

# Foreign Direct Investment, Trade and Development: Firm Linkages and Knowledge Transfer

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To my parents,  
Jesús and Pilar

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## Overview of papers and co-authorship

This thesis includes the following three articles:

- Pérez-Villar, Lucía and Adnan Seric. (2015). "Multinationals in Sub-Saharan Africa: Domestic Linkages and Institutional Distance," *International Economics*, vol. 142, 94-117 <http://dx.doi.org/10.1016/j.inteco.2014.06.001>
- Pérez-Villar, Lucía and Adnan Seric, "Knowledge transfer in global supply chains: Multinationals in Sub-Saharan Africa," mimeo 2015.
- Pérez-Villar, Lucía, "Firm innovation and cooperation in the value chain: evidence from Uruguay" mimeo 2016.

Each co-author contributed significantly to the concept, design and content of the joint article.

## **Introduction**

### **a) Context**

International fragmentation of production has become a major feature shaping today's international trade. Lower trade costs regarding trade barriers, transport, and communication, allow firms to relocate production activities to more efficient production centers. This pattern has giving rise to the notion of global value chains (GVCs) to refer to investments, off-shoring and subcontracting activities that divide production processes in several value-adding stages across the globe towards the manufacture of a final good.

GVCs can open opportunities for firms in developing countries to enter the global economy, diversify their exports and increase competitiveness. Being exposed to more advanced technology or managerial techniques in the context of international trade and foreign direct investment (FDI), firms in developing countries could learn and advance in the processes of structural change and industrialization catching -up. GVCs have been often referred as a fast-track to economic development since they allow firms in developing countries to specialize in specific tasks or production stages accordingly to their respective comparative advantages (World Bank 2016, Kowalski, P., et al. 2015, OECD, 2013, inter alia). The successful experience of several countries in East- Asia including China, India, Malaysia or Vietnam represents examples of how GVCs' participation, combined with the appropriate policies can lead to economic growth and job creation.

It has been in this context of globalization and growing interconnectedness that industrial and public policy in general have gained a renewed central role in the development strategies of countries. Is now clear to academics and policy makers that developmental effects from globalization do not happen automatically (see among others UNIDO, 2015; OECD 2013b). Indeed, while participating in GVCs can have developmental effects, through knowledge spillovers from interaction with global buyers, these positive externalities depend on a number of factors. The possibility that developing economies find themselves locked into low-value adding segments -the so called "modularity trap"- puts at risk the potential development gains from GVCs. Routine and assembly tasks generate low value in terms of profits and salaries and leave little scope for learning, skill acquisition or innovation. Upgrading to capture more value and stay competitive in the GVC should then be central to development strategies of emerging economies. A crucial aspect to allow for upgrading is that there exists a quality interaction between foreign investors or buyers and the local economy that generates

beneficial linkages that are associated with knowledge diffusion (Morrisey, 2012; Giroud and Scott-Kennel, 2009; Saliola and Zanfei, 2009)

The various determinants that drive the development potential of supplier/buyer relationships in GVCs, could be categorised in three interrelated groups:

- The first set of drivers relates to characteristics of domestic industries. Having a relatively dense, reliable, and absorptive domestic sector and skilled human capital will make local sourcing more attractive for firms in the GVCs. Also, local firms need to have enough absorptive capacity in order to be able to learn from potential knowledge transfers (Farole and Winkler, 2012, 2014).
- A second type of drivers refers to foreign investors or international buyers' characteristics. In this regard, a number of factors would determine the quality of the relationships established with the local firms. Some of these factors include: ownership structure, degree of autonomy of subsidiaries, complexity of production processes and GVC governance, importance given to local markets or access to raw material sources or origin of the GVCs players (Saliola and Zanfei, 2009; and Giroud et al, 2012; Javorcik and Spatareanu, 2009; Jindra et al, 2009; Crone and Roper, 2001).
- Finally, central to grasping the benefits of joining GVCs are country level characteristics that relate to, amongst other, appropriate transport and communication infrastructures, an attractive business climate and quality institutions that guarantee security of transactions and reduce uncertainty (Meyer and Sinani, 2009; Gorodnichenko et al, 2007; Farole and Winkler, 2012). The development stage of countries and its production structure also plays a crucial role and challenges and opportunities of GVCs participation are not the same for least developed countries (LDCs) and middle income economies (Pietrobelli, 2008; World Bank, 2016).

The bulk of literature studying developmental effects from globalization is substantial. Aiming at understanding the relationship between enhanced efficiency of domestic firms and global engagement, empirical literature on international trade and foreign direct investment (FDI) associates enhanced firm performance with respectively, exporter or importer status and presence of multinational enterprises (MNEs). In short, studies on outsourcing and learning-by-exporting studies find, although with relatively mixed results for the latter, that exposure to global markets through exports and the use of foreign intermediates, improves firm performance via increased competition

and learning effects<sup>1</sup>. Regarding FDI, the literature has found with some consensus that the main channels through which positive externalities materialize are backward linkages with domestic suppliers<sup>2</sup>.

However, as mentioned above not all linkages and trade interactions are equally beneficial in the context of GVCs. The scope for knowledge exchange varies across a number of firm and country characteristics and little is still known about the underpinning knowledge exchange mechanisms that translate global engagement into firm enhanced performance in developing countries. The three papers in this thesis aim at filling this gap by looking at the three subsequent necessary steps in the materialization of vertical spillovers of global engagement: 1) That there is a trade relationship with global buyers is established by domestic firms (the backward linkage); 2) that there is a knowledge transfer involved in the vertical linkage and, 3) that knowledge is assimilated through a learning process in the domestic sector that translates into enhanced performance.

#### **b) Structure of the thesis**

This thesis is composed by three chapters aim at shedding light on the underpinning mechanisms behind vertical spillovers of global engagement. Each chapter looks closely at one of the three subsequent necessary steps for the materialization of spillovers: establishment of backward linkages, knowledge transfer involved in the vertical linkage, and the learning process in the domestic sector that translates into enhanced performance.

Chapter 1 and 2 look at the first and second steps respectively, focusing on the establishment of backward linkages and a voluntary transfer of knowledge from MNEs to local suppliers in 19 Sub-Saharan African (SSA) countries. The focus of these two chapters is on country and foreign investor characteristics of MNEs. Both papers use cross-sectional data from the African Investor Survey conducted by UNIDO in 2010 and are co-authored with Dr. Adnan Seric. These papers respond to need of disentangling the drivers behind the establishment of linkages and transfer of knowledge by multinationals for the case of SSA. Under the assumption that FDI will contribute to growth by transferring skills, management expertise and technology many African governments have made attracting FDI a priority in their development strategies. However, FDI in the continent remains

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<sup>1</sup> On learning-by-exporting see De Loecker (2013) for an overview of the literature and positive evidence for the case of Slovenia or Crespi et al (2008) for positive evidence in the UK case. A link between the use of imported inputs and enhanced firm productivity has been documented by Kasahara and Rodrigue (2008) for Chile, Halpern, Koren and Szeidl (2010) for Hungary, Smeets and Warzynski (2010) for Denmark and Bas and Strauss-Kahn (2011) for France. Fritsch and Görg (2015) found a positive impact of use of imported intermediates on R&D expenditure in sixteen emerging economies.

<sup>2</sup> See the seminal paper by Javorcik (2004) or Görg and Greenaway (2004) and Havranek and Irsova (2011) for comprehensive literature reviews on FDI spillovers.

mostly in extractive sectors with few domestic linkages and with no significant technology transfer to the local economies. UNCTAD, 2013 and Farole and Winkler, 2014 among others, have stated the crucial role that FDI knowledge spillovers plays for Sub-Saharan African long-run growth and development and draw attention to the need for a better understanding of the dynamics behind FDI spillovers in the region.

Chapter 1 is titled “*Multinationals in Sub-Saharan Africa: Domestic Linkages and Institutional Distance*”. The paper analyses the role of institutional distance in the establishment of domestic linkages by MNEs. It argues that investors’ familiarity with formal and informal procedures in the host country lowers uncertainty and facilitates networking with local firms. Hence, a similar degree of institutional development boosts linkages between domestic firms and multinationals. We find that institutional distance in terms of contract enforcement deters the domestic linkage if institutions are worse in host countries than in the origin country. Additionally, institutional distance matters more for multinationals from industrialized countries. The paper contributes to the literature on domestic linkages by including the understudied institutional dimension. Importantly, it accounts for the changing geography of globalization with key actors switching and adds to the still scarce literature on South-South FDI in LDCs. Hence, the paper makes a contribution to the definition of clearer targets for foreign investment policies to take into account origin of investors and institutional backgrounds.

Chapter 2 titles “*Knowledge transfer in global supply chains: Multinationals in Sub-Saharan Africa*” and analyses determinants of voluntary knowledge transfer from foreign investors to their local suppliers. We investigate the role played for the transfer of knowledge by two broad sets of drivers: foreign investor characteristics and country level factors. We aim at answering the following questions: Which sourcing activities and characteristics of foreign investors are related to transfers of knowledge to local suppliers? And, under which host country economic and institutional characteristics are foreign investors more likely to engage in supplier upgrading practices? We argue that not all backward linkages entail the same potential for spillovers since not all local sourcing activities by multinationals involve a transfer of knowledge to suppliers. Our findings support the idea that foreign investor’s heterogeneity and country environment are key factors shaping the spillover potential of backward linkages. It follows that investment policies that merely focus on promoting larger shares of locally sourced inputs might fail to get the most of FDI positive externalities. Instead, quality linkages that involve a transfer of knowledge should be promoted over quantity linkages.

Chapter 3 titles “*Firm innovation and cooperation in the value chain: evidence from Uruguay*” and turns the focus to the third mechanism at play in the materialization of spillovers: learning from

knowledge exchange in trade relationships and enhanced performance of domestic firms. Here we focus on Uruguay, a small open economy whose external sector plays a significant role as a source of economic and knowledge exchange. The country moved to the high-income category according to the World Bank country classification in 2013. At this stage, innovating to increase the knowledge content of production and capturing more value becomes now crucial for the country in order to close the productivity gap and build a resilient and diversified domestic sector that responds to the new production transformation and development challenges in a global economy.

The chapter studies to what extent innovation outcomes of Uruguayan firms relate to external knowledge flows in the form of cooperation with domestic and foreign suppliers and buyers. We use panel data from three waves of the Uruguayan Firm Innovation Survey, covering the period (2001-09) and employ a “knowledge production function” (KPF) methodological framework. According to our findings cooperation linkages with clients show a positive relationship with product innovation and for novel exports whereas cooperation with suppliers is related with process innovation and larger shares of novel domestic sales. The mechanisms at work relate forward cooperation with clients to product improvements that most probably target to better match customer specifications, while backward exchange of information with input suppliers is likely be related to an optimized use of intermediates, or better production technologies hence playing a role for production process efficiency (Joshi and Sharma, 2004; Freel and Harrison, 2006; Roper et al, 2008). Regarding origin, cooperation with trade partners within the Latin American region shows the largest effects on innovation outcomes. Our results support findings by other authors on the existence of upgrading opportunities derived from value chain ties for Latin America at the regional level (e.g IADB, 2014). These results are also aligned with the arguments on South-South trade and FDI that root on enhanced absorptive capacity brought about by shorter technological distance and cultural proximity (e.g UNCTAD, 2006). Taken together, our results point out the relevance of knowledge exchange in the value chain and the importance of regional and international networks for firm innovation.

## **Conclusion**

The key message that follows from the research presented in this thesis is that in the context of developmental effects of globalization, heterogeneity matters and so do public policies. Different country, investor and domestic firm characteristics have substantial implications for the mechanisms behind positive externalities of global engagement. Hence, a sound combination of policies is necessary to succeed in the process of making GVCs work for development.

The three chapters contribute to the literature on benefits of international trade and FDI spillovers by directly looking at the mechanisms through which positive externalities happen and the drivers of knowledge flows in GVCs. Additionally, the first two chapters, provide importance evidence on Sub-Saharan Africa, a region that remains understudied due to the scarcity of quality firm level data and where FDI inflows are on the rise and can potentially be a source of technology transfer for structural change. Moreover, the focus of the third chapter accounts for the importance of upgrading and learning from external knowledge for a growing small open economy as is the case of Uruguay which currently facing the challenge of innovate to sustain competitiveness and capture more value in the GVCs.

Briefly, our results derive the following policy implications. 1) Effective investment policy needs to attract the “right” type of investors, prioritize sectors that enhance domestic value added and promote knowledge transfer and beneficial linkages to domestic industries. Origin of investors plays a role, perceived uncertainty varies with institutional backgrounds of host countries. This represents opportunities for developing countries derived from the changing geography of globalization and growing South-South relationships, but policies should also account for the relative higher sensitivity of Northern investors to poorer institutional frameworks in host countries. 2) Long-term trust based supply relationships between foreign investors and domestic firm should be promoted, fostering quality linkages that involve a transfer of knowledge over mere local content requirements. 3) Inclusive innovation and industrial policies play a key role facilitating firm upgrading through participation in GVCs. Cooperation for innovation in the value chain matters and therefore alleviating limitations of resource constrained firms to allow them establish beneficial linkages with foreign agents is crucial to the design of inclusive policies. A targeted policy mix should work for achieving a dense, networked and absorptive domestic private sector with strong linkages within the domestic innovation system while promoting openness and quality linkages with foreign agents in the GVCs.

On a closing note, globalization should be seen as a not a zero-sum process that can as a catalyst for economic growth and development. International trade relationships should lead to win-win outcomes where industrialized countries benefit from lower production costs and new markets and developing countries gain from access to information and upgrading opportunities to achieve structural change. A targeted policy mix combining investment, education and innovation policies is needed to make these potential gains materialize into competitiveness, economic growth and rising living standards. As heterogeneity matters and different investors, local industries and country environments entail different potential for positive effects, they require different policies and these should be as targeted as possible to account for specific needs. Policy makers should additionally be

aware that globalization is a dynamic process and GVCs are in constant evolution, therefore flexibility and adaptation to new trade patterns becomes necessary.

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## **Chapter 1:**

# **Multinationals in Sub-Saharan Africa: Domestic Linkages and Institutional Distance**

L. Pérez- Villar<sup>\*</sup>, A. Seric<sup>\*\*</sup>

### **Abstract<sup>3</sup>**

This paper analyzes the role of institutional distance in the establishment of domestic linkages by multinational enterprises in a cross- section of 19 Sub- Saharan countries. Investors' familiarity with formal and informal procedures in the host country lowers uncertainty and facilitates networking with local firms. Hence, a similar degree of institutional development boosts linkages between domestic firms and multinationals. Using a novel dataset from the 2010 Africa Investor Survey by UNIDO, we find that institutional distance in terms of contract enforcement deters the domestic linkage if institutions are worse in host countries than in the origin country. Additionally, institutional distance matters more for multinationals from industrialized countries. The paper contributes to the literature on domestic linkages by including the understudied institutional dimension, to the still scarce literature on South-South foreign direct investment in least developed countries and contributes to the definition of clearer targets for foreign investment policies.

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## Chapter 2:

# Knowledge transfer in global supply chains: Multinationals in Sub-Saharan Africa

L. Pérez- Villar\*, A. Seric\*\*

### Abstract

We analyze in this paper determinants of voluntary knowledge transfer from foreign investors to their local suppliers in 19 Sub-Saharan African countries using data from the 2010 Africa Investor Survey by UNIDO. We argue that not all backward linkages entail the same potential for spillovers since not all local sourcing activities by multinationals involve a transfer of knowledge to suppliers. Our findings support the idea that foreign investor's heterogeneity and country enabling environment are key factors shaping the spillover potential of backward linkages. Local management autonomy and the long-term nature of local procurement contracts are positively associated with the transfer of knowledge. Also sourcing strategies that seek to meet local market requirements, to optimize value chain efficiency and that respond to social responsibility commitments are more likely to involve a transfer of knowledge to suppliers. Additionally, host country institutional quality and institutional distance relative to the origin country of the MNE are relevant determinants of the degree of knowledge transfer. Investment policies that merely focus on promoting larger shares of locally sourced inputs might fail to get the most of FDI positive externalities. Instead, quality linkages that involve a transfer of knowledge should be promoted over quantity linkages.

Keywords: knowledge transfer, global value chains, institutional distance, supplier upgrading, sub-Saharan Africa.

JEL classification: F23, O33

### 1. Introduction

The effect of foreign direct investment (FDI) on host economies and its implications for development has for a long time been a major policy concern in developing countries. In this

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regard, multinational enterprises (MNE) that have access to more advanced technology and know-how can contribute to economic growth and structural change in developing economies via spillovers to the domestic economy. Three main mechanisms through which spillovers materialize have been identified by the literature. First, positive externalities to the local economy can take the form of horizontal spillovers if local firms in the same sector learn from more efficient technologies by competition or demonstration effects. Secondly, vertical spillovers can take place through value chain linkages with domestic suppliers and buyers. In this sense, foreign investors that source intermediates locally -backward linkages- have incentives to share know-how with their suppliers in order to help them meeting required quality levels or higher technical standards. Also, domestic firms that buy from MNEs -forward linkages- have access to more sophisticated inputs and can therefore learn new production techniques or enhance the quality of their final goods. Third, labor market interactions can also generate positive effects in form of wage spillovers and through turnover of skilled workers. Among these various mechanisms, empirical literature has consistently found that the main channels through which positive externalities materialize are backward supply chain linkages with domestic suppliers (Javorcik, 2004 *inter alia*<sup>4</sup>).

However, while it is possible that domestic firms benefit from backward linkages with foreign investors, not all local sourcing activities by multinationals entail the same potential for spillovers. In this regard, for the backward linkage to generate a domestic learning effect, a transmission of knowledge from the multinational to their domestic supplier is needed (Morrisey, 2012). Therefore, local sourcing activities that do not involve a transfer of knowledge or provision of assistance are likely to not translate into local suppliers upgrading and consequently no positive long-run benefits for the local economy will be materialized. As found by Görg and Seric (2015) for the case of Sub-Saharan Africa, supplying to a MNE only has a positive impact on domestic supplier's process innovation and labor productivity when they additionally receive assistance from their multinational customers in terms of training and technology transfer respectively. Similarly, Winkler (2014) finds that MNE's imposed requirements to suppliers have no impact on the latter's productivity whereas effects from technical assistance are positive. Further evidence of the relevance of voluntary knowledge transfer is provided by Giroud et al. (2012) and Saliola and Zanfei (2009) who study the spillover potential derived from different MNE's sourcing behaviors by distinguishing between extent of local sourcing activities and their knowledge sharing intensity. Both studies find that it is the knowledge intensity (quality) and not the extent (quantity) of backward linkages that matters for spillovers generation. This argument suggests that focusing exclusively on extent of

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<sup>4</sup> See Görg and Greenaway (2004) or Havranek and Irsova (2011) for comprehensive literature reviews on FDI spillovers.

backward linkages might lead to a misidentification of the key factors that potentially lead to successful upgrading of local suppliers (Giroud 2007; Giroud and Scott-Kennel, 2009).

But, why would a MNE invest resources to voluntarily promote local supplier upgrading? As suggested by number of case studies, foreign investors deliberately transfer technology to their local suppliers in developing countries. Sound examples are, among others, voluntary transfers of technology by the Japanese electronics MNEs in Malaysia (Campanelli, 1997), the automotive sector MNEs in Mexico and Thailand and the computer/electronic sector in Singapore, Malaysia or Taiwan (Moran, 2001). Moreover, as explained by Ivarsson and Alvstam (2010) for the case of IKEA, local supplier upgrading practices respond not only to corporate ethics and needs regarding technical and quality standards, but they are also driven by economic benefits. Sourcing from smaller and less experienced suppliers in face-to-face relationships translates into large cost savings for the company, while costs of supplier monitoring remain relatively low. Therefore, knowledge intensive local sourcing by foreign investors appears as a win-win process where the MNE benefits from lower production costs and higher quality inputs while local suppliers upgrade their technical capabilities.

Understanding how knowledge is transferred through supply chain relationships becomes crucial in the actual context of increasing internationalization of production. As pointed out by Farole and Winkler (2014) the largest share of non-extractive investment in low-income countries takes place in the context of global value chains (GVCs). Thus, a proper understanding of the spillover potential inherent to this type of investments and the country environment enhancing such positive externalities is necessary in the process of minimizing risks and enhancing the developmental benefits of joining the global economy.

Empirical evidence on the transfer of knowledge involved in MNE's local sourcing activities it is relatively recent and mostly relies on case studies with few observations focusing on specific firms, industries or single countries/regions. An exception is the recent study by Farole and Winkler (2014, chapter 3) which focuses on determinants of productivity spillovers to domestic firms in 78 developing countries using data from the World Bank's Enterprise Surveys. Although the authors consider the voluntary provision of assistance by MNEs as a mediating factor affecting productivity spillovers to domestic firms, the foreign investor characteristics that lead to this transfer of knowledge are not explored.

While extant studies provide a framework for analysis and a first stage understanding of the factors driving the vertical transfer of knowledge their results are not easily generalizable. Neither are the policy implications derived from them. Also, as they concentrate on single or very few countries, they do not allow for an assessment of country level factors.

This paper builds on this literature and adopts a more comprehensive approach in the analysis of determinants of knowledge transfer by multinationals to their local suppliers in 19 Sub-Saharan African countries. More specifically, we investigate the role played for the transfer of

knowledge by two broad sets of drivers: foreign investor characteristics and country level factors. We aim at answering the following questions: Which sourcing activities and characteristics of foreign investors are related to transfers of knowledge to local suppliers? And, under which host country economic and institutional characteristics are foreign investors more likely to engage in supplier upgrading practices?

Disentangling the drivers behind the transfer of knowledge by multinationals is of particular relevance for the case of Sub-Saharan Africa. Under the assumption that FDI will contribute to growth by transferring skills, management expertise and technology many African governments have made attracting FDI a priority in their development strategies. However, FDI in the continent remains mostly in extractive sectors with few domestic linkages and with no significant technology transfer to the local economies (UNCTAD, 2013). Farole and Winkler (2014) state the crucial role that FDI knowledge spillovers plays for Sub-Saharan African long-run growth and development and draw attention to the need for a better understanding of the dynamics behind FDI spillovers in the region.

