. Nonetheless, we take this potential concern seriously and implement an IV approach by instrumenting for the three spillover proxies. As we have found no evidence of a bias due to firms self selecting into introduction of new products, we will apply the IV approach just to the model explaining the complexity of newly introduced products. Our IV strategy is based on alternatively combining the following four variables:

Instrument 1: Turkey is an attractive destination for FDI thanks it to its low wages and customs union with the EU. This means, however, that Turkey is in direct competition for FDI with Eastern European members of the EU, particularly the largest one, Poland, which, like Turkey, has access to the sea and lies on the East-West transit routes. To build our instrument we utilise information on industry-specific FDI stocks found in Poland in 2006-2008 (thus matching the time coverage of our analysis) which are retrieved from the Wiener Institut für Internationale Wirtschaftsvergleiche (WIIW) FDI Database.[31]

Furthermore, not all regions within Turkey are equally appealing to foreign investors. To capture the regional variation of the foreign presence in Turkey, we anticipate that less developed areas may be less attractive to foreign investors. We identify such regions using information on the pre-sample (2005) level of Socio-Economic Development Index (SEDI) from the Turkish State Planning Organization (now Ministry of Development). We create a dummy for underdeveloped 2-digit NUTS regions, which are defined as those including at least one 3-digit NUTS province with the SEDI level below the median.

Our first instrument for $Horizontal\ FDI$ is, then, an interaction between the logged stock of FDI received by Poland in a given 2-digit NACE sector in given year and an indicator variable denoting un-

[31] We focus on stocks because flows tend to be lumpy, and thus stocks better capture the sectoral composition of FDI.

derdeveloped regions of Turkey in the pre-sample period. This instrument varies by region, industry and year. In the case of $Downstream\ FDI$ and $Upstream\ FDI$, the instrument is combined with the appropriate input-output coefficients (as in equations 5 and 6 above). This instrument captures two push factors (competition from Poland and regional backwardness), so we expect it to bear a negative sign in the first stage regressions.

Instrument 2: Our second instrument also uses the logged volume of FDI stocks received by Poland. This sector-year-specific variable is then interacted with the log of the squared distance from each region to the nearest transport gateway which allows to capture the regional dimension. The intuition behind this instrument is that sectors competing for FDI with Poland are likely to receive less FDI, especially in those regions located farther away from transport gateways. The distance to the closest gateway is defined as the distance to the capital of the Turkish region hosting the gateway.

The instrument varies by region, sector and year. Since the instrument captures push factors (competition from Poland and remoteness), we expect it to bear a negative sign in the first stage regressions. We use this instrument as an alternative to the first instrument.

Instrument 3: The third instrument captures the distribution of global supply of FDI across sectors by focusing on the logged stock of outward FDI from OECD countries disaggregated by investor country, 2-digit NACE sector and year. We use this information for 2006-2008.

Since the existing literature has documented the negative effects of information asymmetries on capital flows (Portes *et al.*, 2001; Portes and Rey, 2005; Gelos and Wei, 2005) and shown that it is particularly strong for FDI (Daude and Fratzscher, 2008), we weight the stock of FDI by a proxy capturing information flows between a given Turkish region and the rest of the world.

Following Daude and Fratzscher (2008), as our proxy we use the value of exports of newspapers from a given region to a given destination in a pre-sample year (2004). The information on trade in newspapers comes from the Turkish Statistical Office (TurkStat) and is expressed in thousands of US dollars. We use export flows for HS 6-digit code 490210 *"Newspapers, journals and periodicals, whether or not illustrated or containing advertising material, appearing at least four times a week."* For each Turkish region, we calculate the share of newspapers exports going to a particular OECD destination country and use it to weight outward FDI stocks reported by the OECD. For instance, to create the instrument relevant to $Horizontal\ FDI$ variable for electrical machinery sector located in the Istanbul region in a given year, we weight the outward FDI stock in the machinery sector originating from an OECD country c in the same year using the share of newspapers exports going from the Istanbul region to country c in Istanbul's total exports of newspapers to OECD countries in the pre-sample period as the weight. Then, we sum over all the OECD countries. Put differently, our instrument is the weighted average of outward FDI stocks of OECD countries in a given industry where the weights proxy for the information flows between each Turkish region and the given source country. The instrument varies by region, sector and year. Since the instrument captures the global supply of FDI and a factor facilitating information flows, we would expect it to be positively correlated with FDI entry.