The contribution of this paper is threefold. First, we add to the literature on vertical knowledge transfer by adopting a broader approach in terms of observations, variables and countries that allow us to explore country level factors and to draw more generalizable conclusions and policy implications. Second, we complement previous studies on the extent of backward linkages in Sub-Saharan Africa (Amendolagine et. al, 2013; Pérez-Villar and Seric, 2015) by accounting for the particularly relevant dimension of the knowledge intensity of backward linkages. As argued above, understanding this feature is essential for capturing the full picture of MNE's local sourcing behavior and its potential for spillovers in the context of global value chains. Finally, our focus on Sub-Saharan Africa provides evidence on the still understudied effects of FDI in least developed countries where international transfer of knowledge through FDI flows is a key factor to achieve structural change and technological catch up.

Our findings support the idea that foreign investor's heterogeneity and institutional environments are key factors shaping the sourcing patterns of MNEs and consequently the spillovers potential of backward linkages. More specifically, we find that i) the transfer of knowledge follows a non-linear relationship with the extent of backward linkages. Higher shares of locally sourced inputs are associated with higher probabilities of transfer of knowledge up to a 50% threshold after which the relationship turns negative; ii) the long-term nature of local procurement contracts incentivizes provision of support to local suppliers; iii) the type of investments that are more likely to provide support to their local suppliers are MNE subsidiaries with a certain degree of local management autonomy and with sourcing strategies that seek to meet local market requirements, to optimize value chain efficiency and that respond to social responsibility commitments; iv) host country institutional quality and institutional distance relative to the origin country of the MNE have also an impact on the degree of knowledge

transfer. Finally, v) other firm characteristics such as firm size, the perceived technology gap and targeting developed export markets are positively associated with the transfer of knowledge. The rest of the paper is organized as follows: section 2 briefly reviews the extant literature; section 3 presents the analytical framework; section 4 describes the dataset and the methodology; section 5 discusses the estimation results and section 6 concludes and derives policy recommendations.

## **2. Transfer of knowledge through backward linkages: a literature review**

As pointed out in the introduction, the literature on FDI spillovers has with some consensus, identified the backward linkage as the main channel driving positive externalities to the domestic economy. The typical analysis in this literature strand relates domestic firm performance in a specific sector with a measure of foreign presence in upstream sectors often relying on input-output tables. Then, the assumption is made that knowledge has been transferred from the MNE's to their domestic suppliers if domestic performance in a sector improves due to FDI presence in upstream sectors. However, backward linkages do not automatically lead to spillovers since they do not always involve a transfer of knowledge. Hence, while these studies find positive evidence of spillovers happening through backward linkages quite consistently across countries and industries, they are not able to identify the drivers and specific mechanisms behind the transfer of knowledge involved in local sourcing activities by multinationals that determine the spillover potential of backward linkages.

In order to understand how knowledge spills over from the MNE to the local economies through the vertical channel, a closer look at heterogeneous local sourcing activities is needed. In other words, an understanding of the dynamics at play in supply chain relationships is essential for identifying the mediating factors that lead to the materialization of positive externalities. Giroud and Scott-Kennel (2009) and Farole and Winkler (2014) identify three types of mediating factors: i) domestic firm characteristics that favor absorptive capacity; ii) foreign investor features that enhance their spillover potential and iii) country level factors regarding a proper institutional background and business climate. This study focuses on the last two mediating factors<sup>5</sup>.

Regarding foreign investor characteristics, a number of case studies have tried to disentangle what makes a foreign investor more likely to voluntarily transfer knowledge to local suppliers. In brief, the degree of integration of the MNE with local markets, share of locally sourced

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<sup>5</sup> The issue of domestic firm characteristics and knowledge absorption from forward and backward linkages with MNE's has been addressed by Görg and Seric (2013), also using the UNIDO AIS 2010 dataset. Other studies looking at domestic firm characteristics enhancing the scope from learning from MNEs are Farole and Winkler (2014) and Jordaan (2013). Roughly, these studies find that firm technological capabilities, size, experience and export status are features that foster absorptive capacity and make domestic firms more likely to receive assistance from their suppliers at a first stage and to benefit from the a potential transfer of knowledge at a later stage.

inputs, long term supplier relationships and autonomy of the subsidiary's local management appear to be key determinants of the knowledge-intensive local sourcing behavior by MNEs. In this way, Saliola and Zanfei (2009) study the transfer of knowledge involved in heterogeneous value chain relationships with MNE's of Thai firms. They find that *embeddedness* that is, the degree of integration and adaptation of MNEs into the local market and the capabilities of local suppliers are crucial factors generating knowledge-intensive backward linkages. A relatively larger share of locally purchased inputs is however associated to supply relationships of a lower technological profile. This finding suggests that a distinction between the *extent* (quantity) and the *intensity* (quality) of backward linkages is needed in order to identify potential spillover effects.

The interaction between extent and intensity of backward linkages is further explored by Giroud et al. (2012) for the case of five transition economies. They find a non-linear relationship between the amount of inputs shared locally by a multinational and the knowledge transfer to suppliers. A plausible interpretation of this result is that higher shares of locally sourced inputs are more likely to occur in lower stages of the value chain, are related to non-differentiated goods and therefore not involving a knowledge intensive sourcing behavior. Indeed as Ivarsson and Alvstan (2005) find by studying Volvo's plants in Brazil, China, India and Mexico, the lower the level of standardization in the sector, the higher the transfer of knowledge to suppliers in order to obtain customized parts. Put differently, a large share of local inputs might reflect that the presence of the foreign affiliate in the country is due to cost-saving more than quality motivations. An alternative explanation is also given by Giroud et al (2012) who argue that knowledge flows might be more intense when the multinational combines locally sourced with imported inputs. This combined production process might then require higher quality locally sourced inputs that meet international standards and therefore require potential upgrading of local suppliers. Additionally, Giroud et al (2012) find that the degree of *embeddedness* with the local economy and the degree of *autonomy of the subsidiary* are important for enhancing the likelihood of knowledge transfer to suppliers. Further evidence of the importance of subsidiary roles in terms of technological competence and the degree of autonomy is found by Jindra et al (2009) for transition countries, by Gentile-Lüdecke and Giroud (2012) for the case of the Polish automotive sector and by Crone and Roper (2001) for Northern Ireland. Looking at a sample of foreign subsidiaries, these studies find that intra-firm relationships do play a role and a subsidiary's higher degree of autonomy in terms of supply-related decisions is associated with larger probabilities of transferring knowledge to suppliers.

Technological differences between domestic suppliers and MNEs are addressed by Jordaan (2005, 2010, 2013). The author explores the determinants of technology transfers to local suppliers by MNEs in Mexico emphasizing the positive impact of the *technology gap* between the MNE and its local suppliers for the provision of assistance. This shows that a certain scope

for supplier upgrading is important in the decision to transfer knowledge by MNEs. He also finds that larger firms that are engaged in the local production of inputs are more likely to provide support to their local suppliers.

Finally, the above findings are confirmed by several firm-specific case studies by Ivarsson and Alvstam (2005, 2009, 2010, 2011) on the local sourcing behavior of respectively, Swedish engineering firms, Volvo and IKEA in Asian and Latin American countries. By collecting survey data on local suppliers' upgrading and provision of assistance by Swedish firms the authors find that long-term commitment and cooperative supply relationships, deliberate supplier upgrading programs as part of the MNEs global sourcing strategy and the relative technological backwardness of suppliers largely drives knowledge sharing with suppliers. The authors highlight the fact that Swedish MNE's benefit from closer and trust-based supplier relationships and reveal to have strong incentives to provide assistance to their suppliers in developing countries especially for the case of non-standardized intermediates.

To sum up, the extant literature provides a framework for analysis and a first stage understanding of the factors driving the vertical transfer of knowledge. However, these results are not easily generalizable neither are the policy implications derived from them. Also, they do not allow for an assessment of country level factors since they are limited to single or small samples of countries. In the next subsection, we build on the literature and present our analytical framework expanding the scope of the analysis and capturing a wider range of factors shaping the local sourcing behavior by foreign investors and the transfer of knowledge to suppliers.

### **3. Analytical framework: What drives the transfer of knowledge by MNE's?**

As proposed by Giroud and Scott-Kennel (2009) and Farole and Winkler (2014) we distinguish between two broad types of determinants. First, we look at firm-level factors stemming from foreign investor's structural and organizational heterogeneity. Second, we account for host country and origin characteristics that define location strategies and value chain governance of multinationals.

#### **3.1 Foreign Investor characteristics**

As it suggested by the literature reviewed above, accounting for investor heterogeneity is crucial to understanding the mechanisms behind knowledge spillovers to the domestic economy. A common finding has been that the degree of integration of MNEs into the local economy, often referred to as *embeddedness*, is positively related to the generation of positive externalities. This is a broad concept and includes several aspects that influence to what extent foreign investors' organizational characteristics and activities lead to integration and involvement in the host economy. Among them are, for instance the time since the investment took place, the degree of adaptation to local practices or the share of foreign ownership. In this section we review these

and other factors behind the transfer of knowledge to local suppliers. We classify the different factors into three main groups: a) factors regarding the type of backward linkage; b) factors referring to the type of investment in terms of ownership, sourcing strategy and autonomy of the subsidiary and c) other relevant firm characteristics.

a. Type of backward linkage

As stated above foreign investors with different motivations and strategies generate different types of backward linkages. In this regard, we argue that two attributes of backward linkages are likely to have an impact on the transfer of knowledge: the extent or size of backward linkage and the nature of the sourcing contract.

The first issue we account for is the relationship between the *extent* (quantity) and the *intensity* (quality) of backward linkages i.e how the share of local sourced inputs relates to knowledge transfers to suppliers. Saliola and Zanfei (2009) and Giroud et al (2012) have found either a negative or a non-linear relationship between the amount of inputs sourced locally and the likelihood of knowledge transfer. As explained above, the drivers of these results might relate to the likelihood of higher shares of locally sourced inputs relating to non-differentiated goods and therefore not involving a knowledge intensive sourcing behavior. An alternative explanation is given by Giroud et al (2012) who argue that knowledge flows might be more intense when the multinational combines locally sourced with imported inputs. This combined production process might then require higher quality locally sourced inputs that meet international standards and therefore require potential upgrading of local suppliers.

The second key attribute of backward linkages fostering knowledge transfers refers to the long-term nature of local sourcing contracts. As found by Ivarsson and Alvstan (2005, 2011) and Gentile-Lüdecke and Giroud (2012) long-term contracts are more likely to generate knowledge intensive linkages and trust-based cooperative sourcing relationships. Thus, repeated interaction with suppliers will translate into higher likelihood of knowledge transfer relative to sporadic short-term sourcing orders.

b. Type of investment

The type of investment strongly influences the sourcing behavior of multinationals in host countries. Naturally, there are a number of criteria according to which one may classify the type of FDI taking place in a host country. Also it should be kept in mind that multinationals are complex entities that usually respond to hybrid types of investment. Here we focus on three aspects commonly found by the FDI literature to be relevant for host country effects: ownership structure, sourcing strategy and subsidiary autonomy.

*Ownership structure:* Several studies provide evidence that foreign investors that are in joint ventures with domestic firms tend to integrate to a higher degree into the local economy and to engage in local sourcing. Javorcik and Spatareanu (2009) find for Romania that vertical spillovers are more likely to materialize in domestic-foreign joint ventures. Similarly, Amendolagine et al (2013) provide evidence that having a local partner is associated with a higher share of locally sourced inputs. Also, Jindra et al (2009) find that the degree of foreign ownership has a negative impact on the intensity of backward linkages. Having a local partner facilitates access to information about suppliers, reduces transaction uncertainty perceived by foreign investors and fosters subsidiaries embeddedness. Joint ventures might therefore be more likely to engage in transfer of knowledge.

*Sourcing strategy:* Motivations behind the multinational decision to source locally respond to the strategic organization of production along the global value chain. In this regard different value chain governance modes determine sourcing strategies and potential for value-adding of each production stage (Saliola and Zanfei, 2009). On the one hand, local sourcing activities might seek access to cheap raw materials which are considered standardized goods with little scope for upgrading. In this case the possibilities for knowledge transfer are expected to be rather limited. On the other hand, motivations behind local sourcing can be driven by factors that enhance embeddedness of multinationals into the domestic economy such as adaptation to the local market or optimization of logistics and inventory management. We argue that sourcing strategies that promote embeddedness are more likely to generate transfer of knowledge to suppliers relative to resource seeking local sourcing.

*Subsidiary Autonomy:* Subsidiary roles and assigned capabilities within the multinational global network have been found by several studies to be a key variable defining their interaction with local economies. Autonomous subsidiaries more easily adapt to local markets, gain local expertise and reach a higher degree of embeddedness with the domestic economy. They are additionally more likely to innovate since their technological capabilities are larger. Jindra et al. (2009) analyze subsidiary data from Eastern European countries and find that the extent of backward linkages is positively related to the subsidiary autonomy in terms of supply and

logistics and product development. Similarly, Giroud et al (2012) find that more autonomous subsidiaries are more likely to engage in knowledge intensive linkages with their local suppliers in transition economies. Crone and Roper (2001) find that autonomy of the subsidiaries is a key feature of MNE plants that transfer knowledge to local suppliers in Northern Ireland. Autonomous subsidiaries have then the ability to influence their scope for value-adding, decide on supplier selection and establish close supplying relationships (Giroud et al, 2012). Therefore, we argue that decentralization of competencies from the headquarters to the subsidiaries will translate into higher likelihood of knowledge transfer to domestic suppliers.

c. Other firm characteristics

Five additional foreign investor characteristics have been found in previous studies to play a role for vertical transfer of knowledge by multinationals. Here we account for the effect of the technology gap, size and experience of the firm in the market, the degree of R&D carried out in the subsidiary and the main destination market.

*Technology gap:* The effect of productivity or technological differences between foreign and domestic investors on the transfer of knowledge is not a priori clear. On one hand, if differences are too large, the domestic supplier might not be able to benefit from potential transfer of knowledge since they lack the necessary absorptive capacity to learn from the knowledge being transferred. In this case the MNE might not find operational to source locally and might opt for imported inputs. On the other hand, certain degree of technological differences between the multinational and the domestic supplier is needed in order to create scope for learning and to motivate the MNE to transfer knowledge that upgrades supplier's capabilities. In this case, the technology gap will encourage the transfer of knowledge. Békés et al (2009) and Jordaan (2008, 2013) find evidence of the positive impact of the technology gap for FDI spillovers in Hungary and for knowledge transfer to Mexican suppliers respectively. For the specific case of IKEA, Ivarsson and Alvstan (2010) identify that the MNE tends to provide more assistance to smaller and less technically advanced suppliers where scope for learning is larger.

*R&D at the affiliate:* Technological capabilities of the subsidiary are also likely to influence the sourcing behavior of foreign investors. In this regard, more innovative subsidiaries that are able to generate their own knowledge and to invest in R&D might also be more likely to transfer the created knowledge to their local suppliers. As Marin and Bell (2006) point out "the potential for spillover is created within local subsidiaries as a result of their own knowledge-creating and accumulating activities in the host economy". They find for Argentina that within subsidiary innovation has a significant positive effect on the domestic spillovers. Further positive evidence of subsidiary R&D capabilities in transfer of knowledge to suppliers has been found by Giroud et al (2012) and Jindra et al (2009).

*Experience in the country:* The time since the investment took place affects foreign investor's embeddedness into the local economy. In line with what Kiyota et al (2008) describe as "vintage effects", more experienced investors are more familiar with local market requirements, the way of doing business in the country and with supplier's networks. Therefore they are able to establish longer-term and trust based sourcing relationships that will increase the scope for knowledge transfer. Evidence of a positive effect of experience for the transfer of knowledge has been found by Gentile-Lüdecke and Giroud (2012) for the Polish automotive sector.

*Size:* Larger firms are able to dedicate more resources to local sourcing development and might therefore be more likely to transfer knowledge to their suppliers. Positive effects of the size of the firm regarding number of employees on provision of assistance to suppliers have been found by Jordaan (2011) and Jordaan (2013) for the Mexican regions of Monterrey and Nuevo Leon respectively.

*End Market:* The level of sophistication and standards of the market where the final product of the multinational is sold might also influence the willingness to transfer knowledge to local suppliers. If the final market demands high quality standards, the MNE has then incentives to provide assistance to suppliers in order to enhance input quality and meet requirements by final customers. Evidence for this argument is provided by Giroud et al (2012). The authors find for the automotive sector in Poland that market orientation plays a role for the intensity of backward linkages and firms that target international markets are more likely to transfer knowledge to their suppliers relative to foreign investors that sell exclusively in the domestic market. Also Jabbour and Muchielli (2007) study vertical spillovers in the Spanish manufacturing industry and present evidence that export orientation of the subsidiary is associated with a positive impact of backward linkages in domestic firm's productivity.

### 3.2 Country level determinants

Host country environments in terms of institutional quality and technological development determine to a large extent MNEs choices about location and organizational strategy. The FDI literature has found with some consensus that the quality of institutions is crucial for attracting quantity and quality foreign investments<sup>6</sup>. Broadly speaking, empirical evidence is consistent in showing that poor institutions deter FDI inflows and attract more resource- seeking relative to market-seeking FDI. However, evidence on how institutions affect spillovers to the domestic economy remains inconclusive. Indeed, although there is a variety of channels through which good institutional environments might enhance positive externalities, the extant spillovers literature at the industry level shows mixed results. Meyer and Sinani (2009) perform a meta-

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<sup>6</sup> See for example, Zurawicki and Habib (2010), Cuervo- Cazurra (2006), Asediu (2006) or Wei (2000).

analysis including 66 studies on productivity spillovers. They find that institutional quality regarding transparency and economic freedom presents a U-shape relationship with the extent of spillovers, where only above a certain threshold of institutional quality host countries are able to benefit from spillovers of FDI derived from institutional improvements. Gorodnichenko et al (2007) find that the extent of spillovers is not affected by the business environment in the host country, measured alternatively through corruption and red tape indicators. Farole and Winkler (2012) find for Sub-Saharan Africa that among a number of country level factors education spending and trade openness have a positive impact on spillovers. Institutional quality of the host country has only a significant spillover impact for low-productivity domestic firms. We argue that a closer look at one direct mechanism for spillovers that is, the voluntary knowledge transfer from MNEs to local suppliers, will contribute to shed light on how host country factors affect MNEs potential for spillovers

There are a number of mechanisms through which good institutions will facilitate interaction and exchange of knowledge between MNEs and local firms. Insecurity involved in economic activity is therefore greater when transactions cross national borders (Dixit, 2011). When investors operate in a foreign country they face higher uncertainty relative to the home country regarding ways of doing business, supplier networks and their reliability. Literature on transaction costs defines institutions as the mechanisms that provide the rules of how exchanges are to be made and the mechanisms enforcing them (North 1991). Therefore quality institutions reduce uncertainty as perceived by the foreign investor and facilitate interaction with domestic suppliers.

We exploit the 19-country cross-sectional dimension of our sample and focus on five country level factors that are likely to influence the MNE decision of transferring of knowledge to suppliers: overall governance, contract enforcement, ethical behavior of firms, protection of intellectual property rights and technological readiness of the country.

The degree of overall governance of the host economy, being a broad indicator of institutional quality, is often related to an appropriate business climate, economic stability and lower levels of corruption. If overall governance is good investors will then perceive investing in knowledge intensive relationships with suppliers as less risky and enhance the likelihood of knowledge transfer. Turning to more specific institutional indicators, Pérez-Villar and Seric (2015) found that contract enforcement, ethical behavior of firms and property rights protection matter for the generation of domestic linkages by MNEs in Sub-Saharan Africa<sup>7</sup>. These indicators measure different aspects of the extent to which a host country is able to guarantee security of transactions. Consequently, the more secure is the observance of the terms of commercial exchanges, the less the perceived risk and the more likely it will be that foreign investors will

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<sup>7</sup> This study uses, as we do, the AIS 2010 dataset by UNIDO.

engage in relatively costly knowledge transfer relationships with local suppliers. Finally, besides institutional indicators, the level of technological readiness of the host country, in terms of sophistication of production processes or availability of latest technologies, will determine the needs of local suppliers in terms of knowledge transfer and their scope for learning from MNEs. Therefore the more advanced the host country is regarding its production technologies the less likely it will be that the foreign investors identify a need for transferring knowledge.

While, as stated above, host country institutions are of crucial relevance for foreign investor's sourcing decisions, institutional environment in the *origin country* also plays a role. In this regard, the notion of *institutional distance* was introduced by the literature on South-South FDI to account for the fact that sensitivity towards host-country institutional quality is not homogeneous across investors<sup>8</sup>. The dramatic rise of outward FDI from developing economies in the last decade gave rise to the so called South-South FDI flows as these new *emerging multinationals* tend to locate their investments in other developing economies. Studies on this relatively novel investment flows<sup>9</sup> identified that determinants, location patterns and effects on the host economy of this new investment differ from those traditionally identified by the literature on North-South flows.

Institutional, cultural and technological proximity have often been pointed out as a comparative advantage specific to South-South investors that can promote linkages and generate positive externalities to the local economy. As argued by Dixit (2011) the capacity of southern multinationals to better cope with bribery and also their technology and managerial skills, more adapted to deal with poor governance, overcome northern MNE's advantages in terms of modern technology and access to capital. Institutional proximity allows multinationals to better cope with the foreign environment and consequently, the interaction with local suppliers will be perceived as less risky. Building on this argument, Pérez-Villar and Seric (2015) found for Sub-Saharan Africa that institutional distance in terms of contract enforcement deters the size of backward linkages for investors coming from better institutional backgrounds.

We argue that institutional distance plays a role not only for the size of backward linkages but also for their intensity in terms of transfer of knowledge to local suppliers. Significantly worse institutional backgrounds in the host country relative to the home country faces foreign investors with higher perceived uncertainty linked to commercial transactions. Consequently, trust relationships with suppliers involving a transfer of knowledge are less likely to occur when institutional distance is large and local economic transactions are perceived as uncertain and risky.

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<sup>8</sup> Cuervo-Cazurra and Genc (2008), Bénassy-Quere et al. (2007) and Aleksynska and Havrylchyk (2012) found evidence of the negative impact of institutional distance on bilateral FDI flows at the macroeconomic level. See Pérez-Villar and Seric (2015) for an overview on the notion of institutional distance in South-South FDI literature.

<sup>9</sup> For an overview on South-South FDI particularities see for example UNCTAD (2006), Khana and Palepu (2006), Gammeltoft et al. (2010) or Takii (2011).

#### 4. Data and Methodology

The first part of our analysis focuses on the influence of several *foreign investor characteristics* on the probability of knowledge transfer. We use firm level data from the Africa Investor Survey (AIS) conducted by UNIDO in 2010. The survey provides detailed cross-country firm level information on a number of characteristics of foreign firms -organizational structure, country of origin, market orientation, relationship with local producers, output and production factors . The survey also covers questions related to international trade activities of the firms and to linkages to domestic and foreign producers. After data cleaning and removal of outliers we use information on around 1000 foreign companies from 78 different source economies investing in 19 Sub-Saharan African countries<sup>10</sup>.

It should be kept in mind that causal relationships are not to be derived from the study due to two potential shortcomings. First regarding endogeneity, a simultaneity problem may exist if the firm decides jointly on the extent of backward linkages and the knowledge to be transferred to suppliers. Secondly, giving the cross-sectional nature of the study it does not include a time-dimension to pick up effects that occur through time. While ideally a panel-data study would allow for a more robust identification of causal relationships, we are limited by survey data availability. However, the detailed information on supply chain linkages and local sourcing behavior provided by the UNIDO AIS 2010 allows for a unique and thorough characterization of interactions between investors' characteristics and their economic activities.

We estimate the following probit baseline model<sup>11</sup>:

$$(1) P(\text{Knowl. Transfer}=1)_i = \alpha + \beta_1 \text{BACK\_LINK}_i + \beta_2 \text{INVEST\_TYPE}_i + \beta_3 X_i + \beta_4 Z_i + e_f$$

where our dependent variable (Knowl. Transfer)<sub>i</sub> accounts for the probability of a foreign firm i transferring knowledge to its domestic suppliers and takes the form of a binary variable that is equal to one if the multinational reports to have offered any assistance to its local suppliers in order to improve their operations and it is zero otherwise. The survey includes information about five different forms of assistance provided to suppliers (production process and product upgrading, joint design of products, transfer of technology or know-how and provision of training). For simplicity we build an aggregate variable that indicates if the foreign investor transfers any type of knowledge to its suppliers. Detail on the question and possible answers are included in table A4 in the Appendix.

The first explanatory vector (*BACK\_LINK<sub>i</sub>*) accounts for two attributes of the backward linkage. First, *extent of backward linkage* is measured as the share of locally sourced inputs over total

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<sup>10</sup> Host countries included are: Burkina-Faso, Burundi, Cameroon, Cape Verde, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Tanzania, Uganda and Zambia.

<sup>11</sup> All results are robust to logit estimation. See tables A5 and A6 in the Appendix.

inputs. Second, the long-term nature of the local procurement contract is measured through a dummy variable that takes the value one if the foreign investor reported to have at least one long-term local supplier.

The second regressor ( $INVEST\_TYPE_{it}$ ) refers to the type of investment regarding alternatively ownership structure, sourcing strategy and subsidiary autonomy. *Type of ownership* distinguishes between subsidiaries from MNEs vs. individual investors and joint ventures vs. fully foreign owned establishments. The variable *Subsidiary* takes the value one if the company is a subsidiary of a multinational and zero if it is an individual foreign investor. The variable *JV* takes the value one if the foreign firm has a local partner (10% or more of domestic ownership) and it is zero otherwise. *Sourcing strategy* is built from the main motivation for local procurement as reported by the MNE. It comprises five dummy variables that take the value one if the main reason for local procurement is respectively, adaptation to the local market, optimization of value chain efficiency, access to raw materials, corporate responsibility concerns and other factors. The third investment type regards to *subsidiary autonomy*. This variable records the relationship of the foreign investor with its parent firm and refers to the degree of local management autonomy of the subsidiary. Information about autonomy is only available for the subsample of 408 subsidiaries of MNE (and not for individual investors), therefore we are only able to evaluate the impact of autonomy for this type of investments.

$X_i$  is a vector of controls accounting for five other firm characteristics that have been found by the literature to affect vertical transfer of knowledge namely, experience in the market, firm size, R&D at the subsidiary, technology gap and destination market. *Experience* in the market is accounted for as the number of years since the investment took place; *firm size* is measured as number of employees and *extent of R&D* carried at the subsidiary is reported as R&D expenditures over total sales. We also account for the *technology gap* with respect to the local suppliers as perceived by the MNE. This variable is measured as a dummy variable that takes the value one if the main reported reason for not entering or cancelling local procurement is technical or management skill issues, quality of equipment or process capacity of local suppliers. This measure is built in line with Jordaan (2013) and it captures the technological distance between the domestic supply sector and each foreign investor as perceived by the latest. *End Market* is defined as *Export North (South)* and is a dummy variable that takes the value 1 if most of the firm's exports target industrialized (developing) countries. Finally, the vector  $Z_i$  includes industry dummies at the ISIC-2 digit level and country dummies referring to both host and origin economies.

Table 1 provides descriptive statistics on knowledge transfer by type of assistance provided, sector, host, and origin countries. 55% of firms in the sample reported having transferred at least

one form of knowledge. The most common type of assistance was provided to suppliers aiming to upgrade the efficiency of their production processes and the quality of their products, with respectively 45% and 33% of MNEs reporting a positive answer in these areas. Less common forms of knowledge transfer are the provision of training, transfer of technology or know-how and joint design of products with less than 20% of the foreign investors reporting to have provided these forms of assistance. The distribution across *sectors* of firms that transferred knowledge to suppliers is relatively homogeneous. Vehicles and transport equipment, basic metals and tobacco products present higher shares of assistance provision. Regarding the *origin* of the foreign investors, the frequency of reported assistance is quite uniformly distributed with some more European, Northern American and Asian (mostly Indian) investors reporting assistance to suppliers. About the breakdown by *host countries*, a similar behavior is found in most of the sample with the exception of foreign investors in Cape Verde, Uganda and Nigeria where 70% of MNEs transferred knowledge to their suppliers. Lesotho and Cameroon appear as the countries with least frequent knowledge transfer to local suppliers with around 30% of investors having reported provision of assistance.

The second part of our analysis focuses on the **country level** and is carried out in two steps: first, for the institutional quality levels at the host country and second, for the institutional distance between origin and host country.

- Regarding host country *institutional quality* we include alternatively the following institutional indicators: First, overall *governance*, measured as the average of the six Worldwide Governance Indicators by the World Bank<sup>12</sup>. For robustness, we repeat our analysis for an alternative measure of overall governance, namely the Ibrahim Index of African Governance by the Mo Ibrahim Foundation<sup>13</sup>. Second, we include an indicator of *contract enforcement* measured through the efficiency of legal framework in settling disputes taken from the Executive Opinion Survey by the World Economic Forum (WEF). Third, we look at *ethical behavior of firms* which is taken from the Executive Opinion Survey (by WEF) and it records frequency of private sector corruption practices such as bribery. Third, we look at the degree of protection of property rights measured through the 2010 Ginarte-Park Index of Patent Rights<sup>14</sup>. Finally we account for the degree of production process sophistication as measured in the Executive Opinion Survey (by WEF). Finally, besides institutional and technological

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<sup>12</sup> We follow Aleksynska and Havrylchuk (2012) and compute a simple average of the Worldwide Governance Indicators by the World Bank, defined by Kaufmann et al. (2010). These include six institutional dimensions: Voice & Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption.

<sup>13</sup> This comprehensive indicator is built exclusively for African economies using a number of national and international sources and includes information about safety and rule of law, human rights, sustainable economic opportunity and degree of human development.

<sup>14</sup> We thank Professor Park for kindly providing the last version of the Index.

development a number of country level factors relating to welfare, education and infrastructure are likely to influence the sourcing behavior by MNEs. Therefore we include as a control the Ibrahim Index of Human Development by the Mo Ibrahim Foundation that includes welfare, education and health indicators.

- Next, *institutional differences* between origin and host country are accounted for by computing the difference between investor's origin and host country institutional indicators. Following Aleksynska and Havrylchyk (2012), we distinguish between negative (positive) distance i.e. worse (better) institutions at the home country than at the host country. We define each negative (positive) distance variable as equal to the value of the difference if it is negative (positive) and zero otherwise. To account for non-linearities across different levels of institutional distance we include the quartile partition with values below the first, second and third quartiles representing low, medium and high distance respectively. Finally, in our distance analysis and aiming at accounting for relevant country-pair effects we additionally add a set of host-home *bilateral variables*. These comprise geographical distance, common colonizer or colonial relationship and are taken from the Gravity Database by CEPII.

Means of the institutional indicators by origin region and host countries are shown in Table 2. When looking at investor's origin, Swedish and Cote d'Ivoire investor's account for the most and the least ethical behavior respectively. Intellectual property right protection among origin countries is strongest in United States while Somalia records the weakest protection degree. The most efficient legal system is found in Singapore whereas the Italian legal system appears as the least efficient. Regarding host countries, Burundi and Nigeria record the lowest levels of overall governance, while Cape Verde and Ghana account for the best overall governance. Burundi scores the lowest regarding firm's ethical behavior whereas firm ethics are the highest in Zambia and Malawi. Lesotho and Kenya show the weakest contract enforcement which reaches its maximum for Nigeria and Burkina-Faso. Regarding protection of intellectual property rights, it presents its weakest score for the case of Burundi and it scores highest in Ghana. Finally, the most technological advanced among our host countries are Nigeria and Senegal and the least Uganda.

Finally, as we are aware that transfer of knowledge might be determined by factors that also affected the location decision of the multinational in the first place, we control for availability of local suppliers or skilled workers as reported location factors in all our specifications. A detailed description of each variable as well as descriptive statistics and the correlation matrix are provided in the Appendix in tables A1-A3 respectively.

**Table 1: Knowledge transfer to local suppliers: type of knowledge, sector, host and origin country.**

Total no. firms=1017		Percent of knowledge transfer firms = 55,36%		
<b>Type of Knowledge</b>		<b>% firms</b>		
Product upgrading		33.91		
Production process upgrading		45.73		
Provision of training		19.33		
Transfer of technology and know-how		19.18		
Joint design of products		18.67		
		<b>No. Firms</b>	<b>% total</b>	<b>% Any Transfer Knowledge</b>
<b>By Sector</b>				
Food and beverages		193	19.0	61,13
Tobacco products		12	1.2	75,00
Textiles		41	4.0	58,36
Garments		79	7.8	50,63
Leather and footwear		26	2.6	50,00
Wood products and furniture		75	7.4	56,00
Paper and paper products		32	3.1	56,25
Publishing		28	2.8	64,28
Petroleum products and chemicals		133	13.1	54,88
Rubber and plastics		133	13.1	48,87
Non-metallic minerals		44	4.3	52,27
Basic metals		37	3.6	67,56
Fabricated metal products		98	9.6	45,91
Machinery and equipment		62	6.1	56,45
Vehicles and transport equipment		18	1.8	66,66
Other manufacturing		6	0.6	50,00
<b>By Investor Origin</b>				
Europe+North America		400	39.3	57
China & Easter Asia		118	11.6	50,21
India & Other Asia		205	20.2	49,10
Mena		88	8.7	53,34
Other (LAC&Oceania)		6	0.6	66,66
SSA		197	19	50,76
South		584	57.4	56,83
North		431	42	54,30
<b>By Host Country</b>				
Burkina Faso		6	0.6	50,00
Burundi		9	0.9	33,33
Cameroon		34	3.3	26,47
Cape Verde		20	2.0	70,00
Ethiopia		78	7.7	64,10
Ghana		94	9.2	46,80
Kenya		200	19.7	56,00
Lesotho		48	4.7	31,25
Madagascar		46	4.5	54,34
Malawi		14	1.4	50,00
Mali		27	2.7	40,74
Mozambique		62	6.1	59,67
Niger		6	0.6	50,00
Nigeria		81	8.0	71,60
Rwanda		14	1.4	35,71
Senegal		22	2.2	45,45
Tanzania		89	8.8	55,05
Uganda		131	12.9	70,99
Zambia		36	3.5	41,66

Notes: North America, USA and Canada; Mena (Middle East and North Africa); LAC (Latin America and Caribbean); SSA (Sub-Saharan Africa).

**Table 2: Institutional Indicators: Means by origin region and host country.**

	Overall Governance	Contract Enforcement	Firm Ethics	IPR Protection	Tech. Readiness
<b>By Investor Origin</b>					
Europe+North America	1.25	4.65	5.46	5.57	5.39
China & Easter Asia	0.02	4.21	4.55	4.12	4.48
India & Other Asia	-0.33	4.30	4.10	3.62	4.19
Mena	-0.42	4.29	4.65	3.04	4.23
Other (LAC&Oceania)	1.10	4.65	5.46	4.57	5.39
SSA	-2.62	3.97	4.15	3.21	3.53
South	-0.28	4.16	4.22	3.52	3.97
North	1.24	4.64	5.45	4.56	5.38
<b>By Host Country</b>					
Burkina Faso	-0.28	3.91	3.84	0	2.32
Burundi	-1.16	3	2.84	1.98	2.41
Cameroon	-0.88	3.82	3.25	2.89	2.68
Cape Verde	0.48	-	-	2.89	-
Ethiopia	-0.95	3.42	3.64	2.13	2.45
Ghana	0.10	3.68	3.95	3.35	2.55
Kenya	-0.66	2.92	3.77	3.22	3.21
Lesotho	-0.12	2.75	3.48	-	3.05
Madagascar	-0.75	2.85	3.44	2.18	2.59
Malawi	-0.29	3.72	4.41	2.44	2.34
Mali	-0.44	3.70	3.68	2.77	2.46
Mozambique	-0.26	3.45	3.21	3.02	2.98
Niger	-0.70	-	-	2.77	-
Nigeria	-1.16	3.99	3.46	2.89	3.24
Rwanda	-0.25	-	-	2.48	-
Senegal	-0.42	3.46	3.87	2.77	3.28
Tanzania	-0.35	3.80	3.79	3.10	2.78
Uganda	-0.60	3.61	3.43	3.10	2.26
Zambia	-0.35	3.70	4.10	2.23	2.79

Notes: North America. USA and Canada; Mena (Middle East and North Africa); LAC (Latin America and Caribbean); SSA (Sub-Saharan Africa). Overall Governance refers to the average of the six Worldwide Governance Indicators by the World Bank. Contract Enforcement is measured by the Efficiency of the judicial system in Settling Disputes from the Executive Opinion Survey by the World Economic Forum. Firm Ethics refers to Ethical Behaviour of Firms taken from the Executive Opinion Survey by the World Economic Forum. Protection Intellectual Property Rights refers to the Ginarte-Park Index of Patent Rights. For a detailed description of variables see table A1 in Appendix. Indicators from the the Executive Opinion Survey by the World Economic Forum are not available for Cape Verde, Niger and Rwanda that sum up to 50 obs.

## 5. Results

### *a. Investor' characteristics and knowledge transfer*

Average marginal effects from the probit estimation on foreign investor characteristics are presented in Table 3 and 4. We start by looking at how *backward linkage* (model 1) attributes affect the likelihood of transfer of knowledge to suppliers. First, regarding the extent of the linkage, we find a non-linear relationship with the share of locally sourced inputs related to higher probabilities of transfer of knowledge until reaching a threshold (50%) beyond which the relation turns negative. This finding is consistent with results by Saliola and Zanfei (2009) and Giroud et al (2012) and can be interpreted as larger scale linkages reflecting local sourcing of non-differentiated goods responding to cost-saving more than quality motivations. Second, also in line with previous findings, the long-term nature of the local procurement agreements fosters trusts relationships and encourages the transfer of knowledge.

Next, we look at the role played by *type of investment* regarding ownership structure, sourcing strategy and subsidiary autonomy for the transfer of knowledge to local suppliers. We find that subsidiaries from multinationals are more likely to transfer knowledge to their suppliers relative to individual investors and that having a local partner does not play a significant role (model 2). Putting these findings in relation with previous studies on size of backward linkages<sup>15</sup> it suggests that whereas individual investors and JV's tend to source larger shares of their inputs locally, the knowledge transfer involved is however less likely for this type of firms. Second, regarding the MNE's sourcing strategy (model 3) we find that foreign investors that source locally to better match requirements of local customers or that search to optimize value chain efficiency are around 16% more likely to transfer knowledge. Similarly, when the local sourcing decision is based on corporate social responsibility concerns such as environmental or local development commitments MNE's are 18% more likely to support their local suppliers. Local sourcing that aims at accessing raw materials is not related to higher probability of knowledge transfer according to our results. This is consistent with findings by previous studies that appoint local sourcing of non-differentiated goods as poor in terms of knowledge transfer and with studies that reflect rather limited interaction with the domestic sector of resource seeking FDI<sup>16</sup>. Additionally, our findings support the positive role played by local embeddedness for knowledge intensive supply chain relationships. Third, in models (4) and (5) we look at type of investment regarding autonomy of the subsidiary<sup>17</sup>. More autonomous subsidiaries are about 6% more likely to transfer more knowledge to its domestic suppliers and this effect derives mostly from autonomy regarding selection of suppliers<sup>18</sup>. This finding confirms results by Jindra et al. (2009), Giroud et al. (2012) and Crone and Roper (2001) that more autonomous subsidiaries tend to engage in more knowledge intensive relationships with local firms.

Finally, *other firm level characteristics* show intuitive and interesting results consistent with the previous literature. Size of the firm, measured as the number of employees, has a positive impact on the transfer of knowledge. Our measure of technology gap shows positive coefficients, implying that with firms that are mostly concerned about technical capabilities and workforce skills of suppliers tend to transfer knowledge to promote its upgrading. Our finding provides support for the argument that technical differences should be large enough so that there

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<sup>15</sup> Amendolagine et al (2013), Pérez-Villar and Seric (2015) (also using the AIS 2010 dataset by UNIDO).

<sup>16</sup> See Farole and Winkler (2014, pp: 32) for an overview.

<sup>17</sup> Note that the survey only provides information about the degree of autonomy for the subsample of subsidiaries of MNE (letting out individual investors). With this subsample, variables regarding sourcing strategy, the extent of the backward linkage and technology gap become insignificant given the lower number of observations. We performed the whole analysis for the subsample of subsidiaries and results are consistent with those from models (4) and (5). See table A7 in Appendix for detail.

<sup>18</sup> The survey reports information about the degree of autonomy regarding nine management areas. For simplicity reasons we include an average autonomy index and the most significant autonomy area, namely selection of suppliers.

is scope for transfer of knowledge and learning possibilities in line with Békés et al (2009) and Jordaan (2008, 2013). Further, we find that investments that serve export markets are more likely to transfer knowledge to suppliers relative to investments targeting exclusively the domestic market but only when the main destination markets are developed economies<sup>19</sup>. This finding goes in line with the arguments by Jabbour and Muchielli (2007) and Giroud et al. (2012) that investors targeting more sophisticated markets have incentives to assist upgrading of local suppliers. This provides access to better inputs that meet international standards or requirements of the final market. Finally, experience in the market and the amount of R&D performed in the subsidiary seem not to influence the transfer of knowledge according to our analysis.

Summarizing, our results on foreign investor' characteristics show that, first, the transfer of knowledge follows a non-linear relationship with the extent of backward linkages. Higher shares of locally sourced inputs are associated with higher probabilities of transfer of knowledge only up to a 50% threshold where the relation turns negative. Second, the long- term nature of the local procurement contracts incentivizes provision of support to local suppliers. Third, the type of investments that are more likely to provide support to their local suppliers are subsidiaries of MNE with certain degree of local management autonomy and with sourcing strategies that seek to meet local market requirements, to optimize value chain efficiency or that respond to social responsibility commitments. Finally, other firm characteristics such as firm size, the perceived technology gap and targeting developed export markets are positively associated with the transfer of knowledge.

*b. Country factors and knowledge transfer*

In the second part of our analysis we explore several country level characteristics that potentially play a role for the transfer of knowledge to suppliers. As discussed in the previous section, foreign investor's behavior and their interaction with the local economy are influenced by the institutional environments and degrees of technological development. In this regard we argue that not only the host country environment but also origin country conditions play a role.