Instrument 4: Our final instrument is based on the belief that it might be easier for Turkey to attract FDI from countries with whom it has signed double taxation treaties and from countries with whom information asymmetries are lower. Furthermore, the ability of Turkey to attract FDI may be affected by the effectiveness of investment promotion efforts performed by other countries.

We use information on how long Turkey has had a double taxation treaty with country c in a given year, if at all. We create a weighted sum of the treaty duration in years using as weights regional newspapers exports to country c (defined above). We then divide this measure by a proxy for global competition for FDI in a given sector.

To capture global competition for FDI in a given sector we take advantage of the fact that, according to investment promotion professionals, targeting particular sectors in investment promotion efforts is considered to be best practice since it is a more effective strategy than trying to attract FDI across the board (Loewendahl, 2001; Proksch, 2004). We create a sector-specific variable capturing the number of countries in the world considering a given sector as a priority sector in their investment promotion efforts. This variable is defined at the 2-digit NACE sector and pertains to 2004, a pre-sample year. It has been obtained from the 2005 World Bank Census of Investment Promotion Agencies.[32]

[32]For more information on the Census, see Harding and Javorcik (2011). According to the data, Turkey did not engage in sector targeting in its own investment promotion efforts.

The instrument varies by sector, year and region. Since it captures pull factors (double taxation treaties, availability of information and inverse of competition for FDI in a given sector), we expect it to be positively correlated with FDI in Turkey.

By alternatively combining the four IVs, we are able to exploit four different IV sets. IV set 1 includes instrument 1 and instrument 3; IV set 2 instrument 2 and instrument 3; IV set 3 is based on instrument 1 and instrument 4; IV set 4 uses instrument 2 and instrument 4. Due to missing information for some sectors in the OECD FDI Database and WIIW FDI Database, the sample size of IV differs slightly across IV sets.

As visible in Table 5, the IV results confirm our baseline findings. We find a positive and statistically significant relationship between the presence of FDI and complexity of newly introduced products in all four specifications. The estimated coefficients are very similar in magnitude to the estimates from the OLS specification (see column 1). The Hansen test reported at the bottom of Table 5 does not cast doubt on validity of our instruments. The F-statistics indicate that the instruments are good predictors of foreign presence (reported at the bottom of Table 5). This message is confirmed by the Kleinbergen-Paap LM test. In most cases, the instruments also bear the expected signs (see online Appendix Table A.5).

Table 5: *Instrumental Variable Approach. Second Stage*

	OLS	IV Set 1	IV Set 2	IV Set 3	IV Set 4
	[1]	[2]	[3]	[4]	[5]
$Downstream\ FDI_{it-1}$	**3.014*** **	**3.348***	**3.725***	**3.736****	**3.550***
	[0.852]	[1.809]	[2.085]	[1.877]	[2.135]
$Upstream\ FDI_{it-1}$	-0.607	0.731	0.325	0.197	0.206
	[0.868]	[0.526]	[0.479]	[0.392]	[0.341]
$Horizontal\ FDI_{it-1}$	0.093	1.827	-2.021	-5.695	-5.717
	[0.115]	[7.692]	[6.899]	[4.566]	[3.962]
Fixed effects					
Sector-Year	y	y	y	y	y
Region-Year	y	y	y	y	y
Observations	4493	4493	4493	4721	4721
R-squared	0.738				
Hansen P-value		0.279	0.088	0.204	0.126
Kleibergen-Paap LM Test (test)		39.47	62.61	158.89	190.41
Kleibergen-Paap LM Test (p-value)		0.000	0.000	0.000	0.000
First stage F-test:					
$Downstream\ FDI$		48.07	40.41	40.44	35.47
$Upstream\ FDI$		7.93	14.09	22.02	28.55
$Horizontal\ FDI$		21.40	34.14	35.72	45.40

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
Robust standard errors, clustered by firm, are displayed in brackets.
IV Set 1 is based on Competition*Indicator for Underdeveloped Regions and FDI Supply*Information Flow. IV Set 2 is based on Competition*Distance to Gateways and FDI Supply*Information Flow. IV Set 3 is based on Competition*Indicator for Underdeveloped Regions and DTTs*Information Flow/Competition for FDI. IV Set 4 is is based on Competition*Distance to Gateways and DTTs*Information Flow/Competition for FDI.