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<sup>19</sup> European Union and United States

**Table 3: Investor characteristics and transfer of knowledge. Probit estimation (average marginal effects).**

MODEL	(1)	(2)	(3)	(4)	(5)
<i>Type of Backward Linkage</i>					
Long Term Contract	0.105*** (0.0354)	0.103*** (0.0355)	0.0884** (0.0358)	0.136** (0.0560)	0.125** (0.0561)
Backlink1	0.00444** (0.00175)	0.00487*** (0.00175)	0.00494*** (0.00173)	0.00395 (0.00262)	0.00404 (0.00260)
Backlink2	-0.00004695** (-0.0000195)	-0.0000507*** (-0.0000195)	-0.0000495** (-0.0000194)	-0.0000415 (-0.0000280)	-0.0000429 (-0.0000277)
<i>Type of Investment</i>					
<i>-Ownership Structure</i>					
Subsidiary		0.0814** (0.0375)	0.0916** (0.0373)	0.108* (0.0603)	0.110* (0.0609)
JV		0.0465 (0.0358)	0.0515 (0.0356)	0.0298 (0.0597)	0.0386 (0.0601)
<i>-Sourcing Strategy</i>					
Adapt local market			0.160*** (0.0577)	0.128 (0.0969)	0.141 (0.0953)
Value Chain Efficiency			0.160*** (0.0583)	0.113 (0.0958)	0.101 (0.0966)
Corp.Social Respons			0.180** (0.0706)	0.231** (0.0997)	0.211** (0.106)
Raw Materials Access			0.0472 (0.0578)	0.0232 (0.0973)	0.0190 (0.0970)
Other			-0.0259 (0.0613)	-0.0370 (0.0993)	-0.0295 (0.0983)
<i>-Subsidiary Autonomy</i>					
Autonomy Index				0.0628** (0.0281)	
Autonomy Sel. Supplier					0.0575*** (0.0214)
<i>Other MNE characteristics</i>					
Experience	0.000880 (0.00113)	0.000809 (0.00113)	0.00103 (0.00114)	-0.000682 (0.00154)	-0.000645 (0.00152)
Size	0.0373** (0.0149)	0.0297** (0.0151)	0.0219 (0.0156)	0.0228 (0.0213)	0.0235 (0.0213)
Tech. gap	0.123*** (0.0320)	0.120*** (0.0320)	0.0945*** (0.0324)	0.0559 (0.0515)	0.0547 (0.0521)
R&D	0.0381 (0.0440)	0.0285 (0.0441)	0.0305 (0.0434)	0.0159 (0.0647)	0.00329 (0.0648)
Exports North	0.204*** (0.0494)	0.196*** (0.0502)	0.205*** (0.0487)	0.277*** (0.0606)	0.267*** (0.0615)
Exports South	-0.000580 (0.0381)	-0.00626 (0.0380)	-0.00106 (0.0378)	0.0540 (0.0541)	0.0568 (0.0537)
Location supp.	0.000629 (0.0345)	0.00306 (0.0346)	0.000360 (0.0344)	0.0229 (0.0554)	0.00965 (0.0558)
Observations	918	914	897	394	392
Pseudo R-squared	0.1118	0.1149	0.1328	0.1842	0.1900

Industry, Host and Origin Country dummies are included

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

We therefore conduct our analysis in two steps: first, we focus on the host country institutional environment and second, we look at differences in institutional environments between host and origin country of the MNE. We proceed by removing alternatively host and origin country dummies from our baseline probit model and replacing them by five institutional and

technological indicators firstly in levels and secondly in host-origin institutional differences. Regarding our differences indicators, we include the quartile partition (second and third quartiles dummies representing medium and high distance respectively and first quartile or low distance dummy as the reference variable) to account for non-linearities across different levels of institutional distance. Further, we distinguish between negative and positive institutional distance that is, we construct separate variables to account for worse or better institutional frameworks relative to the origin country<sup>20</sup>. Regarding the controls in our differences regressions, we include a set of host-origin bilateral variables regarding physical distance and colonial ties. As in the previous regression and to account for the fact that many of the variables included in our analysis might have affected the location decision of the multinational in the first place, we control for availability of local suppliers as a location factor. To control for host country factors not including in our selection of institutional and technological indicators we include the Mo. Ibrahim Index of Human Development that accounts for welfare, health and education levels and it is specifically built for African economies<sup>21</sup>. Finally, in all specifications we control for the firm level characteristics from our baseline analysis, as well as for 2-digit ISIC level industries.

Table 4 shows regression results regarding host country institutional quality and institutional distance with the origin country. Models (1) to (9) include respectively indicators on average governance, ethical behavior of firms, contract enforcement and protection of property rights. In Model (10) we account for the technological development of the country by means of the degree of production process sophistication<sup>22</sup>. Our findings suggest that the level of contract enforcement in the host country is positively related to the likelihood of transferring knowledge (model 3). Further, foreign investor's decision to transfer knowledge is impeded by relatively high differences between contract enforcement levels when MNEs are in a country with worse institutions than the origin country. Host country overall governance and the degree of property right protection show insignificant results when considered in host country levels (models 1 and 7). However, when the differences with respect to the origin country are taken into account (models 2 and 8, respectively) a significant negative impact of institutional distance is found. In other words, when the quality of institutions at the host country is worse than at the origin country, it significantly impacts the foreign investor's decision of transferring knowledge. Ethical behavior of firms, referring mostly to frequency of bribery practices in the private

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<sup>20</sup> Since for the case of our analysis, only few pairs of host-origin country show positive institutional distance and for the sake of clarity we do not report these indicators.

<sup>21</sup> For the case of our first specification including Overall Governance We substitute this control in for the level of GDP per capita due to high given the high correlation of both institutional measures (60%)

<sup>22</sup> Note that indicators from the Global Competitiveness Survey (ethical behavior of firms, contract enforcement and production process sophistication) are not available for Cape Verde (21 firms), Niger (7 firms) and Rwanda (22 firms). The Ginarte-Park Index is not available for Lesotho (8 firms).

sector, does not seem to have an impact for the transfer of knowledge to suppliers in levels nor in distances. These results are consistent with the argument made above that quality institutions reduce uncertainty as perceived by the foreign investor and facilitate more intense interaction with domestic suppliers. Moreover, *distance* regarding overall governance and quality of institutions that secure transactions also plays a role for the transfer of knowledge to local suppliers. It follows that higher perceived uncertainty linked to commercial transactions deters trust relationships with suppliers that entail a transfer of knowledge.

Finally, our technological readiness indicator (models 9 and 10) shows that the degree of production process sophistication is negatively related with the probability of knowledge transfer. This finding is consistent with the argument that suppliers in relatively technologically advanced host countries might not benefit as much from a transfer of knowledge since the scope for learning is relatively less significant. Foreign investors might not identify a need for transferring knowledge to suppliers if they have access to relatively advanced technology and sophisticated production processes.

Summarizing our country level analysis, we find that host country factors matter for the transfer of knowledge and further, its importance is influenced by factors relating to MNEs' country of origin. More specifically, an efficient judicial system that guarantees contract enforcement, protection of intellectual property rights and overall governance play a significant role enhancing the transfer of knowledge. Investors from countries with more advanced institutions are more sensitive about host country security of transactions in terms of contract enforcement and protection of intellectual property rights. Technological backwardness of the host country regarding production processes incentivizes foreign investors to provide assistance to local suppliers independently from their country of origin. Finally, the frequency of corruption practices at the firm level does not seem to play a role according to our analysis.

**Table 4: Host country factors and transfer of knowledge. Probit estimation (average marginal effects)**

MODEL	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Host Country Factors										
Governance	-0.0460 (0.0625)									
Worse Gov: Medium		-0.0941** (0.0466)								
Worse Gov: High		-0.0831 (0.0561)								
Contract enforcement			0.143*** (0.0491)							
Worse ConEnfor: Medium				-0.0858 (0.0633)						
Worse ConEnfor: High				-0.137** (0.0655)						
Firm Ethics					-0.0779 (0.0785)					
Worse Firm Ethics: Medium						0.0422 (0.0482)				
Worse Firm Ethics: High						-0.0285 (0.0599)				
IPR protection							-0.0402 (0.0453)			
Worse IPRprot: Medium								-0.0851 (0.0526)		
Worse IPRprot: High								-0.124** (0.0583)		
Technological readiness									-0.148*** (0.0489)	
Worse TechRead: Medium										0.000122 (0.0466)
Worse TechRead: High										-0.0139 (0.0557)
Controls										
Host country	No	No	No	No	No	No	No	No	No	No
Origin country	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Bilateral variables	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry 2-digit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	871	897	871	813	871	813	835	771	871	813
Pseudo R-squared	0.0966	0.0895	0.0988	0.0948	0.0925	0.0920	0.0838	0.0904	0.0989	0.901

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 6. Conclusions and policy implications

This paper examines determinants of vertical and voluntary knowledge transfer from MNE to their local suppliers in 19 Sub-Saharan African countries. We argue that not all local sourcing activities by MNEs are associated with a transfer of knowledge to suppliers and therefore they are not equally beneficial to the domestic economy. Specifically, we analyze which foreign investor activities, organizational characteristics and country level factors maximize the likelihood of knowledge transfer. Our findings support the idea that foreign investor's heterogeneity and institutional environments are key factors shaping the sourcing patterns of MNEs and consequently the spillovers potential of backward linkages. Thus, investment policies that merely focus on promoting larger shares of locally sourced inputs might fail to get the most of FDI positive externalities. Instead, knowledge-involving quality linkages should be promoted over quantity linkages.

Regarding the *backward linkage attributes* we find first, that the long-term nature of the local procurement relationships enhances the transfer of knowledge. Secondly, in line with previous findings by the literature, we find a non-linear relationship between the share of locally sourced inputs and the probability of knowledge transfer which is positively related with the amount of local inputs only until reaching a certain threshold, 50% according to our analysis, where the relationship turns negative. This effect might be due to larger scale linkages reflecting local sourcing of non-differentiated goods responding to cost-saving more than to quality motivations. Next, we find that the *type of investments* that are more likely to provide support to their local suppliers are subsidiaries of MNEs with a certain degree of local management *autonomy* especially regarding selection of suppliers. Sourcing strategies that seek to meet local market requirements, to optimize value chain efficiency or that respond to social responsibility commitments translate into more knowledge transfer to suppliers compared with raw material seeking strategies. Finally, *size* of the firm, the *technology gap* as perceived by the foreign investor and *developed markets export* orientation are positively related to local supplier upgrading.

With respect to our country level analysis, we find that host country overall governance enhances the potential for knowledge transfer to local suppliers. More specifically, an efficient judicial system in settling disputes plays a significant role enhancing the transfer of knowledge and furthermore, investors from better institutional backgrounds care more about host country judicial efficiency. Similarly, weak protection of intellectual property rights deters the transfer of knowledge for investors from better institutional backgrounds. Finally, technological backwardness of the host country regarding production processes incentivizes foreign investors to provide assistance to local suppliers independently from their country of origin.

Investment policies should therefore account for the fact that attracting the “right type” of FDI and promoting development enhancing-behavior of investors goes hand in hand with creating a business environment that secures transactions and reduces uncertainty and perceived risk. Additionally, investor’s origin matters determining their degree of transaction uncertainty and their sensitivity to institutional quality. This suggests that policy makers should be aware that heterogeneous investments respond differently to the same environment and might therefore call for adapted investment programs.

As a final note, while the present study focuses on the determinants of knowledge transfer it should not be assumed that domestic suppliers automatically benefit from the assistance provided by their MNE’s customers. Absorptive capacity and learning commitment of suppliers will determine to what extent the knowledge transferred is internalized.

Our findings support the idea that investment policy plays a crucial role in enhancing scope for spillovers. At a first stage, policies should target to identify and attract investors and sourcing strategies more likely to generate knowledge spillovers by for instance, promoting local market

seeking or GVC-integrating investors over mostly resource seeking MNEs. Also delegation of competencies to the subsidiaries should be encouraged. At a second stage, policies should aim to promote not only linkages with the domestic sector but also the exchange of knowledge and provision of support through these linkages. Quality and long-term relationships that involve sourcing of non-standardized local inputs and that allow for value-adding and upgrading should be promoted. Other appropriate policies at this stage would aim at making foreign investors aware of the win-win process of local sourcing and knowledge transfer, to fill information gaps and to reduce perceived uncertainty. Additionally, although this study looks at transfer of knowledge from the foreign investor perspective, the role of a dynamic domestic sector enhancing spillovers potential should be taken into account. Private sector development measures that promote entrepreneurship help domestic firms meet requirements of international markets or account for specific needs of small and medium enterprises will improve domestic sector capabilities to generate beneficial linkages with foreign investors. Therefore successful investment policy should be complemented by domestic private sector upgrading measures. We conclude that there is a chance for LDCs to benefit from the global economy and multinationals are a key channel for promoting structural change through international knowledge transfer. However, materializing FDI spillovers in these countries represents a great challenge and heterogeneous foreign investors and countries account for differential spillover potential. Hence, proactive investment policies are needed in order to identify and support the type of investments that are more likely to generate positive externalities and to create the appropriate country environment for the spillovers to materialize.

## Appendix

**Table A1: Description of variables**

Variable Description			
Variable	Variable Name	Description	Source
<i>Dependent Variable</i>			
Anytransfer	Transfer of Knowledge	1 if the firm transferred at least one type of knowledge to suppliers	AIS 2010 by UNIDO
<i>Firm level Explanatory Variables</i>			
Backlink	Domestic Linkage	Share of locally manufactured inputs over total inputs	AIS 2010 by UNIDO
Experience	Experience in the Market	Number of years since start of operations	AIS 2010 by UNIDO
Size	Firm size	Number of full time employees (log)	AIS 2010 by UNIDO
Tech Gap	Techology Gap	1 if the foreign firm identified lack of technical skills or production capabilities as the main reason to cancel or not starting local procurement	AIS 2010 by UNIDO
R&D	high R&D	1 if subsidiary R&D expenditures are above the average expenditures	AIS 2010 by UNIDO
LongTerm Cont	Long term sourcing contract	1 if MNE has at least one long term local supplier	AIS 2010 by UNIDO
Subsidiary	Subsidiary of MNE	1 if the firm is subsidiary of MNE and has 10% or more of domestic capital	AIS 2010 by UNIDO
JV	Individual Investor	1 if the firm is individual investor of MNE and has 10% or more of domestic capital	AIS 2010 by UNIDO
Adapt local market	Local sourcing for adapt to local market	1 if main reason for local procurement is local market acceptability or local content is encouraged by ultimate customer	AIS 2010 by UNIDO
Raw material access	Local sourcing for raw material access	1 if main reason for local procurement is access to local raw material sources	AIS 2010 by UNIDO
Value Chain Efficiency	Local sourcing for value chain efficiency	1 if main reason for local procurement is easier logistics and reduced inventory or fiscal efficiency in the supply chain	AIS 2010 by UNIDO
Corp. Social Respons.	Local sourcing for corporate social responsibility commitments	1 if main reason for local procurement is environmental concerns or local supplier development commitment	AIS 2010 by UNIDO
Other	Other local sourcing	1 if main reason for local procurement is other as the above	AIS 2010 by UNIDO
Export North	Mostly North export oriented	1 if the ratio of exports to the North over total export is more than 50%	AIS 2010 by UNIDO
Export South	Mostly South export oriented	1 if the ratio of exports to the South over total export is more than 50%	AIS 2010 by UNIDO
Autonomy	Autonomy Index	Average of local management autonomy indicators. Ranges from 1 (lowest)-5 (highest)	AIS 2010 by UNIDO
Autonomy sel. Supplier	Autonomy in selection of suppliers	Local management autonomy on supplier selection. Ranges from 1 (lowest)-5 (highest)	AIS 2010 by UNIDO
Loc_SupSkills	Local Supplier/ Skill dummy	1 for local suppliers or skilled workers availability as crucial or very important location factor	AIS 2010 by UNIDO
<i>Country level Explanatory Variables</i>			
Governance	Overall Governance	Simple average of the Worldwide Governance Indicators by the World Bank, defined by Kaufmann et al. (2010). These include six institutional dimensions: Voice & Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption	Worldwide Governance Indicators. The World Bank 2010
Contract enforcement	Efficiency of legal framework in settling disputes	How efficient is the legal framework in your country for private business in settling disputes [1 = extremely inefficient; 7 = highly efficient]	Global Competitiveness Report. World Economic Forum, Executive Opinion Survey (GCS) 2010
Firm Ethics	Ethical behaviour of firms	How would you compare the corporate ethics (ethical behavior in interactions with public officials, politicians, and other enterprises) of firms in your country with those of other countries in the world? [1 = among the worst in the world; 7 = among the best in the world]	GCS 2010
IPR protection	Intellectual Property Right Protection	Ginarte and Park Index of Intellectual Property Right Protection	Ginarte-Park Index of Patent Rights
Technological readiness	Production process sophistication	In your country, how sophisticated are production processes? [1 = not at all-labour intensive methods or previous generations of process technology prevail; 7 = highly- the world's best and most efficient process technology prevails.	GCS 2010
dist	Distance	kms between most important cities/agglomerations (in terms of population)	GeoDist database CEPPI
comcol	Common col. Dummy	1 for countries with a common colonizer	GeoDist database CEPPI
colony	Colony dummy	1 for pair of countries ever in colonial relationship	GeoDist database CEPPI
Ibrahim Index of Human Development	Ibrahim Index of Human Development	Ibrahim Index of Human Development: Welfare, Education and Health	Mo Ibrahim Foundation

**Table A2: Summary Statistics**

Descriptive Statistics					
Variable	Mean	Std. Dev	Min	Max	
<i>Dependent Variable</i>					
Anytransfer	0.553589	0.497365	0	1	
<i>Firm level expl. Variables</i>					
Backlink	21.69479	31.89029	0	100	
Experience	18.03406	16.39321	0	111	
Size (log)	4.721249	1.321487	1.098612	9.673257	
Tech Gap	0.445905	0.497317	0	1	
LongTerm Cont	0.588176	0.49241	0	1	
Subsidiary	0.071631	0.257997	0	1	
JV	0.312559	0.463755	0	1	
Adapt local market	0.224242	0.417293	0	1	
Raw Materials	0.228283	0.419938	0	1	
Value chain efficiency	0.186869	0.390003	0	1	
Corp. Social Resp	0.050505	0.219095	0	1	
Other local sourcing	0.223232	0.416623	0	1	
Export North	0.140038	0.347189	0	1	
Export South	0.292293	0.45503	0	1	
R&D	0.18609	0.389363	0	1	
Autonomy Index	2.985	0.9101	1	5	
Autonomy sel. supplier	3.143	1.213	1	5	
<i>Country level expl. Variables</i>					
Overall Gov	56.62942	7.292554	43.3	76.7	
IPR protection	2.880236	0.4619	0.2	3.35	
Dispute Settling	3.417307	0.389569	2.75219	3.992749	
ProdProc Sophis	2.789623	0.357585	2.265862	3.288728	

**Table A3: Correlation Matrix**

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1. Anytransfer	1																							
2. Backlink	0.06	1																						
3. LongTerm Cont	0.15*	0.20*	1																					
4. Experience	0.04	0.07*	0.09*	1																				
5. Size	0.08*	0.01	0.10*	0.26*	1																			
6. Tech Gap	0.14*	-0.05	0.03	-0.03	-0.04	1																		
7. R&D	0.05	0.02	0.08*	0.01	-0.03	-0.02	1																	
8. Export North	0.08*	0.03	0.01	-0.03	0.33*	-0.04	-0.05	1																
9. Export South	-0.04	0.03	0.08*	0.15*	0.11*	-0.05	0.00	-0.24*	1															
10. Subsidiary	0.02	-0.10*	-0.00	0.09*	0.22*	0.02	0.04	0.14*	0.07*	1														
11. JV	0.06*	0.16*	0.11*	0.19*	0.11*	0.00	0.06*	-0.07*	0.023	-0.08*	1													
12. local market	0.07*	-0.05	0.06*	-0.06*	-0.03	0.07*	0.04	-0.06*	-0.12*	-0.05	-0.02	1												
13. Raw material	0.02	0.15*	0.08*	-0.00	0.01	0.05	0.04	0.04	0.03	-0.06	0.01	-0.29*	1											
14. V.Chain Efficiency	0.08*	-0.07*	-0.00	0.03	0.07*	0.06*	-0.00	-0.01	0.06*	0.09*	-0.00	-0.25*	-0.26*	1										
15. Corp. Social Resp.	0.053	-0.07*	-0.00	0.03	-0.01	0.05	-0.04	0.02	-0.02	0.02	0.02	-0.12*	-0.12*	-0.11*	1									
16. Other	-0.17*	0.01	-0.17*	0.01	-0.01	-0.21*	-0.05	0.00	0.04	0.06	-0.00	-0.28*	-0.29*	-0.25*	-0.12*	1								
17. Autonomy	0.10*	0.01	0.01	0.12*	0.00	0.06	0.03	-0.10*	0.16*	-0.12*	0.17*	-0.10*	0.02	0.09*	-0.00	0.00	1							
18. Autonomy supp sel	0.16*	0.04	0.08	0.12*	0.03	0.13*	0.04	-0.06	0.09*	-0.00	0.10*	-0.11*	0.02	0.15*	0.12*	-0.11*	0.74*	1						
19. Overall Gov.	0.07*	0.06*	0.10*	-0.13*	-0.13*	0.01	-0.09*	-0.00	-0.07*	-0.01	-0.00	0.14*	-0.03	-0.07*	-0.08*	0.03	-0.09*	-0.01	1					
20. IPR protection	0.02	0.12*	0.03*	0.10*	0.01	-0.04	0.04	-0.07*	0.10*	-0.09*	0.05	0.04	0.04	-0.09*	0.05	-0.02	-0.04	0.00	-0.07*	1				
21. Ethical bev	-0.05	0.08*	0.02	-0.03	0.00	-0.12*	-0.00	-0.05	0.05	0.03	0.04	-0.10*	0.00	0.00	-0.02	0.09*	0.07	0.06	0.09*	0.06*	1			
22. Contract Enfr	0.08*	-0.15*	-0.09*	-0.04	-0.20*	0.17*	0.03	-0.31*	-0.07*	-0.09*	-0.04	0.16*	0.01	0.06*	0.04	-0.20*	0.05	0.09	-0.21*	-0.03	0.11*	1		
23. ProdProc Sophis	-0.02	0.18*	0.13*	0.23*	0.20*	-0.11*	0.10*	0.04	-0.01	0.05	0.24*	0.00	-0.03	-0.04	0.00	0.07*	-0.01	-0.03	-0.10*	0.29*	0.09*	-0.33*	1	

**Table A4: Survey question on knowledge transfer (dependent variable)**

-Does this company interact with local suppliers/sub-contractors with the intention of helping them to improve their operations in any of the following ways?

<b>Types of assistance</b>	<b>YES (1)</b>	<b>NO (2)</b>
<b>26.1</b> Upgrade the efficiency of their production processes		
<b>26.2</b> Upgrade the quality of their products		
<b>26.3</b> Upgrade the quality of their workforce (provision of training)		
<b>26.4</b> Transfer of technology or know-how through designs or process know-how		
<b>26.5</b> Conduct joint product design / product development / specifications etc.		

**Table A5: Investor characteristics and transfer of knowledge. Logit estimation (average marginal effects).**

MODEL	(1)	(2)	(3)	(4)	(5)
<i>Type of Backward Linkage</i>					
Long Term Contract	0.105*** (0.0356)	0.104*** (0.0357)	0.0876** (0.0362)	0.141** (0.0590)	0.130** (0.0593)
Backlink1	0.00436** (0.00176)	0.00479*** (0.00175)	0.00492*** (0.00176)	0.00382 (0.00269)	0.00395 (0.00267)
Backlink2	-4.65e-05** (1.96e-05)	-5.03e-05*** (1.95e-05)	-4.96e-05** (1.96e-05)	-4.10e-05 (2.87e-05)	-4.29e-05 (2.85e-05)
<i>Type of Investment</i>					
<i>-Ownership Structure</i>					
Subsidiary		0.0814** (0.0375)	0.0901** (0.0379)	0.103* (0.0615)	0.106* (0.0622)
JV		0.0469 (0.0358)	0.0528 (0.0360)	0.0296 (0.0620)	0.0405 (0.0623)
<i>-Sourcing Strategy</i>					
Adapt local market			0.157*** (0.0582)	0.120 (0.101)	0.133 (0.0992)
Value Chain Efficiency			0.159*** (0.0584)	0.109 (0.0985)	0.0986 (0.0996)
Corp.Social Respons			0.176** (0.0709)	0.212** (0.107)	0.193* (0.114)
Raw Materials Access			0.0445 (0.0578)	0.0118 (0.0998)	0.0108 (0.0995)
Other			-0.0253 (0.0615)	-0.0407 (0.101)	-0.0315 (0.100)
<i>-Subsidiary Autonomy</i>					
Autonomy Index				0.0622** (0.0287)	
Autonomy Sel. Supplier					0.0566*** (0.0217)
<i>Other MNE characteristics</i>					
Experience	0.000966 (0.00115)	0.000918 (0.00116)	0.00111 (0.00117)	-0.000686 (0.00156)	-0.000651 (0.00155)
Size	0.0364** (0.0148)	0.0287* (0.0151)	0.0209 (0.0159)	0.0229 (0.0218)	0.0232 (0.0217)
Tech. gap	0.123*** (0.0321)	0.120*** (0.0321)	0.0939*** (0.0327)	0.0583 (0.0549)	0.0551 (0.0558)
R&D	0.0394 (0.0448)	0.0296 (0.0446)	0.0341 (0.0435)	0.0150 (0.0686)	0.00393 (0.0684)
Exports North	0.204*** (0.0492)	0.196*** (0.0502)	0.206*** (0.0484)	0.276*** (0.0633)	0.267*** (0.0647)
Exports South	0.00325 (0.0381)	-0.00320 (0.0381)	-0.000127 (0.0381)	0.0565 (0.0554)	0.0585 (0.0555)
Location supp	0.00176 (0.0345)	0.00398 (0.0347)	0.00125 (0.0348)	0.0252 (0.0588)	0.0111 (0.0594)
Observations	920	916	899	396	394
Pseudo R-squared	0.1149	0.1183	0.1384	0.1822	0.1871

Industry, Host and Origin Country dummies are included

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table A6: Host country factors and transfer of knowledge. Logit estimation**

MODEL	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Host Country Factors										
Governance	-0.0464 (0.0630)									
Worse Gov: Medium		-0.0935** (0.0466)								
Worse Gov: High		-0.0782 (0.0562)								
Contract enforcement			0.146*** (0.0495)							
Worse ConEnfor: Medium				-0.0868 (0.0645)						
Worse ConEnfor: High				-0.135** (0.0670)						
Firm Ethics					-0.0803 (0.0796)					
Worse Firm Ethics: Medium						0.0417 (0.0488)				
Worse Firm Ethics: High						-0.0253 (0.0603)				
IPR protection							-0.0392 (0.0450)			
Worse IPRprot: Medium								-0.0841 (0.0527)		
Worse IPRprot: High								-0.128** (0.0587)		
Technological readiness									-0.151*** (0.0484)	
Worse TechRead: Medium										0.000775 (0.0471)
Worse TechRead: High										-0.0120 (0.0561)
Controls										
Host country	No	No	No	No	No	No	No	No	No	No
Origin country	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Bilateral variables	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry 2-digit	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	873	899	873	814	873	814	863	772	873	814

Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table A7: Subsample of Subsidiaries and Joint Ventures. Investor characteristics and knowledge transfer. Probit estimation (average marginal effects).**

MODEL	(1)	(2)	(3)
Long Term Contract	0.168*** (0.0544)	0.165*** (0.0544)	0.127** (0.0564)
Backlink1	0.00259 (0.00266)	0.00315 (0.00264)	0.00399 (0.00263)
Backlink2	-3.45e-05 (2.88e-05)	-3.75e-05 (2.85e-05)	-4.29e-05 (2.82e-05)
<hr/>			
<i>-Ownership Structure</i>			
Subsidiary		0.0887 (0.0614)	0.0993* (0.0603)
JV		0.0362 (0.0591)	0.0323 (0.0593)
<i>-Sourcing Strategy</i>			
Adapt local market			0.124 (0.0985)
Raw Materials Access			0.0359 (0.0972)
Value Chain Efficiency			0.131 (0.0950)
Corp.Social Respons			0.247*** (0.0935)
Other			-0.0227 (0.0997)
<hr/>			
Other MNE characteristics			
Experience	-0.00105 (0.00154)	-0.00113 (0.00154)	-0.000818 (0.00154)
Size	0.0382* (0.0199)	0.0328 (0.0204)	0.0254 (0.0213)
Tech. gap	0.107** (0.0489)	0.104** (0.0493)	0.0704 (0.0513)
R&D	0.00709 (0.0626)	0.000756 (0.0635)	0.0158 (0.0647)
Exports North	0.271*** (0.0621)	0.263*** (0.0635)	0.275*** (0.0605)
Exports South	0.0564 (0.0527)	0.0568 (0.0528)	0.0628 (0.0536)
Location supp.	0.0299 (0.0541)	0.0306 (0.0545)	0.0239 (0.0553)
Observations	405	403	396

Industry, Host and Origin Country dummies are included

Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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## Chapter 3:

# Firm innovation and cooperation in the value chain: evidence from Uruguay

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### Abstract

This paper uses data from three waves of the Uruguayan Manufacturing Firm Innovation Survey and employs a *knowledge production function* (KPF) framework to explore firms' knowledge sourcing patterns. Specifically, we explore patterns of cooperation with trade partners -suppliers and buyers- and their implications for innovation outcomes. Further, we explore the implications of origin -domestic, regional, and international- of the trade cooperation partners. Our main findings show that first, the use of external knowledge sources, such as cooperation linkages, is strongly associated with innovation outcomes but it is complementary to the use of internal resources that also play a crucial role for innovation. Second, backward cooperation with suppliers is strongly related to enhanced process efficiency and larger shares of novel domestic sales, while forward cooperation with clients is related to product innovation and to larger shares of novel exports. Third, regarding the origin, cooperation with trade partners within the Latin American region shows the largest effects on innovation outcomes.

Keywords: innovation, knowledge transfer, value chains, linkages, Uruguay.

JEL classification: O54, O3, F14

### 1. Introduction

Knowledge creation and firm innovation are primary sources of economic growth and are key to achieve inclusive and sustainable development. In the current context of increasing international fragmentation of production, upgrading to capture value is essential to stay competitive and to benefit from global engagement. These issues are especially relevant for a small open economy like Uruguay, whose external sector plays a significant role as a source of economic and

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knowledge exchange. The country moved up to the high-income category in 2013 according to the World Bank country classification. Hence, innovating to increase the knowledge content of production and capturing more value becomes now crucial for Uruguay, to close the productivity gap and to build a resilient and diversified domestic sector that responds to new development challenges and demands from the raising middle class.

Innovation processes are increasingly complex and external knowledge sourcing has become a major trend in the global economy. As Cassiman and Veugelers (2002) point out, successful firm innovation depends not only on the knowledge generated internally but also on external knowledge flows. Innovative processes become then the result of interactions among several actors (De Faria et al, 2010). This trend towards cooperation in innovation represents particularly relevant opportunities for emerging economies where the major share of economic activity is carried out by small and medium enterprises (SMEs) that often suffer from severe resource constraints. Networks and exchange of information can facilitate access to complementary knowledge, skills and technology and allow for the necessary economies of scale (Zeng et al, 2010). In Uruguay SMEs represent 99% of the economy<sup>23</sup> and carried out 35% of the total investment in firm innovation activities in between 2010 and 2012 (ANII, 2013).

In this context, strong linkages between trade partners in the value chain can facilitate exchange of knowledge and foster mutual learning processes. As pointed out by Pietrobelli and Rabellotti (2011), interactions between national innovation systems<sup>24</sup> and global value chains (GVCs) present significant learning and innovation opportunities for developing countries via international information exchange and collaboration for the generation and diffusion of knowledge through inter-firm and intra-firm networks. Globally engaged firms have access to more intense knowledge flows because they are exposed to a larger number of information sources and potential cooperation partners.

A significant amount of research in the last decade has tried to understand the relationship between global engagement and firm performance. Generally, the empirical literature shows that globally engaged firms tend to show enhanced productivity or innovation outcomes<sup>25</sup>. The rationale behind is that firms that take a global approach can benefit not only from market diversification, lesser exposure to domestic market shocks and increased demand but also from exchange of information, learning opportunities and expanded business networks. However,

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<sup>23</sup> According to the definition from the Uruguay National Statistical Institute (INE) small enterprises are those with less than 20 employees, medium enterprises are those employing between 21-100 workers and large firms are classified as having more than 100 employees. As of 2014, from the total number of Uruguayan firms (161.257) 96% were small enterprises, 3% were medium-sized enterprises and only 0.5% were classified as large enterprises. (INE, 2014).

<sup>24</sup> Innovation systems refer to the set of agents (firms, research institutions, government, experts) that interact in the process of innovation and technology development.

<sup>25</sup> See De Loecker (2013); Criscuolo et al (2010); Görg and Greenaway (2004) or Havranek and Irsova (2011) for overviews of this literature branch.

although participating in the global economy presents opportunities for firms in less industrialized countries that derive from specialization gains and exposure to international advanced knowledge flows, these development effects are not automatic. A dynamic, innovative, and dense private sector is needed, as well as a proactive, inclusive and coordinated public policy mix that encourages linkages to maximize the scope for learning and upgrading.

In the global economy, it becomes therefore crucial to understand the value chain channels and mechanisms through which knowledge reaches the firm and how they impact innovation output. Whereas there is a significant amount of research focusing on cooperation within innovation systems, little is known about the international trade and cooperation for innovation nexus. This paper contributes to fill this gap and analyzes the relationship between innovation activities of Uruguayan manufacturing firms and their trade cooperation linkages of domestic, regional and international origin. We build on insights from the literature on cooperation for innovation activities and spillovers from global engagement and contribute to a better understanding of the underpinning mechanisms behind positive externalities.

We use data from three waves of the Uruguayan Manufacturing Firm Innovation Survey<sup>26</sup> (2001-03, 2004-06 and 2007-09) including 2503 observations from 1370 firms. We follow the approach by Criscuolo et al (2010) and Roper and Arvanitis (2012) and employ a *knowledge production function* (KPF). Our main findings suggest that first, the use of external knowledge sources, such as cooperation linkages, is strongly associated with innovation outcomes but it is complementary to the use of internal resources that also play a crucial role for innovation. Second, backward cooperation with suppliers is strongly related to enhanced process efficiency and larger shares of novel domestic sales; while forward cooperation with clients is related to product innovation and larger shares of novel exports. Third, regarding origin, cooperation with trade partners within the Latin American region shows the largest effects on innovation outcomes. Our results support findings by other authors on the existence of upgrading opportunities derived from value chain ties for Latin America at the regional level (e.g IADB, 2014). These results are also aligned with the arguments on South-South trade and FDI that root on enhanced absorptive capacity brought about by shorter technological distance and cultural proximity (e.g UNCTAD, 2006).

The contribution of the present paper is threefold. First, we add to the literature on cooperation and innovation by including the value chain perspective and by looking at the role played by the origin of domestic, regional, and international trade linkages. Second, we contribute to the

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<sup>26</sup> Although more recent survey waves are available at the date, due to a methodological change in the content of the questionnaire from survey year 2010-12 information on main cooperation agents and origin is only answered by innovative firms. To be consistent with the other three waves where all firms reported this information and avoid endogeneity issues we do not include observations from further survey waves.

studies on development effects of globalization by having a direct look at one specific channel through which productivity spillovers materialize, that is knowledge exchange linkages in trade relationships and derived enhanced domestic innovation. Finally, our focus in Uruguay provides substantial insights on the role of domestic and foreign external sources of knowledge for a growing small open economy currently facing the challenge of innovate to sustain competitiveness and capture more value.

The rest of paper is organized as follows. Section 2 provides a brief overview of the empirical literature. Section 3 provides background information about Uruguay and its policy framework for innovation. Section 4 presents the methodology. Section 5 describes the dataset and presents some descriptive statistics. Section 6 focuses on exploring complementarities between different sources of external knowledge. Our estimation strategy and regression results are reported in Section 7. Finally, section 8 concludes and points out some policy implications.

## **2. Literature review**

This section briefly reviews the two literature strands that the present paper brings together, that is, cooperation activities and innovation and knowledge spillovers of international trade.

### **2.1. External knowledge inputs and innovation. What do we know?**

The use of external sources of knowledge has increasing importance for firm innovation activities (Hagedoorn, 2002; Powel and Grodal, 2005). As production processes become more complex and competition from global markets intensifies, cooperation with other agents through networks in the innovation system becomes necessary to keep up the upgrading pace (Becker and Dietz, 2004; de Faria et al, 2010). Information sharing and network linkages with trade partners, competitors and other agents can facilitate access to complementary knowledge, skills and technology and help reaching the necessary economies of scale (Zeng et al, 2010). OECD (2010) points out that collaboration on innovation is indeed used to complement firm's competencies and internal sources of innovation and that cooperation with both foreign and domestic partners plays an important role in OECD economies.

The positive impact of the use of collaboration partners for innovation outcomes has been widely documented by the empirical literature<sup>27</sup>. In short, cooperative firms perform better in terms of productivity, R&D intensity and product or process innovation. Additionally, different collaboration agents have different impacts on the innovation outcome. Atallah (2002) explores from the theoretical point of view the role of vertical knowledge spillovers and cooperation for innovation. Its predictions are that vertical cooperation linkages with suppliers and buyers have a more prominent impact on firm performance than other cooperation forms with competitors or

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<sup>27</sup> See for example Becker and Dietz, 2004, de Faria et al 2010, Primi and Rovira (2011) or Arvanitis and Bolli (2013) for deeper reviews on the literature on innovation and cooperation.

research institutions. This pattern was empirically found by Jaklic et al. (2008) for the case of Slovenia and by Zeng et al (2010) for the case of Chinese SMEs. The study finds that vertical inter-firm linkages are the most significant form of cooperation relative to other collaboration types including research organizations or intermediary institutions.

Additionally, several examples in the literature have documented that specific forms of cooperation relate to specific types of innovation outcomes. In this way, linkages with customers tend to be more related to product innovation whereas linkages with suppliers have been found to be more related to process innovation. Freel and Harrison (2006) document, for the case of SMEs in Scotland and Northern England, positive associations between product innovation and cooperation with customers while success in process innovation is related to cooperation with suppliers and universities. Similarly, Joshi and Sharma (2004) found that knowledge about costumers' preferences triggers product innovation and Roper et al. (2008) point out a positive significant relationship between backward knowledge linkages with suppliers and process upgrading. Roper and Arvanitis (2012) find for the cases of Ireland and Switzerland that knowledge sourcing from costumers has positive impact in both product and process innovation, while backward and horizontal linkages are related to process innovation although they show a less significant association. Finally, Criscuolo et al (2010) found for the case of globally engaged British firms that information flows from customers and suppliers are related to both, process and product innovation, while information from universities is associated to patenting activities.

On the implications of origin of cooperation agents, evidence is still scarce and limited to OECD countries but some examples have documented a stronger effect of international cooperation linkages relative to domestic collaboration for innovation. Arvanitis and Bolli (2013) found evidence of positive effects of international cooperation on innovation performance in five European economies (Belgium, Germany, Norway, Portugal and Switzerland) while innovation outcomes were not affected by national cooperation. Jaklic et al (2008) found that cooperation with other European partners implied higher probability to innovate for Slovenian firms relative to domestic cooperation.

Regarding studies on cooperation for innovation in Latin America, evidence is rather scarce. Crespi and Zuniga (2012) study determinants of innovation activities in a cross-section of six Latin American countries<sup>28</sup>. Market information sources are found to be associated with larger investment in innovation but only for the case of Colombia. Other types of collaboration in the form of public information and scientific sources presented weak associations with innovation investment which is interpreted by the authors as evidence on weak linkages within Latin

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<sup>28</sup> The paper includes one wave of the Uruguay innovation survey (2004-06) that is however not fully exploited as information appears highly aggregated to allow for comparison with other country's surveys.

American innovation systems. A need to strengthen these linkages has been also identified by Cimoli, Primi and Rovira (2011) in a compendium of studies on innovation surveys in Latin America. The analysis of innovation activities and cooperation patterns in Argentina, Brazil, Chile, Mexico and Uruguay reveals that collaboration in innovation is still limited in the region. According to the study, absorptive capacity of firms is the key element to translate collaboration agreements into realized innovation meaning that a dense and capable domestic sector is a precondition to successful innovation. Similar results are found by Guiliani, Pietrobelli and Rabelloti (2005) that study linkages to GVCs within Latin American clusters. In the specific case of Uruguay, the study by Bianchi, Gras and Sutz (2011) find, for the innovation survey year of 2000-2003, that skilled workers are the main determinant of cooperation activities.

The topic of knowledge flows in Uruguay<sup>29</sup> has received further attention regarding the specific case of the software cluster in Montevideo. Kesidou and Romijn (2008) look at local knowledge sources within the cluster and find a positive effect on firm innovation performance that happens through labor mobility, company spin-offs, and informal inter-firm interactions. Further, in a complementary study, Kesidou and Snijders (2012) explore the role of non-local linkages and find that non-local knowledge networks are of crucial importance for the most innovative firms in the cluster. Although without making a distinction between vertical or horizontal inter-firm linkages, results from these studies point towards a complementary role of foreign and domestic agents as external knowledge sources.

In this paper, we build on the literature on cooperation in innovation activities reviewed above including the GVC perspective by looking at the foreign origin of vertical linkages. We therefore account for the exchange of knowledge as a learning channel potentially happening in international trade relationships and whose related literature we review in the next subsection.

## **2.2. Learning effects from global engagement of firms**

Literature on international trade and technology diffusion has identified different learning mechanisms that take place through GVC relationships. Firms can participate in GVCs by using imported intermediates/services or by exporting intermediates/services that are used in other countries' exports. Alternatively, domestic firms can establish linkages with multinational enterprises (MNEs) based in the country, either as suppliers of inputs/services for the MNEs or as customers purchasing foreign inputs/services produced by the MNEs. These diverse vertical linkages between domestic and foreign firms generate not only access to new markets but also important opportunities for knowledge exchange, learning and upgrading.

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<sup>29</sup> A recent study by Bianchi et al. (2015) looks at determinants of innovation activities by Uruguayan firms from a more general perspective. The study finds that international engagement (exporter status and foreign ownership) as well as firm size are the main determinants of firm innovation.

First, the connection between enhanced performance of firms and the *use of imported inputs* or services has been widely documented by the empirical literature. For example, a link between the use of imported inputs and enhanced firm productivity has been found by Kasahara and Rodrigue (2008) for Chile, Halpern, Koren and Szeidl (2010) for Hungary, Smeets and Warzynski (2010) for Denmark and Bas and Strauss-Kahn (2011) for France. Fritsch and Görg (2015) found a positive impact of use of imported intermediates on R&D expenditure in sixteen emerging economies. The learning and knowledge transfer mechanisms at work are the following: first, by integrating foreign inputs or services into their production processes, firms can produce at a higher quality and more efficiently if these inputs are more sophisticated or technologically advanced. Second, when a firm sources inputs from outside and takes advantage of other firms' core competencies and specialization, its own competitiveness raises as it is allocating resources in a better way. Finally, by taking a global sourcing approach, firms can potentially concentrate in what they do best and allocate limited resources in an optimal way.

Second, *learning effects of exporting* have also been largely explored by the literature on international trade. Although a consensus on this topic has not yet been reached, a number of studies on learning by exporting find a connection between improvements in firm performance and entry to export markets. See De Loecker (2013) for an overview of the literature and positive evidence for the case of Slovenia or Crespi et al. (2008) for positive evidence in the UK case. The learning mechanisms at play are twofold. On the one hand the increased exposure to foreign competition at the horizontal level forces firms to produce more efficiently and on the other hand, foreign buyers have incentives to provide assistance and transfer knowledge to their suppliers in order to have access to more efficient inputs.

Finally, the two internationalization types complement and enhance each other. The use of intermediate inputs and export entry and upgrading are closely related as found by several recent studies. For example Bas and Strauss-Kahn (2014) for the case of France, Feng and Swenson (2012) for China or Amighini and Sanfilippo (2014) for African economies. Here three mechanisms are at play. First, an indirect productivity channel, through which imported inputs that enhance productivity make it relatively easier to deal with export fixed costs; Second, a direct-cost channel through which the use of cheaper, more competitive imported inputs may increase the export profit margin; and third, an enhanced quality channel, as embedded technology or higher sophistication of imported inputs may enhance quality of exports and open opportunities in more demanding export markets or segments (Bas and Strauss-Kahn, 2014).