To summarise, our findings are consistent with a scenario (depicted in our anecdotal evidence) where MNCs actively help Turkish firms to upgrade their production structure by providing them with product blueprints and designs, helping Turkish firms improve their quality control systems by providing training for Turkish employees or sending own experts to the Turkish firm, supplying Turkish firms with information about suitable or perhaps superior inputs, etc. They are also consistent with a scenario where MNCs advertise their willingness to purchase an input with given technical specifications and stipulate the percentage of faulty parts per million (a commonly used measure of quality) they are willing to accept and possibly specify exactly what inputs should be used to produce it. In both cases, there is an information flow between MNCs and Turkish producers. In the former case, we would refer to it as "real" knowledge spillovers, while in the latter case we would call them pecuniary spillovers. Although the case for "real" knowledge spillovers is supported by our anecdotal evidence, we cannot discard the possibility that our result is driven by the other type of externality. Nonetheless, what really matters from the policy perspective is that such knowledge transfers take place.

3.4 *Additional Margins of Adjustment*

The evidence provided so far suggests that FDI inflows can lead to upgrading of the host country production structure by stimulating introduction of new products with a higher level of complexity. It is conceivable, however, that a similar adjustment could take place along other margins as well. Therefore, in additional exercises (not reported here), we have considered several other possibilities.

First, it seems plausible that the presence of FDI could stimulate entry of new suppliers in the upstream sectors by creating an additional market for the relevant inputs. However, it is also possible to find scenarios when MNE entry can have the opposite effect. If, for instance, MNE production replaces production previously undertaken by local firms and if MNEs are more reliant on imports, then entry of MNEs may translate into a *smaller* market for local firms in the supplying sectors and thus may lead to firm exit in those sectors. We have investigated this possibility by examining the relationship between the number of entering (or exiting) firms in each industry-region-year cell and the presence of foreign affiliates in the same, upstream and downstream industry. We controlled for the lagged number of firms in a given industry-region-year cell, their output and employment as well as for the concentration ratio (Herfindahl index). We did not find a statistically significant relationship between FDI and entry (or exit) of Turkish firms in the same, upstream or downstream industry. The analysis of firm-level exit decision has led to similar results.

Second, it is possible that greater demand for more complex inputs resulting from MNE entry could lead to a larger scale of production of *existing* complex products. We investigated this possibility by focusing on non-innovators, that is firms that do not introduce new products throughout the period considered, and relating the change of complexity of their production structure to the presence of MNEs. As before, we measured complexity of the production structure using the weighted average of the complexity of all products produced with the production shares serving as weights. We also controlled for unobservable firm heterogeneity. We did not find a statistically significant relationship between $Downstream\ FDI$ and production complexity change. In contrast, when we focused on innovators (namely, firms in our sample, that is, firms which introduced at least one new product during the time frame considered), we found a positive and statistically significant relationship between the two variables.

Finally, we investigated whether there exists a relationship between the complexity range of a firm's production portfolio (defined as the difference in complexity level between the most and the least sophisticated product produced) and MNE presence. No statistically significant relationship was detected.

Based on all these pieces of evidence, we conclude that stimulating introduction of more complex products is the main channel through which FDI inflows have affected the production structure in Turkey.

3.5 *Allowing for Heterogeneous Effects of Foreign Presence in Downstream Sectors*

In Table A.6 in the online Appendix, we allow for heterogenous effects of foreign presence in downstream sectors on product sophistication depending on domestic firms' pre-existing characteristics and on the nationality of foreign investors.