An alternative mode through which firms in developing countries participate in GVCs occurs through linkages with multinational enterprises (MNEs) based in the country. MNEs have access to more advanced technology and possess a knowledge-based advantage that can potentially contribute to economic growth and structural change in developing economies via

spillovers to the domestic economy. Three main mechanisms through which spillovers materialize have been identified by the literature (see Görg and Greenaway (2004) or Havranek and Irsova (2011) for comprehensive literature reviews on FDI spillovers). First, positive externalities to the local economy can take the form of horizontal spillovers if local firms in the same sector learn from more efficient technologies by competition or demonstration effects. Secondly, vertical spillovers can take place through value chain linkages with domestic suppliers and buyers. In this sense, foreign investors that source intermediates locally -backward linkages- have incentives to share know-how with their suppliers in order to help them meeting required quality levels or higher technical standards. Also, domestic firms that buy from MNEs -forward linkages- have access to more sophisticated inputs and can therefore learn new production techniques or enhance the quality of their final goods. Third, labor market interactions can also generate positive effects in form of wage spillovers (increased domestic wages being pushed by higher MNEs' wages) and through turnover of skilled workers. Among these various mechanisms, empirical literature has consistently found that the main channels through which positive externalities materialize are backward supply chain linkages with domestic suppliers (Javorcik, 2004 *inter alia*).

For the specific case of Uruguay, Peluffo (2011), Barboni et al (2012) and Peluffo and Zaclicever (2013) study respectively, productivity spillovers to Uruguayan firms derived from trade openness, learning by exporting effects and productivity effects of the use of imported intermediates. The first study analyzes productivity effects in Uruguayan firms derived from the three potential sources for positive externalities: imports of intermediate goods, learning by exporting and foreign direct investment. The author finds positive evidence of spillovers from learning by exporting and imports of intermediate goods while FDI is found to have a “crowding out effect” to local firms. This effect is however diminished once absorptive capacity is taken into account. Barboni et al (2012) looks more specifically at productivity spillovers on Uruguayan firms derived from exporting. They find evidence of self-selection of more productive firms into exporting to industrialized countries while learning by exporting effects are found in firms that export to less developed countries. Finally, Peluffo and Zaclicever (2013) focus on the use of imported intermediates and performance of Uruguayan firms and find a positive productivity spillover effect that is enhanced by the absorptive capacity of firms, measured as the share of skilled labor.

In brief, evidence of positive externalities of global engagement has been found by a range of countries and for the specific case of Uruguay. We add to the above reviewed literature on development effects of globalization by having a direct look at a specific channel through which productivity spillovers can materialize, that is through knowledge intensive linkages in trade relationships and derived enhanced domestic innovation.

### **3. Uruguay: country context**

Uruguay is a small open economy with a population of 3,4 million. In terms of per capita income the country ranks third in South America after Chile and Argentina with a GDP per capita of 13,580 US \$ according to World Bank data. As of 2013 Uruguay was upgraded to the high-income category by the World Bank country classification. Following a quick recovery after the 2002 crisis and in a framework of stable macroeconomic policies, good institutions and increasing in labor productivity Uruguay's GDP has been growing at a steady path of 5.1% (OECD, 2014). The unemployment rate reached an historical minimum of 6% in 2014. On its production structure, Uruguay is a service oriented economy, with tourism and retail representing 14% and transportation and distribution account for 16% of GDP in 2013. Manufacturing represents 12,35% of the economy and the primary sector accounts for 7,6% (construction and other activities account respectively for 5% and 30% of GDP). As of 2013, from the total number of Uruguayan firms (161.257) 96% were small enterprises, 3% were medium-sized enterprises and only 0.5% were classified as large enterprises (INE, 2014).

Regarding Uruguay's external sector, total imports of goods and services account for 27% of Uruguay's GDP and imports of intermediates in 2013 represented 59% of Uruguay total imports. China, Brazil and Argentina are the main source countries. Industrial supplies and transport and machinery parts accounted for 38% and fuels represented 17% of total intermediate imports. Exports represent 20% of Uruguayan GDP and China, Brazil and Argentina are the main destination countries (INE, 2014). On export composition, traditional (meat, cellulose and soja) and non-traditional (auto parts, wood products, plastics, and pharmaceuticals) exports accounted respectively for 43% and 13% of Uruguay total exports in 2013. Primary and resource-based exports accounted for 75% of total exports in the period 2009-11. Hence and as pointed out by OECD (2014), the degree of sophistication and diversification of exports are issues that need to be considered at this stage to avoid the country's specialization in low-value adding exports. The production transformation and openness strategy of Uruguay has been partly driven by the Free Trade Zones (FTZs) regime. According to Vaillant and Lalanne (2014), the 12 FTZs generated 1,7% value added to GDP in 2010 and have contributed to diversifying Uruguay's exports (OECD, 2014).

On what concerns to innovation policies<sup>30</sup>, Uruguay has placed substantial efforts in reforming and strengthening the institutional framework for innovation. Reforms started in 2005 and ended in 2010 with the approval of the National Strategic Plan for Science, Technology and Innovation (PENCTI) which designs the science, technology and innovation policy of the country. In this process, two institutions were created in 2006 to ensure coordinated and

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<sup>30</sup> For a detailed description of Uruguay's institutional framework for innovation and policies see Aboal et al. (2011) or OECD (2015).

functional policies. First, the National Council for Innovation, Science and Technology (CONICYT) which is responsible for coordination and articulation of government policies. Second, the National Agency for Research and Innovation (ANII) was also created in 2006 as the implementation agency of the PENCTI. The ANII provides funds and tools for innovation and facilitates coordination among the agents of the innovation system. Uruguay is therefore, with these reforms, responding to the increasing needs of coordination between public policies that arise in the growth and upgrading path.

Since the reforms started in 2005, Uruguay has made significant progress in terms of firm innovation. In the last decade, R&D to GDP ratio has doubled to reach the level of 0.5%. However, figures are still far from innovation efforts made by OECD economies whose median is 2,4% (OECD, ECLAC, 2014). According to ANII (2014) 26% of Uruguayan manufacturing firms engaged in at least one type of innovation activity in the period 2010-2012 and innovation-intensive sectors have increased their share from around 19% of GDP in 1997-99 to 25% in the period 2009-11 at constant prices (OECD, ECLAC, 2014).

Despite the substantial efforts and significant progress made in terms of innovation in Uruguay, challenges remain to strengthen the linkages between agents in the innovation system and to make the most of the learning opportunities of global engagement. Our analysis aims to shed some light on this issue by looking at the role of linkages and interaction with external agents for innovation activities of Uruguayan manufacturing firms.

#### 4. Methodology

Following other studies in the literature (Criscuolo et al, 2010; Roper and Arvanitis, 2012), we carry out our analysis employing the knowledge production function (KPF) framework as introduced by Griliches (1979). The KPF considers the output of new knowledge to be dependent on a set of knowledge inputs. First, investment for discovering new knowledge (commonly measured as intramural R&D); second, sources of already available knowledge that are internal to the firm (experts, parent company ...) and third, external sources of knowledge (trade partners, universities, public sector, etc.). The KPF can be written as:

$$(1) K_i = f(INV_i, K_{i\_int}, K_{i\_ext})$$

Where  $K_i$  represents the knowledge output of firm  $i$ ,  $INV_i$  refers to firm  $i$ 's investment in the generation of new knowledge and  $K_{i\_int}$  and  $K_{i\_ext}$  are respectively internal and external sources of knowledge employed by firm  $i$  in the generation of new knowledge.

Our estimation equation looks as follows:

$$(2) INNO_i = \beta_1 INV_i + \beta_2 K_{i\_int} + \beta_3 K_{i\_ext} + \beta_4 X_i + e_i$$

Where the *dependent variable*  $INNO_i$  represents the innovation output of the firm that we measure by two alternative variables: first we use the variable  $Innovate_i$  that we construct as a dummy variable that takes the value one if the firm reported to have performed alternatively, product or process innovation, and zero otherwise. Second, we use as knowledge output measure the variable  $Novel Sales_i$ , which captures the percent of sales that can be attributed to innovation activities carried out by the firm  $i$ . We build two separate indicators for the percentage of novel domestic sales and novel exports.

Our *explanatory variables* are defined as follows:

- **Investment** in the generation of new knowledge ( $INV_i$ ) is captured by R&D expenditures over total employees.
- As **internal knowledge sources** ( $Ki\_int$ ) we include the use of internal information and information from the parent firm (if the firm is a multinational). These variables rank the importance for the firm of the use of these two information sources for innovation purposes and range between the values one (irrelevant) and four (high importance).
- The variables on **external knowledge sources** are the main focus of this paper and they refer to the cooperation linkages that the firm establishes with different agents in the innovation system. We follow a number of examples in the literature, Belderbos et al. (2004), Roper and Arvanitis (2012) or Meriküll et al. (2012) among others, that have used cooperation linkages as the measure of external knowledge inputs. We define variables for the existence of cooperation partners for innovation in the value chain with suppliers (backward linkages) and customers (forward linkages). Additionally we include other cooperation with competitors (horizontal linkage), consultants and experts, with university and scientific institutions and with government agencies (public linkage). Importantly, at this stage, we account for the foreign and domestic origin of the agents.

Besides cooperation linkages, innovation surveys often collect data about the use of informal information sources for knowledge sourcing activities. These variables usually indicate whether the company uses information from customers, suppliers, competitors or public and private institutions for innovation purposes. Other studies (eg. Criscuolo et al., 2010; Crespi and Zuniga, 2013) have used these information sources as measures of external knowledge inputs. This paper focuses on cooperation linkages for innovation which are a more explicit and intense form of external knowledge sourcing. However, it seems reasonable that different knowledge sources would play a complementary role on the firm innovation activities. To address this issue, we explore the relationship between information sources in section 6 and perform

robustness checks including information sources both as controls and as main dependent variables (appendix table A6).

- Finally,  $X_i$  is a vector of controls including other variables that are likely to affect innovation output of firms other than the specified above. Here we include the size of the firm, measured as the log of total employees, vintage of the firm (log of number of years since the start of business), a dummy variable controlling for financial constraints and exporter and foreign ownership (foreign capital larger than 10%) dummies.

Detail on the survey questions used to generate these variables is included in the Appendix in Table A2.

## 5. Data

Our analysis employs an unbalanced panel data set built on three waves of the Uruguay Manufacturing Innovation Survey (2001-03, 2004-06 and 2007-09) including 2503 observations from 1370 firms from which 367 firms are present in the three waves. The survey is conducted jointly by the National Innovation Agency (ANII) and the National Statistical Institute (INE) on a triennial basis and it covers firm innovation activities carried out over the last three years. The survey contains a wide range of aspects including innovation outcomes, impact of innovation activities and resources invested in innovation as well as a set of indicators on firm characteristics and performance. The sample includes formal firms with at least five employees and is selected by stratified random sampling, firms in the stratum with more than 50 workers are included in the sample with probability one. The sampling is conducting assuring sector representativeness at the 2-digit industry level of the ISIC classification<sup>31</sup>. The response rate is around 90%.

Table 1 shows the number of observations included in the sample by industry (ISIC Rev. 3), industry technology intensity (OECD classification) and survey year. The number of observations by sector distributes homogeneously across survey years. Food processing and beverages is the largest subsector and accounts for one third of the sample. The second largest sector is chemical products, representing around 11% of the firms each year. Textiles, publishing and rubber and plastics are the third present sectors in order of importance accounting for about 5 to 6% of the surveyed firms. Regarding technology intensity, more than half (61%) of the firms fall into low technology intensity sectors. High and medium-high technology sectors account together for around 22% of the surveyed firms.

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<sup>31</sup> In 2008 the INE changed the industry classification from ISIC Rev 3 to the Rev 4. We reclassify all survey years to the ISIC Rev 3 classification.

**Table 1: Number of observations by manufacturing sector, technology content and survey wave.**

<b>Manufacturing Sector (ISIC Rev.3)</b>	2000-2003		2004-2006		2007-2009		Total	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%
Food and beverages	269	33.05	267	31.86	271	31.84	807	32.24
Tobacco products	4	0.49	2	0.24	2	0.24	8	0.32
Textiles	62	7.62	61	7.28	46	5.41	169	6.75
Wearing apparel, Garments	43	5.28	45	5.37	13	1.53	101	4.04
Leather and footwear	29	3.56	30	3.58	35	4.11	94	3.76
Wood products and furniture	26	3.19	30	3.58	33	3.88	89	3.56
Paper and paper products	14	1.72	13	1.55	22	2.59	49	1.96
Publishing	46	5.65	46	5.49	64	7.52	156	6.23
Coke, petroleum products, nuclear fuel	1	0.12	1	0.12	1	0.12	3	0.12
Chemical products	92	11.30	102	12.17	83	9.75	277	11.07
Rubber and plastics	36	4.42	41	4.89	44	5.17	121	4.83
Other non-metallic mineral products	33	4.05	31	3.70	36	4.23	100	4.00
Basic metals	6	0.74	9	1.07	10	1.18	25	1.00
Fabricated metal products	42	5.16	42	5.01	54	6.35	138	5.51
Machinery and equipment	20	2.46	22	2.63	42	4.94	84	3.36
Office, accounting and computing mach.	0	0.00	6	0.72	3	0.35	9	0.36
Electrical mach. and apparatus	18	2.21	18	2.15	20	2.35	56	2.24
Radio, TV and comm. equip. and appar.	11	1.35	3	0.36	1	0.12	15	0.60
Medical, precision and optical inst., watche	11	1.35	18	2.15	7	0.82	36	1.44
Motor vehicles, trailers and semi-trailers	19	2.33	18	2.15	22	2.59	59	2.36
Other transport equipment	10	1.23	9	1.07	13	1.53	32	1.28
Furniture; manufacturing n.e.c.	22	2.70	24	2.86	28	3.29	74	2.96
Recycling	0	0.00	0	0.00	1	0.12	1	0.04
<b>Technology Intensity Manufacturing Sector (OECD class.)</b>								
High	22	2.70	31	3.70	28	3.29	81	3.24
Medium- high	159	19.53	160	19.09	162	19.04	481	19.22
Medium- low	118	14.50	129	15.39	146	17.16	393	15.70
Low	511	62.78	518	61.81	515	60.52	1544	61.69
<b>TOTAL</b>	<b>814</b>	<b>100</b>	<b>838</b>	<b>100</b>	<b>851</b>	<b>100</b>	<b>2503</b>	<b>100</b>

Table 2 shows some descriptive patterns regarding innovation outcomes. Specifically, the table reports the percent of observations by each of our four alternative dependent variables on innovation outcome and by size (large firm is defined as having more than 20 employees) and ownership (foreign firm is defined as having 10% or more of foreign capital). Process innovation appears to be the most frequent outcome with 35% of the firms reporting having performed this type of innovation.

Overall, a significantly larger share of large firms relative to small firms reported innovation outcomes. The share of larger firms that performed product and process innovation is nearly triple the share of small firms with this innovation outcome. Shares of novel sales and exports are also significantly larger for firms with more than 20 employees. Shares of foreign firms and domestic firms are reported in the last two columns of Table 2. Generally, a larger share of foreign owned firms reported innovation activities relative to domestic ones. Among foreign

firms, shares of innovative firms are significantly above average. Product and process innovations frequency and the share of novel exports are larger for foreign firms.

**Table 2: Percent of firms by innovation output, size, and foreign ownership.**

	All obs.	Size		Ownership	
		Small	>20	Domestic	Foreign
<i>Total</i>	100	29.84	70.16	87.25	12.75
<b>Knowledge Ouput</b>					
<i>Innovation (dummies 0-1)</i>					
Product Innovation	26.04	12.8	31.6	24.66	35.8
Process Innovation	35.47	17.4	43.1	32.74	54.83
<i>Novel Sales (%)</i>					
Novel Domestic Sales	9.98	6.28	11.56	9.62	12.55
Novel Export Sales	6.06	1.91	7.83	4.83	14.74

Note: All values in the table are percentages of firm of a given type that reports innovation outcome over the total firms of that type. See table A1 in the Appendix for a detailed variable description

Turning to the external knowledge inputs, linkages with the innovation system, 57% of the firms reported to have a main cooperation partner for innovation. Nearly all (93%) innovative firms (product and process innovation) had a cooperation partner in the innovation system while only 44% of non-innovators reported a linkage. Among innovative firms, most frequent cooperation partners are suppliers (59%) followed by research institutions and consultants (57%). The least frequent linkage among innovators is with public institutions (23%). Regarding cooperation with trade partners, 61% of the firms that cooperated either with suppliers or clients reported an innovation.

Summary statistics from our main explanatory variables, namely external knowledge inputs from trade partners, are shown in table 3. We report means and standard deviations (in parenthesis) of the trade linkages variables for innovative firms by our four innovation measures: product and process innovation (dummy variables taking values 0 and 1) and percentage of novel domestic sales and exports (taking values between 0-100). First, we look at the first linkage variables in our analysis "suppliers" and "customers" that indicate if the firm established a cooperation link with the agents. Second, we look at the variables referring to the primary cooperation agents of the firm ("Main link"). A firm can report cooperation linkages with several agents but only one primary cooperation agent. Information on origin is available only for the primary cooperation agents and for two survey waves (04-06 and 07-09). Tables A1 and A2 in the Appendix include a full description of the variables and survey questions. On average, approximately half of the firms that cooperate with trade partners (around 40-50%) report product and process innovation. At the descriptive average level, product and process innovation do not appear to follow a different pattern for backward or forward cooperation in

the value chain. Regarding the percent of novel sales due to innovation, firms that cooperate with clients show on average larger percent of novel exports relative to those that cooperate with suppliers. Turning to the origin of the agents, firms that report primary linkages with foreign partners either regional or international appear more innovative with a larger share of these firms reporting product innovation and larger novel domestic sales and export percentages.

**Table 3: Summary statistics on knowledge inputs (obs. number, mean and std. deviation)**

	Product inn. (dummy)	Process inn. (dummy)	Novel dom. sales (percent)	Novel exports (percent)
<i>All observations</i> (N= 2503 )	0.26 (0.439)	0.354 (0.478)	9.989 (24.58)	6.064 (21.27)
<i>Coop. linkages with trade partners</i>				
Suppliers (backward) (N=973)	0.427 (0.494)	0.549 (0.497)	15.65 (28.46)	9.809 (25.96)
Customers (forward) (N=699)	0.453 (0.498)	0.506 (0.5)	16.26 (28.51)	12 (28.30)
Main link suppliers (backward) (N=244)	0.344 (0.476)	0.532 (0.499)	15.81 (30.17)	5.17 (18.9)
Domestic (N=133)	0.24 (0.429)	0.413 (0.494)	10.9 (26.19)	1.65 (10.31)
Latin American (N=40)	0.425 (0.5)	0.7 (0.464)	17.62 (31.07)	6.62 (22.57)
RoW (N=72)	0.486 (0.503)	0.652 (0.479)	23.65 (34.7)	10.80 (26.26)
Main link clients (forward) (N=131)	0.442 (0.498)	0.412 (0.494)	14.8 (0.275)	14.26 (0.316)
Domestic (N=77)	0.389 (0.49)	0.376 (0.437)	13.49 (26.35)	4.67 (20.16)
Latin American (N=21)	0.476 (0.511)	0.476 (0.511)	22.76 (36.66)	30.57 (42.67)
RoW (N=33)	0.545 (0.505)	0.454 (0.505)	12.78 (23.26)	26.27 (37.68)

*Notes:* for each cell, indicated summary statistics are means (and standard deviations in parenthesis). The variables "suppliers" and "customers" indicate if the firm established a cooperation link with the agents. The variables "Main link" indicate that the firm has a trade partner as the primary cooperation agent. A firm can report cooperation linkages with several agents but only one primary cooperation agent. Information on origin is available only for the primary cooperation agents and for two survey waves (04-06 and 07-09). N indicates the number of observations that reported each type of cooperation. See tables A1 and A2 in the Appendix for a full description of the variables and survey questions.

Regarding the relationship between information sources and linkages, relatively low correlations show that that the use of a specific source of information does not imply deeper collaboration in the form of cooperation linkages. Significant correlations are found between the use of information and linkages with universities (19%), private consultants (17%) and customers (15%) and suppliers (14%). Correlation matrixes, a detailed description of all

variables included in the analysis as well as summary statistics are included in the Appendix in tables A1-A4.

## **6. Complementarity between knowledge inputs**

Innovation activities of firms are the product of a combination of different knowledge sources, therefore, seems reasonable to expect that internal and external knowledge sources are used in a complementary (or substitute) way. In this section, we aim at exploring those complementarities to understand, for example, how does internal R&D or the use of information from universities relate to the existence of cooperation linkages with suppliers, or if the use of informal information sources from customers relate to more formal cooperation linkages with customers. We first look at pairwise correlations between information and cooperation sources and second, following the approach by Roper and Arvanitits (2012) and Cassiman and Veugelers (2006) we estimate a multivariate probit model for the main knowledge sourcing variables. We then consider positive error correlations from these regressions as indicators of complementarities. By adopting this approach we acknowledge complementary relationships between the different sources of knowledge but focus our analysis in the most formal mode of knowledge sourcing which is the cooperation linkages (vis a vis information sources).

Table 4 shows pairwise correlations between having established a cooperation linkage with an agent and rating that same agent as an important or highly important source of information. As expected, correlations show a positive and significant relationship between information sourcing and formal cooperation with the agent. Correlation coefficients range from 10 to 34% suggesting that although closely related, these variables capture different dimensions of the knowledge sourcing patterns of the firms. A look at the number of firms that use each type of knowledge sourcing reveals that the use of cooperation linkages is less frequent than the use of information sources. For example, 63% of the firms report clients as an important or highly important information source for innovation activities while 29% report cooperation linkages with clients. From those firms reporting information from clients as important or highly important only 40% report cooperation linkages; 24% of the firms in the sample report both knowledge sourcing activities. The variables regarding relationships with suppliers and other agents follow a similar pattern, showing that cooperation linkages are likely to indicate a stronger or more formal external knowledge sourcing activity relative to the use of information. We therefore chose to focus the main analysis on the cooperation linkages.

**Table 4. Correlation matrix for external knowledge inputs: information sources and cooperation linkages**

	Link-supp.	Link-clients	Link-public	Link-scienc.	Link-comp.	Link-consul	Info-supp.	Info-clients	Info-public	Info-scienc.	Info-comp.	Info-consu
Link-suppliers	1											
Link-clients	0.4918*	1										
Link-public	0.1443*	0.1430*	1									
Link-science	0.2778*	0.2432*	0.2679*	1								
Link-competitors	0.2813*	0.3115*	0.0485*	0.1764*	1							
Link-consultants	0.3644*	0.2993*	0.2267*	0.3643*	0.2391*	1						
Info-suppliers	<b>0.2660*</b>	0.1144*	0.0665*	0.0512*	0.0308	0.0792*	1					
Info-clients	0.1029*	<b>0.2745*</b>	0.0349	0.0738*	0.0768*	0.0462*	0.3161*	1				
Info-public	0.1287*	0.0886*	<b>0.1055*</b>	0.1483*	0.0374	0.1337*	0.1897*	0.1618*	1			
Info-science	0.0145	0.0203	0.1571*	<b>0.2191*</b>	0.0123	0.1041*	0.1323*	0.1323*	0.3042*	1		
Info-comp.	0.0676*	0.0990*	0.0168	0.0676*	<b>0.1580*</b>	0.0754*	0.2290*	0.3481*	0.1472*	0.1529*	1	
Info-consult.	0.1094*	0.0765*	0.1634*	0.1962*	0.0438*	<b>0.3140*</b>	0.1787*	0.1515*	0.2890*	0.3974*	0.1542*	1

Note: \* refers to significance at the 5% level. link- variables are dummies taking the value 1 if the firm reported a linkage with the cooperation agent and zero otherwise. info- variables are dummies taking the value 1 if the firm reported an agent as important or highly important information source and zero otherwise.

To further explore complementarities, we adopt the approach by Cassiman and Veugelers (2006) and Roper and Arvanitis (2012) and estimate a multivariate probit model for each knowledge sourcing variable. The dependent variables are alternatively the following indicators of knowledge sources: a variable indicating if the firm performs internal R&D (1), variables regarding the use of different information sources: internal (2), clients (3), suppliers (4) and scientific institutions (5) and cooperation linkages variables with: clients (6), suppliers (7), scientific institutions (8) and consultants (9). As explanatory variables we include our set of controls for firm characteristics that are likely to affect innovation behavior of firms: the size of the firm, age of the firm, a dummy variable controlling for financial constraints and exporter and foreign ownership dummies.

The specification for the multivariate probit model is as follows:

$$(3) K_{i\_source} = \beta_1 X_i + e_i$$

Where  $K_{i\_source}$  represents alternatively the nine knowledge sources and  $X_i$  is the vector including the set of firm characteristics as indicated above.

Table 5 reports error correlations from the multivariate probit. The full estimated model is included in table A4 in the Appendix. Statistically significant error correlations between two knowledge inputs indicate that they are used complementarily. Consistent with Roper and Arvanitis (2012) the error correlations reveal statistically and economically significant complementarities among the knowledge inputs for both investment in innovation (intramural R&D) and external knowledge sourcing inputs, i.e the use of one input triggers the use of other inputs for innovation. According to the literature the most likely mechanisms at play behind these complementarities are, first an absorptive capacity effect (Cassiman and Veugelers, 2002)

for which firms that are able to develop R&D internal capacities, might also have an increased ability to recognize the value of new information and assimilate it. The second mechanism behind deals with the scope in the management of external relationships (Roper and Arvanitis, 2012) for which a firm networking capacities and ability to maintain trust relationships increase as it deals with different agents. In our model, the only non-complementary relationship appears between sourcing knowledge from universities and research institutes and value chain cooperation linkages with suppliers and customers.

**Table 5: Complementarities between knowledge sources reflected in error correlations**

	Internal R&D	Info-science	Info-suppliers	Info-clients	Info-internal	Link-suppliers	Link-clients	Link-science
Info-science	0.0925*** (0.0351)							
Info-suppliers	0.0651* (0.0334)	0.156*** (0.0313)						
Info-clients	0.0801** (0.0339)	0.189*** (0.0322)	0.467*** (0.0326)					
Info-internal	0.286*** (0.0382)	0.209*** (0.0342)	0.399*** (0.0338)	0.429*** (0.0341)				
Link-suppliers	0.308*** (0.0348)	-0.0115 (0.0317)	0.383*** (0.0322)	0.189*** (0.0315)	0.232*** (0.0323)			
Link-clients	0.358*** (0.0356)	0.0380 (0.0326)	0.213*** (0.0325)	0.452*** (0.0345)	0.273*** (0.0342)	0.790*** (0.0371)		
Link-science	0.473*** (0.0366)	0.309*** (0.0339)	0.106*** (0.0324)	0.134*** (0.0323)	0.229*** (0.0341)	0.376*** (0.0336)	0.406*** (0.0337)	
Link-private	0.313*** (0.0350)	0.123*** (0.0325)	0.107*** (0.0317)	0.0939*** (0.0320)	0.188*** (0.0334)	0.489*** (0.0339)	0.486*** (0.0339)	0.477*** (0.0337)

Note: Error correlations are derived from probit model in shown in table A4 in the Appendix. \* refers to significance at the 5% level. link- variables are dummies taking the value 1 if the firm reported a linkage with the cooperation agent and zero otherwise. info- variables are dummies taking the value 1 if the firm reported an agent as important or highly important information source and zero otherwise.

## 7. Empirical strategy and results

We conduct the empirical analysis in two steps. First, by means of the KPF, we look at the impact on firm innovation outcomes of firm **cooperation linkages** with agents in the innovation system. We conduct this first step on the three- year panel build on three waves of the innovation survey (2001-03, 2004-06 and 2007-09) that includes 2503 observations on 1370 different firms. In this unbalanced panel 367 firms are included in the three years, 399 are reported in two survey years and 604 firms correspond to single year appearances. Second, we explore the impact of the **origin** of the main agents for cooperation on firm's innovation outcome. Information on the origin is only available for the last two waves of the survey and therefore this part of the analysis is performed on the pooled sample for the two years. This second part includes 1688 observations on 556 different firms.

Our *dependent variables* measuring innovation outcomes are alternatively product innovation, process innovation, the percentage of novel domestic sales and novel exports that are due to innovation. The first two variables are binary and take the value one if the firm reported any product or process innovation and zero otherwise. We estimate a *probit* model to look at the probability that the firm reports product or process innovation. The last two variables refer to the percent of novel sales, domestic and exports, that are attributable to innovations introduced by the firm. As the dependent variable in this case is a percentage share taking the values between 0 and 100, we perform *tobit* analysis to look at the impact of cooperation for innovation on the percentage of novel sales and exports and on the probability to show novel sales. The share of novel exports, is a distinctive feature included in the Uruguay Innovation survey and has not been included as an innovation outcome in other innovation studies. The use of this variable adds value to our analysis as it allows us to explore implications of trade linkages for the generations of new exports.

Regarding our explanatory variables, we have explored complementarities between different knowledge inputs in section 6. As explained above, our main analysis focuses on cooperation linkages for innovation as external knowledge sources. The analysis is however robust to alternative specifications that include information sources for innovation as controls (see table A6 in Appendix).

We are aware of possible endogenous relationships involved in our set up model. For example, reverse causality arises if the degree of external cooperation is determined as a function of a priori planned innovation activities. We employ four different measures innovation outcomes which allows for some robustness as not all innovation measures will be as sensitive to the reverse causality issue. However, our analysis aims at identifying knowledge sourcing patterns in the value chain of Uruguayan firms and their relationship with innovation outcomes, and one should be aware that causal relationships are not to be derived from our study. Proper instruments, such as lagged variables over a larger time span would be needed to draw conclusions on causality.

Random effect (RE) estimation allows us to account for individual heterogeneity by capturing unobserved firm characteristics that are likely to affect innovation outcomes (e.g different business practices or management skills). We prefer RE over fixed effects (FE) for two main reasons: first, an identification issue, our independent variable on focus, namely external knowledge sourcing, is unlikely to vary over our sample period. Indeed, a firm is likely to use the same set information sources over time, as collaboration with partners is likely to trigger trust relationships that remain over longer periods of time. In our data, 87% and 71% of the firms that collaborate with, respectively, suppliers and clients, show repeated collaboration in

more than one period. By estimating FE, time invariant information sources would be not considered in the analysis. Second, on a practical note, most of our dependent variables are binary and therefore most of our specifications regard probit models whose estimation does not allow for the inclusion of FE.

As part of our analysis (not reported in the main text but available under request), we repeated the analysis by constraining the sample to firms that switch innovation status over the years<sup>32</sup>. Most coefficients turn insignificant in this specification type. Criscuolo et al. (2010) found the same pattern in their analysis and attributed it to serial correlation between innovation outcomes and its knowledge inputs and the scarce number of observations to detect significant results. In our sample, only 133 and 172 firms switched status regarding, respectively product and process innovation.

### 7.1. Cooperation linkages and firm innovation

The first part of our analysis looks at the relationship between the establishment of cooperation linkages with different agents in the innovation system and innovation outcomes of the firm. The linkages are measured as dummy variables that take the value 1 if the firm reported to have established a cooperation linkage for innovation with an agent and zero otherwise<sup>33</sup>. See tables A1 and A3 in the Appendix for a detailed description of the variables and the survey questions used.

Table 6 shows results (marginal effects) from the random effects (RE) panel probit for product and process innovation (columns 1 and 2) and the RE panel tobit for novel domestic sales and exports (columns 3 to 6). Results show that overall, cooperation linkages have a significant positive effect on the innovation outcome of the firm. Cooperation linkages with suppliers and clients are shown in the first two rows. Cooperation with suppliers shows the largest effect among all linkages, increasing the probability to undertake process innovation by nearly 60 %. Cooperation with suppliers is also related to product innovation and increases this probability by 46%. Cooperation with clients has an impact on product innovation increasing the probability by 40% but doesn't impact the probability to conduct process innovation. These results are in line with the literature that has generally found that forward cooperation with clients tends to be related to product improvements that most probably target to better match customer

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<sup>32</sup> This was done by defining the dependent variable as taking the value one if the innovation status changed in one period relative to the previous one. That is, alternatively for all innovation output measures, if product/process innovation status switched from "no" to "yes" and if the novel domestic sales/ exports went from zero to non-zero. The switcher dependent variable takes then the value zero if the innovation status did not improve along the four time periods: novel sales remained constant or the firm never performed product/process innovation. Finally, observations from single appearances, firms that always innovate and firms are dropped.

<sup>33</sup> All surveyed firms answered this question regardless of their innovation status.

specifications, while backward cooperation with input suppliers is likely to be related to an optimized use of intermediates hence playing a role for production process efficiency (Joshi and Sharma, 2004; Freel and Harrison, 2006; Roper et al, 2008). The size of the effects is in line with the literature. For example, Roper and Arvanitis (2012) found effects of around 45- 50% for linkages with suppliers and clients in Ireland and of around 20% for the Swiss case. This study deals with endogeneity by applying an instrumental variables (IV) approach based on lagged variables of the knowledge sourcing variables. Coefficient sizes tend either to turn insignificant or increase in the IV specifications. Criscuolo et al. (2010) found effects of around 30- 40% for the use of vertical information sources in UK.

Columns 3 and 4 report marginal effects of a unit change in the knowledge inputs on the percentage of novel sales given that novel sales are different from zero (intensive margin); columns 5 and 6 report the impact of the explanatory variables on the probability of reporting novel sales (extensive margin). Regression results show that cooperation linkages have positive effects on the generation of novel sales derived from innovation activities. Linkages with suppliers increase the percent of novel domestic sales and exports by around 23- 25% (columns 3 and 4) and increase the probability of generating novel exports by 1.6%. Cooperation with clients has a larger effect on the percentage of novel exports that increases by 40% while the probability of showing novel exports raises by 2.5%

Regarding other cooperation agents, linkages with research institutions also have large significant effects and increase the probability of product and process innovation by 53 and 47% respectively. Similarly, cooperation with research institutions increases the probability of generating novel exports by 3.5%. Linkages with public institutions have slightly lower but similar effects on both product and process innovation but no impact on novel sales. Linkages with consultants, impact positively product and process innovation and on the percentage of novel sales. Horizontal cooperation with competitors doesn't have any significant impact on innovation outcomes. Internal knowledge inputs, including R&D expenditures, internal information sources and information from the parent firm for multinationals are also relevant for innovation and present significant positive effects. The coefficients for R&D expenditures appear significant but surprisingly low, which might be due to the complementary use of internal R&D capacities with external knowledge sources. As for our control variables, larger firms and exporters are more likely to conduct product and process innovation. Foreign ownership shows a negative relationship with the innovation outcome. This could be caused by correlations between the control variables (see table A.4 in Appendix). An alternative interpretation of this result is that multinational companies are carrying out innovation activities at the headquarters or other locations different from their subsidiaries in Uruguay.

**Table 6: Linkages with the innovation system and innovation outcome.**

**Knowledge production function. Probit RE and Tobit estimation. Marginal effects.**

	Probit RE		Tobit RE		Tobit RE Prob ( 0 < sales < 100)	
	(1)	(2)	(3)	(4)	(5)	(6)
	Product inn.	Process inn.	Novel domestic sales	Novel exports	Novel domestic sales	Novel exports
<i>Knowledge Inputs</i>						
<i>External Cooperation Linkages</i>						
Suppliers	0.458*** (0.0845)	0.581*** (0.0835)	23.29*** (5.078)	25.09** (11.06)	2.567 (41.05)	1.638** (0.796)
Clients	0.387*** (0.0889)	-0.105 (0.0911)	15.15*** (5.212)	39.61*** (11.06)	1.671 (5.021)	2.586*** (0.906)
Public Institutions	0.267** (0.115)	0.461*** (0.117)	10.45 (6.805)	16.34 (13.10)	1.153 (25.68)	1.066 (0.883)
Research Institutions	0.532*** (0.0829)	0.469*** (0.0766)	27.27*** (5.070)	54.97*** (11.56)	3.019 (216.4)	3.589*** (1.064)
Competitors	0.0154 (0.100)	0.0747 (0.0954)	4.764 (5.552)	-0.601 (11.70)	0.522 (24.61)	-0.0392 (0.764)
Private (Consultants)	0.356*** (0.0872)	0.536*** (0.0787)	22.91*** (4.927)	15.50 (10.79)	2.530 (21.24)	1.012 (0.734)
<i>Internal Info Sources</i>	0.182*** (0.0368)	0.160*** (0.0317)	10.18*** (2.273)	17.35*** (5.453)	1.111 (145.9)	1.133*** (0.428)
<i>Investment in Innov. (R&amp;D Exp.</i>	8.69e-05 (6.22e-05)	0.000137** (5.95e-05)	0.00115 (0.00110)	0.00438*** (0.00168)	0.000126 (0.0165)	0.000286** (0.000126)
<i>Controls</i>						
Size (log employment)	0.193*** (0.0426)	0.246*** (0.0379)	9.529*** (2.567)	5.742 (4.810)	1.040 (136.6)	0.375 (0.323)
Financial Constraints	-0.0890 (0.0728)	-0.0928 (0.0681)	-1.907 (4.545)	-24.77** (10.17)	-0.208 (35.43)	-1.617** (0.745)
Exporter	0.297*** (0.0889)	0.209*** (0.0796)	3.575 (5.429)		0.391 (19.63)	
Foreign Ownership	-0.263** (0.121)	0.0453 (0.107)	-12.52* (7.395)	1.097 (11.68)	-1.350 (64.77)	0.0716 (0.763)
Firm Age (log)	0.0450 (0.0453)	0.0610 (0.0407)	2.950 (2.892)	-3.258 (6.090)	0.322 (42.31)	-0.213 (0.400)
Observations	2,482	2,479	2,482	972	2,483	975
Observed probability	0.259	0.352	0.195	0.186	-	-
Predicted prob. (at x-bar)	0.202	0.319	-	-	-	-

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Note: year and industry dummies are included. Regressions in columns (4) and (6) are run over the subsample of exporter firms

## 7.2. Origin of primary cooperation linkages and firm innovation

In this subsection, we focus on the impact of the origin of the cooperation agents in the value chain. At this stage, we face some data limitations, as information about origin is available only for two waves of the survey. Hence, analysis in this section is conducted on the *pooled sample* of the two waves for which the information is available (2004-06 and 2007-09). Despite this data limitation, information on the main cooperation agents, when available, is extremely detailed and includes information on foreign origin of linkage partners. This unique piece of information allows us to explore implications of cooperation for innovation in the GVC and complement the analysis on cooperation linkages and account for potential innovation spillovers of international trade.

This part of the analysis aims at understanding if innovation outcomes vary with the domestic, regional, and international origin of cooperative suppliers and buyers. The survey does not include information about the origin of every cooperation agent for innovation but only about the *main cooperation agent*. Therefore, the construction of the linkage variables with suppliers and buyers differs from the previous subsection. We define the variable *Main link suppliers/ Main link clients* as a binary variable that takes the value one if the suppliers/ buyers are the main cooperation agents for the firm and zero otherwise. In a further step, we breakdown this variable by origin to construct categorical variables that take the value 1 if the cooperative supplier/ buyer is domestic; 2 if the cooperative supplier/ buyer is foreign from the Latin American region; 3 if the cooperative supplier/ buyer is foreign from other than Latin America; and zero if the agent is not the main cooperation partner of the firm. The variables on linkages with the other agents are built as in the previous subsection (they take the value 1 the firm reported cooperation with the agent and zero otherwise) and are included for control purposes in this subsection as we want to focus on value chain cooperation.

Table 7 shows marginal effects from the probit estimation on product (columns 1 and 2) and process (columns 3 and 4) innovation. We first estimate the KPF including the *Main link* variables and second, we break them down by origin. Having suppliers and buyers as main cooperation partners is positively related with both types of innovation but the effect differs by agent and type of innovation. On the one hand the effect of cooperation with suppliers is larger and more significant on process innovation. Firms that have suppliers as main cooperation partners are 9% more likely to conduct process innovation. On the other hand, having clients as main cooperation linkages present a positive relationship only on product innovation whose probability increases by 13%. As in the previous subsection, results are in line with the literature that relates cooperation with suppliers to improved process efficiency likely striving from the use of better inputs and cooperation with clients turning into improved or new products (Joshi and Sharma, 2004; Freel and Harrison, 2006; Roper et al, 2008).

Turning to the breakdown by origin, cooperation with suppliers within the Latin American region shows the largest and most significant effect increasing the probability of process innovation by 36%. This effect is 23% and 16% for cooperation with respectively other foreign and domestic suppliers. Although one should be cautious interpreting these results due to the data constraints explained above, the larger innovation effects of cooperation with regional trade partners supports the evidence on positive externalities of South-South trade and FDI that root on shorter technological distance and cultural proximity<sup>34</sup>. For the case of forward linkages, cooperation with domestic and Latin American clients shows the largest and more significant effect increasing the probability of product innovation by 20% and 18% respectively. The rest of the variables in the analysis show similar results as in the previous regression in Table 7.

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<sup>34</sup> For an overview on South- South FDI particularities see for example UNCTAD (2006), Gammeltoft et al. (2010) or Takii (2011).

**Table 7: Origin of main cooperation in the value chain and innovation outcome: product and process innovation.** Knowledge production function. Probit estimation. Marginal effects.

	Product inn. (1)	Product inn. (2)	Process inn. (3)	Process inn. (4)
<b>Knowledge Inputs</b>				
<i>External Cooperation Linkages</i>				
<i>Main link suppliers</i>	0.0674* (0.0386)		0.0887** (0.0374)	
<i>Main link suppliers origin</i>				
Domestic		0.0894** (0.0376)		0.157*** (0.0396)
Latin American		0.175** (0.0778)		0.363*** (0.0751)
Rest of the world		0.203*** (0.0519)		0.235*** (0.0550)
<i>Main link clients</i>	0.133*** (0.0456)		-0.0622 (0.0473)	
<i>Main link clients: origin</i>				
Domestic		0.199*** (0.0505)		0.0958* (0.0502)
Latin American		0.176** (0.0890)		0.117 (0.0863)
Rest of the world		0.123* (0.0642)		-0.0712 (0.0648)
Public Institutions	0.0979** (0.0386)	0.0924*** (0.0305)	0.0990** (0.0401)	0.130*** (0.0365)
Research Institutions	0.131*** (0.0315)	0.167*** (0.0246)	0.0653** (0.0324)	0.150*** (0.0267)
Competitors	0.0318 (0.0324)	0.0515** (0.0252)	0.0135 (0.0328)	0.0605** (0.0283)
Private (Consultants)	0.0711** (0.0299)	0.122*** (0.0222)	0.0865*** (0.0317)	0.187*** (0.0252)
<i>Internal Info Sources</i>	0.0629*** (0.0152)	0.0436*** (0.00916)	0.0390*** (0.0150)	0.0382*** (0.00920)
<i>Investment in Innov. (R&amp;D Exp.)</i>	2.58e-05 (1.64e-05)	1.68e-05 (1.11e-05)	3.60e-05** (1.64e-05)	3.30e-05** (1.30e-05)
<i>Controls</i>				
Size (log employment)	0.0270* (0.0142)	0.0170* (0.00880)	0.0748*** (0.0147)	0.0518*** (0.00930)
Financial Constraints	-0.0355 (0.0287)	-0.0179 (0.0176)	-0.0383 (0.0298)	-0.0156 (0.0191)
Exporter	0.0950*** (0.0337)	0.0578*** (0.0219)	0.0690** (0.0346)	0.0393* (0.0232)
Foreign Ownership	-0.0710* (0.0383)	-0.0232 (0.0251)	-0.000833 (0.0437)	0.0322 (0.0304)
Firm Age (log)	0.0195 (0.0168)	0.0117 (0.0102)	0.0106 (0.0177)	0.0103 (0.0112)
Observed probability	0.375	0.232	0.552	0.331
Predicted prob. (at x-bar)	0.362	0.169	0.532	0.288
Observations	1,028	1,676	1,022	1,670

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 Standard errors in parentheses  
Note: year and industry dummies are included

Table 8 shows Tobit estimates on the impact of a unit change in the cooperation variables in on the percent of novel domestic sales (columns 1 and 2) and novel exports (columns 3 and 4) i.e the intensive margin. For space saving reasons, we only report in table 8 regression results for the focus variables external knowledge inputs, although all variables in the KPF from the

previous analysis have been included in the estimations. These show similar results as above, with firm size and internal information sources playing a positive significant role for the innovation outcome across most specifications. As in our previous regression we first estimate the KPF including the *Main link* variables and second, we break them down by origin. For novel sales, significant effects of having trade partners as main cooperation agents arise mostly in the origin breakdown. Main cooperation linkages with suppliers show a significant impact the percent of novel domestic sales but not the percent of novel exports. Among suppliers, the effect of cooperation with foreign suppliers is larger than for domestic ones increasing the percent of novel sales by over 50%. Turning to forward cooperation with clients, only cooperation with Latin American agents shows an impact for both novel domestic and exports. The latter shows the largest effect cooperation with clients within the Latin American region increases the percent of novel exports by 73%. As above, this results point as regional trade cooperation ties as a potential trigger of firm innovation for Uruguayan firms.