The indigenous firms' pre-existing complexity and productivity Benefits that indigenous firms enjoy from their interactions with foreign investors could depend on their existing capabilities. On the one hand, domestic players with greater absorptive capacity may be better positioned to take advantage of knowledge spillovers. On the other hand, larger benefits may accrue to firms with a larger need for external support and aid in the process of production upgrading. Which of these effects dominates is an empirical question. To shed light on this issue we extend our baseline specification (equation 7) by adding the interaction between spillovers from foreign customers, $Downstream\ FDI$, and a dummy denoting domestic firms with a pre-existing sophistication level, K^{All}_{it-1}, above the sample median. The results, presented in the first column of Table A.6, suggest that firms with a lower initial level of product sophistication derive greater benefits from FDI presence in downstream sectors. These benefits are roughly three times higher in magnitude than the benefits accruing to more sophisticated firms. In other words, the presence of multinationals seems to contribute to the convergence of sophistication among firms, at least among innovators.[33]

Whereas the pre-existing firm complexity level appears to shape the magnitude of the spillover effect, firms' pre-existing labour productivity levels do not seem to matter for the way spillovers from FDI in downstream sectors operate. As visible in column 2 of Table A.6, the coefficient on the interaction term between spillovers from foreign customers and a dummy denoting domestic firms with the above median labour productivity level does not appear to be statistically significant.

The firm size Next, we test for the possible moderating role of another dimension of firm heterogeneity: the firm size. We interact the downstream FDI measure with a dummy denoting firms with the number of employees above the median in the sample (42 employees, see column 3) or above 100 employees (see column 4). The estimated coefficients on the interaction terms are negative and statistically significant, thus suggesting that vertical linkages with foreign affiliates tend to stimulate complexity upgrading among smaller firms in the supplying sectors.

Should we be surprised by the findings suggesting that less sophisticated and smaller firms tend to be more affected by the presence of foreign affiliates in downstream sectors? We should not. When making a decision from whom to source inputs multinationals weigh several factors: (i) ability to deliver a product of a sufficient quality in a timely manner; (ii) price; (iii) desire to create a diversified supplier base to avoid the risk of losing access to inputs due to a shock to a specific supplier and to keep some bargaining power vis-à-vis the largest suppliers. Point (iii) offers one reason why it makes sense for multinationals to source from smaller suppliers in addition to making purchases from the

[33] Further results, not shown here for the sake of brevity, reveal that the presence of foreign producers in downstream sectors helps domestic Turkish firms to close the gap with respect to the leader firm in their same region and sector of activity.

large established one.[34]

FDI country origin So far, we have assumed that knowledge spillovers from foreign affiliates are independent of their country of origin. It is possible, however, that multinationals from high and low income economies are characterised by different levels of technological sophistication and, thus, present different potential to serve as a source of knowledge externalities. We examine this hypothesis by exploiting the information on investor countries available in our data. We split foreign spillover proxies into two groups according to the foreign investor's origin: high income and low income country.[35] We expect that spillovers from high income countries play a more relevant role in stimulating the production upgrading of Turkish firms. This indeed appears to be the case. The results in column 5 of Table A.6 suggest that the positive link between the foreign presence in downstream sector and product upgrading is driven by MNEs from high income countries. FDI from low income countries does not appear to exert a statistically significant effect.

4 Conclusions

Governments of developing countries and emerging markets often strive to find policies to stimulate upgrading of the national production structure. This paper argues that attracting inflows of foreign direct investment can help them achieve this goal.

We examine whether multinational activity can boost the sophistication of the host country's production structure. More specifically, we use firm-product level data from the Turkish manufacturing sector for the period 2006-9 to study the link between the complexity of products newly introduced by Turkish firms and the regional presence of foreign affiliates in the input sourcing sectors. We find evidence consistent with interactions between multinational firms and their Turkish suppliers facilitating product upgrading by the latter group. The effects seem to be more pronounced for smaller and less sophisticated Turkish firms. They are also primarily driven by multinationals from industrialised countries. Consistent with the broad conclusions of the FDI spillover literature, we find no evidence

[34] Wal-Mart's sourcing decision in Mexico illustrate this point very nicely: "By exercising its bargaining power, it [Wal-Mart] squeezed profit margins among the major brands, offering them higher volumes in return. It also engaged the most efficient small-scale local producers as suppliers of store brands, thereby creating for itself a residual source of SDS [soaps, detergents and surfactants] products that could be used in bargaining with the major (multinational) branded suppliers." (Javorcik *et al.*, 2008).

[35] Countries' income level is from the 2011 World Bank classification.

of the impact of FDI presence in the same or upstream sectors.

Our analysis supports the view that attracting inflows of FDI may serve as a catalyst for upgrading the national production structure in an emerging economy. They also suggest that FDI can be a force for intra-national convergence as smaller and less sophisticated firm appear to benefit more from knowledge brought by foreign investors.

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