**Table 8: Origin of main cooperation in the value chain and innovation outcome: percent of novel sales.** Knowledge production function. Tobit estimation. Marginal effects.

	Novel Dom. Sales		Novel Exports	
	(1)	(2)	(3)	(4)
<b>External Cooperation Linkages</b>				
<i>Main link suppliers</i>	14.58*		-19.49	
	(8.110)		(18.60)	
<i>Main link suppliers origin</i>				
Domestic		33.61***		-24.63
		(11.34)		(39.39)
Latin American		50.21***		27.80
		(18.80)		(46.28)
Rest of the world		57.54***		22.41
		(12.53)		(24.39)
<i>Main link clients</i>	11.45		15.76	
	(8.476)		(18.66)	
<i>Main link clients: origin</i>				
Domestic		45.01***		20.38
		(11.88)		(43.37)
Latin American		49.18**		73.33**
		(20.68)		(35.65)
Rest of the world		6.291		33.99
		(15.99)		(25.44)
Observed probability	0.285	0.171	0.246	0.174
Observations	1,030	1,677	469	650

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 Standard errors in parentheses

Note: year and industry dummies are included. Regressions in columns 3 and 4 are run over the subsample of exporting firms. All variables specified in table 7 are included in this regression but not reported for space saving reasons.

To complement the analysis above, we also estimate marginal effects for the impact of the explanatory variables on the probability of reporting novel sales (extensive margin). Regression results are reported in table 9 and show a similar pattern as for the intensive margin. Primary cooperation with foreign suppliers raises de probability of showing novel domestic sales by 5-6% whereas does not appear to be related with the probability of novel exports. Regarding primary cooperation with clients, both Latin American and domestic cooperation rise the probability of showing novel sales by around 5%. For the probability of reporting novel exports, regression results turn insignificant. Taking this together with results in table 8, primary cooperation with customers in the Latin American region appears to be associated with larger volumes of novel exports given that the firm generated novel exports but not on the probability of starting to report novel exports.

**Table 9: Origin of main cooperation in the value chain and innovation outcome: probability of novel sales.**

Knowledge production function. Marginal effects. Tobit estimation Prob ( 0 < sales < 100)

	Novel Dom. Sales		Novel Exports	
	(1)	(2)	(3)	(4)
<b>External Cooperation Linkages</b>				
<i>Main link suppliers</i>	1.758*		-1.291	
	(0.986)		(1.246)	
<i>Main link suppliers origin</i>				
Domestic		3.377***		-1.395
		(1.162)		(38.89)
Latin American		5.127***		1.575
		(1.983)		(43.98)
Rest of the world		5.916***		1.270
		(1.363)		(35.54)
<i>Main link clients</i>	1.382		1.044	
	(1.044)		(1.236)	
<i>Main link clients: origin</i>				
Domestic		4.600***		1.155
		(1.279)		(32.41)
Latin American		5.045**		4.155
		(2.226)		(116.3)
Rest of the world		0.618		1.926
		(1.580)		(54.02)
Observed probability	0.285	0.171	0.174	
Observations	1,030	1,677	469	650

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1 Standard errors in parentheses

Note: year and industry dummies are included. Regressions in columns 3 and 4 are run over the subsample of exporting firms. All variables specified in table 7 are included in this regression but not reported for space saving reasons.

## **8. Conclusions and preliminary policy implications**

Aiming at a better understanding of the trade channels through which external knowledge reaches the firm and how it relates to innovation outputs, this paper estimates the KPF for Uruguay using firm level data from three waves of the innovation survey covering the period 2001-2009. As production processes fragment and value chains become global, some experts point out that opportunities exist for emerging countries to benefit from international knowledge flows. In this context, innovating and upgrading to stay competitive in the global economy becomes crucial. At the same time, innovation processes are becoming increasingly complex and firms increasingly rely on external sources of knowledge and cooperation activities to complement their innovation capacities.

The present study analyzes the relationship between firm innovation outcomes and external knowledge inputs in the form of cooperation with trade partners in the value chain. In a second stage, we explore the role of the foreign origin of cooperation agents. The analysis provides a better understanding of how Uruguayan firms make use of linkages in the value chain and its relationship with innovation outcomes. We exploit the richness of the Uruguayan innovation survey by looking at a range of variables including two unique features: the share of novel exports due to innovation activities and the breakdown of trade cooperation linkages by origin.

Our main findings suggest that cooperation linkages with clients show a positive relationship with product innovation and for novel exports whereas cooperation with suppliers is related with process innovation and larger shares of novel domestic sales. These results are aligned with the empirical literature. The mechanisms at work relate forward cooperation with clients to product improvements that most probably target to better match customer specifications, while backward exchange of information with input suppliers is likely be related to an optimized use of intermediates, or better production technologies hence playing a role for production process efficiency (Joshi and Sharma, 2004; Freel and Harrison, 2006; Roper et al, 2008). Regarding origin, cooperation with trade partners within the Latin American region shows the largest effects on innovation outcomes. Our results support findings by other authors on the existence of upgrading opportunities derived from value chain ties for Latin America at the regional level (e.g IADB, 2014). These results are also aligned with the arguments on South-South trade and FDI that root on enhanced absorptive capacity brought about by shorter technological distance and cultural proximity (e.g UNCTAD, 2006).

Finally, and consistent with other studies in the literature (e.g. Criscuolo et al 2010), we find that internal knowledge sources, R&D expenditures as well as firm size are significant

innovation inputs across most specifications. This suggests that although external knowledge flows play key role, they do so in a complementary fashion with internal resources of the firm as determinants of innovation activities. As firm size and internal resources matter for innovation, policies facilitating integration into the innovation system and GVCs of resource constrained firms and SMEs could play a role encouraging firm innovation.

On a different note, our results on *horizontal cooperation linkages* are consistently insignificant throughout all specifications. This suggests that Uruguayan firms might not be getting the most of cooperation for innovation with similar firms at the horizontal level. However, as found by several studies, horizontal linkages could be relevant sources of external knowledge, especially for SMEs. Horizontal sharing of information about technology, management and markets can enhance firm productivity and their collective performance (Lazzarini, Chaddad and Cook, 2000; Mesquita and Lazzarini, 2010). Appropriate policies would go in line with promotion of networks and exchange of information within clusters facilitating access to both, domestic and local knowledge flows.

Taken together, our results point out the relevance of knowledge exchange in the value chain and the importance of regional and international networks for firm innovation. Further research to improve this analysis could for example include larger time series to overcome endogeneity caveats and infer stronger causality relationships or more in depth analysis on the trade partners characteristics. For example, including information about long vs. short term contracts, or distinction by trade partners that are MNEs could shed light on the type of trade linkages that maximize positive spillovers.

Beneficial effects of trade relationships do not materialize automatically and depend on several factors such as a dense network that facilitates cooperation and knowledge exchange and the availability of internal resources. These results support public policies that promote an absorptive domestic private sector and a connected innovation system internally and internationally.

## Appendix

Table A1 : Variable Description.

Variable	Variable Name	Description
<b>Dependent Variable: INNO<sub>i</sub></b>		
<i>Novel Sales<sub>i</sub></i>	Share of novel sales	
	Share of novel domestic sales (%)	Percent of sales in the domestic market attributed to new or significantly improved products
	Share of novel exports (%)	Percent of sales in the export market attributed to new or significantly improved products
<i>Innovate<sub>i</sub></i>	Firm Innovation (0/1)	1 if the firm performed innovation regarding:
	Product innovation	Product new to the market or the firm
	Process Innovation	Process new to the market or the firm
<b>Explanatory Variables</b>		
<i>External Knowledge Inputs (Ki_int)</i>		
Linkages with innovation system (0/1)		
Customers (forward)		1 if the firm reported cooperation with:
Suppliers (backward)		Customers
Competitors (horizontal)		Suppliers
Private (consultants)		Other firms
Research institutions		Consultants, experts or financial institutions
Public institutions		Universities, laboratories or research institutions
		Government institutions for STI promotion
Main linkages with innovation system (0/1)		
Customers (forward)		1 if the firm reported as primary cooperation agent:
Suppliers (backward)		Customers
		Suppliers
Main linkages with innovation system_Origin (0/1/2/3)		
0 if the firm did not reported it as primary cooperation agent, and otherwise:		
Customers (forward)		
Domestic		1 if domestic customers are the main cooperation agent
Latin America		2 if Latin American customers are the main cooperation agent
Rest of the World		3 if foreign customers from RoW are the main cooperation agent
Suppliers (backward)		
Domestic		1 if domestic suppliers are the main cooperation agent
Latin America		2 if Latin American suppliers are the main cooperation agent
Rest of the World		3 if foreign suppliers from RoW are the main cooperation agent
<i>Investment in Innovation (INVi)</i>		
R&D expenditures		Share of R&D expenditures over sales (%)
Innovation personnel		Share of employees related to innovation activities over total employees (%)
<i>Internal Knowledge Inputs (Ki_int)</i>		
Internal Info	Degree of importance of internal information sources for innovation activities	Low (=1) to high (4=) importance of internal information sources for innovation activities.
Parent Info	Degree of importance of parent firm information for innovation activities	Low (=1) to high (4=) importance of parent firm information for innovation activities (If MNE)
<i>Controls (X<sub>i</sub>)</i>		
Size	Size of the firm (log)	Log total number of employees
Age	Age of the firm	Log number of years since start of operations
Exporter	Exporter dummy (0/1)	1 if firm is an exporter
Foreign Ownership	Foreign Ownership dummy (0/1)	1 if foreign capital is larger than 10%
Financial constraints	Financial constraints dummy (0/1)	1 if firm reported financial constraints
Industry	Industry dummies	1- 23 according to the 2-digit ISIC level , Rev.3 of the manufacturing sector (category D, codes 15 to 37) <sup>1</sup>
Tech	Industry dummies	1 (low) to 4 (high) OECD Technology Intensity classification of manufacturing sector <sup>2</sup>
Year	Year dummies	1-3 according to survey year

<sup>1</sup> International Standard Industrial Classification of All Economic Activities, Rev.3. United Nations Statistics Division<sup>2</sup> Classification of manufacturing industries into categories based on R&D intensities for ISIC Rev. 3 OECD Directorate for Science, Technology and

**Table A2: Survey questions on main variables used in the analysis**

***Innovate***

**Q: Indicate if you performed innovation activities in t-t+2 by type innovation (Yes/No)**

**Type of innovation**

**1) Product Innovation** refers to introduction to the market of a technologically new product (whose technological characteristics or purposes differ significantly to those of the existing products of the company) or significantly improved product (existing product whose performance has been significantly improved).

**2) Process Innovation** refers to adoption of new production methods or significantly improved. It can refer to production or delivery of new or improved products that can not be produced or delivered using conventional production methods, or

***Novel Sales***

**Q: Indicate the percent value of domestic sales and exports in t+2 by innovation degree of the product.**

	Domestic Sales	Exports
1 Technologically new or significantly improved products for both the firm and the market (local and/or international)		
2 Technologically new or significantly improved products for the firm but already existing in the market		
3 Not significantly modified products		
TOTAL	100 %	100 %

***Linkages with innovation system***

**Q: Indicate if in the context of innovation activities performed in t-t+2 the firm had linkages with the following agents (Yes/No)**

- 1 Universities
- 2 Technological Centers
- 3 Technical Training Institutions
- 4 Laboratories
- 5 Units of Technology support
- 6 Financial Intermediation Entities
- 7 Suppliers
- 8 Customers
- 9 Other firms
- 10 Consultants and Experts
- 11 Government Agencies for technology promotion
- 12 Parent Company (if the firm is MNE)

***Main linkages with innovation system***

**Q: From the above agents that the firm linked with in t-t+2, indicate the three main ones and the origin of the agent**

**Agent:**

**Country of origin of the agent:**

- Uruguay
- Rest of Mercosur
- Rest of LatAm
- Rest of the world

**Table A3. Variable summary statistics**

Variable	Obs	Mean	Std.Dev.	Min	Max
Product inn.	2503	0.260	0.439	0	1
Process inn.	2503	0.355	0.479	0	1
Novel dom. Sales	2503	9.990	24.58	0	100
Novel exports	2503	6.065	21.27	0	100
Link suppliers	2502	0.389	0.488	0	1
Link clients	2502	0.279	0.449	0	1
Link public instit.	2503	0.0999	0.300	0	1
Link research inst.	2503	0.349	0.477	0	1
Link competitors	2503	0.166	0.372	0	1
Link consultants	2503	0.351	0.477	0	1
Main link suppliers*	1033	0.236	0.425	0	1
Main link clients*	1033	0.127	0.333	0	1
Main link suppliers origin*	1688	0.254	0.702	0	3
Main link clients origin*	1688	0.129	0.505	0	3
R&D exp	2503	273.9	1639	0	42000
Internal Info	2502	2.978	1.103	1	4
Size (log empl)	2503	3.641	1.185	0	7.711
Fin. Constraints	2503	0.465	0.499	0	1
Exporter	2503	0.394	0.489	0	1
Foreign ownership	2503	0.124	0.329	0	1
Age	2484	3.079	0.855	0	5.394

Note: \* Variables are available for only 2 of the 3 survey waves included.

**Table A4. Variable Correlation Matrix**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	
(1) Product inn.	1																			
(2) Process inn.	0.5531*	1																		
(3) Novel dom. Sales	0.6552*	0.3752*	1																	
(4) Novel exports	0.4693*	0.3088*	0.4021*	1																
(5) Link suppliers	0.3034*	0.3250*	0.1837*	0.1403*	1															
(6) Link clients	0.2736*	0.1972*	0.1587*	0.1738*	0.4918*	1														
(7) Link public instit.	0.2000*	0.2348*	0.1029*	0.1354*	0.1443*	0.1430*	1													
(8) Link research inst.	0.3583*	0.3632*	0.1972*	0.2252*	0.2778*	0.2432*	0.2679*	1												
(9) Link competitors	0.1344*	0.1477*	0.0761*	0.0645*	0.2813*	0.3115*	0.0485*	0.1764*	1											
(10) Link consultants	0.2956*	0.3606*	0.1897*	0.1482*	0.3644*	0.2993*	0.2267*	0.3643*	0.2391*	1										
(11) Main link suppliers	-0.0371	0.009	0.0119	-0.0938*	0.4222*	0.0003	-0.1348*	-0.2516*	-0.0184	-0.2285*	1									
(12) Main link Clients	0.052	-0.0858*	-0.005	0.0666*	0.0335	0.4424*	-0.0415	-0.0827*	0.0059	-0.0736*	-0.2119*	1								
(13) R&D exp	0.2197*	0.1815*	0.1126*	0.2271*	0.1095*	0.1137*	0.1399*	0.1708*	0.0542*	0.1220*	-0.0193	0.0274	1							
(14) Internal Info	0.2106*	0.2205*	0.1361*	0.1335*	0.1710*	0.1616*	0.0947*	0.1991*	0.1140*	0.1564*	-0.0161	-0.0453	0.0936*	1						
(15) Size (log empl)	0.2433*	0.3227*	0.1142*	0.2125*	0.1715*	0.0739*	0.1270*	0.2733*	0.0581*	0.2595*	-0.0651*	-0.0494	0.1925*	0.1528*	1					
(16) Fin. Constraints	-0.0515*	-0.0585*	-0.0107	-0.0626*	0.0236	0.0086	-0.0114	-0.0033	-0.0129	0.0306	-0.0003	0.0004	-0.0442*	-0.0173	0.1104*	1				
(17) Exporter	0.2076*	0.2351*	0.0757*	0.3431*	0.0855*	0.0963*	0.1381*	0.2359*	0.0521*	0.1595*	-0.1522*	0.0425	0.1414*	0.1137*	0.4600*	-0.0772*	1			
(18) Foreign ownership	0.0836*	0.1521*	0.0393*	0.1535*	0.0509*	0.0146	0.0325	0.1397*	0.0868*	0.0893*	-0.1423*	-0.0671*	0.0792*	0.1581*	0.2717*	-0.1390*	0.3004*	1		
(19) Age	0.1091*	0.1159*	0.0589*	0.0602*	0.0492*	0.032	0.0489*	0.1108*	0.0316	0.0518*	-0.0069	-0.0132	0.0784*	0.028	0.2381*	-0.0333	0.1048*	0.0232	1	

\* p> 0.05

**Table A5: Multivariate probit model**

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	R&D exp	info research	info suppliers	info clients	info internal	link suppliers	link clients	link research	linkprivate
Size (log employment)	0.256*** (0.0314)	0.0718*** (0.0274)	0.0612** (0.0257)	0.0184 (0.0259)	0.136*** (0.0275)	0.183*** (0.0263)	0.0532** (0.0264)	0.230*** (0.0269)	0.284*** (0.0271)
Financial Constraints	-0.0518 (0.0628)	0.166*** (0.0555)	0.207*** (0.0517)	0.126** (0.0522)	0.0643 (0.0541)	0.127** (0.0523)	0.0701 (0.0530)	0.106** (0.0538)	0.189*** (0.0534)
Exporter	0.333*** (0.0691)	0.180*** (0.0631)	-0.0291 (0.0598)	0.120** (0.0605)	0.0667 (0.0633)	0.0223 (0.0601)	0.194*** (0.0607)	0.327*** (0.0602)	0.119** (0.0602)
Foreign Ownership	0.00163 (0.0906)	-0.0430 (0.0871)	-0.159* (0.0824)	-0.210** (0.0825)	0.432*** (0.0981)	0.0199 (0.0828)	-0.0410 (0.0833)	0.187** (0.0826)	0.0570 (0.0827)
Firm Age (log)	0.115*** (0.0385)	0.0478 (0.0333)	0.0444 (0.0308)	-0.0401 (0.0311)	0.00654 (0.0325)	0.0172 (0.0311)	0.0219 (0.0322)	0.0753** (0.0320)	-0.0153 (0.0317)
Observations	2,483	2,483	2,483	2,483	2,483	2,483	2,483	2,483	2,483

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Note: year and industry dummies are included

**Table A6: Information sources as controls. Robustness check**

VARIABLES	Probit RE		Tobit RE	
	(1) Product inn.	(2) Process inn.	(3) Novel domestic sales	(4) Novel exports
<i>Knowledge Inputs</i>				
<i>External Cooperation Linkages</i>				
Suppliers	0.433*** (0.0860)	0.556*** (0.0851)	21.46*** (5.117)	22.81** (11.27)
Clients	0.394*** (0.0908)	-0.104 (0.0932)	15.07*** (5.235)	41.48*** (11.11)
Public Institutions	0.281** (0.117)	0.522*** (0.123)	10.30 (6.825)	14.18 (13.17)
Research Institutions	0.577*** (0.0832)	0.536*** (0.0783)	29.83*** (5.161)	58.19*** (11.75)
Competitors	0.0236 (0.102)	0.114 (0.0971)	4.828 (5.613)	2.562 (11.86)
Private (Consultants)	0.345*** (0.0885)	0.542*** (0.0804)	21.64*** (4.941)	14.97 (11.10)
<i>External Information Sources</i>				
Info competitors (horizontal)	-0.0358 (0.0365)	-0.0957*** (0.0351)	-1.111 (2.176)	-8.682* (4.791)
Info other sources	-0.206 (0.187)	-0.124 (0.162)	-4.133 (11.59)	0.624 (28.21)
Info Vertical (suppliers & clients)	0.0367 (0.0990)	0.0240 (0.0931)	2.454 (6.055)	3.298 (14.13)
Info Research	-0.304*** (0.0846)	-0.433*** (0.0822)	-17.85*** (5.267)	-12.21 (10.89)
<i>Investment in Innov. (R&amp;D Exp.)</i>	8.50e-05 (6.12e-05)	0.000136** (5.87e-05)	0.00110 (0.00110)	0.00411** (0.00169)
<i>Internal Info Sources</i>	0.191*** (0.0385)	0.184*** (0.0341)	10.21*** (2.310)	17.68*** (5.597)
<i>Controls</i>				
Size (log employment)	0.188*** (0.0431)	0.247*** (0.0389)	9.182*** (2.568)	5.223 (4.851)
Financial Constraints	-0.0882 (0.0739)	-0.0830 (0.0697)	-1.887 (4.561)	-23.33** (10.29)
Exporter	0.297*** (0.0886)	0.206** (0.0805)	3.259 (5.431)	
Foreign Ownership	-0.243** (0.123)	0.0676 (0.110)	-11.47 (7.427)	3.682 (11.95)
Firm Age (log)	0.0523 (0.0458)	0.0672 (0.0418)	3.283 (2.892)	-3.014 (6.175)
Observations	2,483	2,483	2,483	975

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Note: year and industry dummies are included. Regression in columns (4) is run over the subsample of exporter firms

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## **Eidesstattliche Erklärung**

Ich erkläre hiermit, dass ich meine Doktorarbeit “Foreign Direct Investment, Trade and Development: Firm Linkages and Knowledge Transfer“ selbstständig und ohne fremde Hilfe angefertigt habe und dass ich als Koautor maßgeblich zu den weiteren Fachartikeln beigetragen habe. Alle von anderen Autoren wörtlich übernommenen Stellen, wie auch die sich an die Gedanken anderer Autoren eng anlehenden Ausführungen der aufgeführten Beiträge wurden besonders gekennzeichnet und die Quellen nach den mir angegebenen Richtlinien zitiert.

Paris, Januar, 2017

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Lucía Pérez- Villar

