Policy Research Working Paper 9645

Understanding FDI Spillovers in the Presence of GVCs

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WORLD BANK GROUP
South Asia Region
Office of the Chief Economist
April 2021

Policy Research Working Paper 9645

Abstract

Does a global value chain framework provide additional insights into the question of whether foreign direct investment is beneficial to host countries? The literature has found mixed results on whether foreign direct investment provides positive spillovers over and above mere financing. But the studies have focused on one country, or studies with an international focus tend to abstract from intersectoral linkages. By examining this question in the context of global value chains, this paper provides a much better understanding of the association as well as general validity. It harmonizes three major panel data sets: 1) the Multi-Regional Input-Output table for international input-output linkages, 2) the FDI Markets reports for greenfield foreign direct investment, and 3) the World Bank Enterprise Surveys for firm performance measures. The paper produces a rich panel data set from 2011 to 2017. The findings show that foreign direct investment has a positive effect on labor productivity in sectors and firms within those sectors. Moreover, global value chain participation plays a key role in shaping the foreign direct investment effects. Sectors with lower global value chain participation benefit more from foreign direct investment: doubling the foreign direct investment in those sectors results in an 8 percent productivity gain. The positive effect seems to be due to the increased competition created by foreign direct investment. Foreign direct investment spillovers also take place through domestic and foreign backward linkages, which means that foreign direct investment also has positive inter-sector and cross-border spillovers.

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Understanding FDI Spillovers in the presence of GVCs

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JEL codes: F13, F14, F23, O2

Key words: Foreign direct investment, global value chain, labor productivity, spillovers, input-output linkages

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* The authors would like to thank Abdul Abiad (Director, Macroeconomic Research at Asian Development Bank) for initial guidance and participants at the World Bank South Asia Chief Economist brown bag lunch for comments and suggestions. Special thanks for comments from Jules Hugot (ADB) and Zhi Wang (George Mason University) for comments. We also thank Joseph Mariasingham and Donald Bertuflo (both ADB) for making data available and Astrit Sulstarova (UNCTAD). All errors are our own.

Contents

1 Introduction

For years, governments have been actively attracting foreign direct investment (FDI) in the belief that it creates jobs, boosts productivity, and increases wages (World Bank, 2020). However, the existing literature documents both positive and negative effects of FDI on productivity (Aitken & Harrison, 1999; Lu et al., 2017). The ambiguity of the FDI effects might not be surprising since previous research mostly focused only on single-country cases, and the heterogeneity across countries and sectors has been ignored. In this paper, we propose a key source of heterogeneity that can reconcile the mixed empirical results. This paper defines FDI spillovers as the effect of FDI on labor productivity. We find that country variation in global value chain (GVC) participation affects the sign and the size of FDI spillovers and gives rise to the seemingly contradicting results in different countries.

Specifically, this paper sheds light on the following questions. First, if a production process is a series of country/sector 'nodes' joined together in a value chain, how does FDI improve sector and firm productivity through spillovers? What is the role of the GVC participation in shaping FDI spillovers? Does the FDI only affect the recipient sector? Can FDI spillovers occur through the suppliers or the buyers (forward and backward linkages)? Moreover, if there is FDI in a country/sector, can it benefit foreign suppliers and buyers?[1]

To answer these questions, we construct a database with detailed country-sector coverage from 2011 to 2017. Our data is constructed by merging three panel data sets: (i) the fDi Markets data collected by the Financial Times; (ii) the Multi-Regional Input-Output tables (MRIOT) compiled by the Asian Development Bank which includes 61 countries and 35 sectors from 2011 to 2017; and (iii) the World Bank Enterprise survey (WBES) for over 100 countries consisting of detailed data on more than 8,000 firms. The fDi Markets data consist of rich information of the greenfield FDI projects including the source country, the parenting firm, the destination country and the sector, number of projects and the commitment amounts of FDI. The data at the firm level (WBES) and sector (MRIOT) level also allow us to check whether the relationships are robust and hold at the firm and sector

[1] For example, if Nepal is building a hotel, will it help the tourism/real estate sector as well as construction suppliers? Will it also be a great boost to international architecture and engineering firms as well as potential tourists?

level. These datasets with large country-sector coverage also enable us to draw conclusions with high general validity.

We find a positive but weak association between the FDI and labor productivity at the country-sector level. Unlike the existing literature, we take a step further. With a battery of robustness checks at both firm and sector level, we argue that GVC participation plays a key role in shaping the effects of FDI. Specifically, a country-sector with lower GVC participation benefits more from FDI. To establish causality, we adopt a shift-share instrumental variable (IV) for sector FDI. In the IV regression, we find that doubling the FDI into a non-tradable country sector will increase the labor productivity of that sector by 15 percent; for a country-sector with an average GVC participation level (= 0.24), doubling the FDI will increase the labor productivity by 8 percent.

To understand the mechanism through which the spillovers take place, we further argue that lower GVC participation may result in higher exposure to domestic competition generated by FDI and thus higher propensity to do research and development (R&D). Our firm-level analysis supports this argument. We find that firms participating less in the GVC have higher propensity to engage in R&D in response to FDI in their sector. We discuss more about this mechanism in Section 5.3 and 5.4.

Moreover, by looking at cross-border FDI, we provide evidence for the existence of positive FDI spillovers through both domestic and foreign backward linkages. That is, FDI into the downstream sector of a home or foreign country also has positive effects on a domestic upstream sector through input-output linkages.

This paper contributes to the literature on the effects of FDI at least in three ways. First, by taking GVC participation into account, this paper reconciles the contradicting effects of FDI in different countries documented in the previous literature. The country variation of the extent of GVC participation explains why the effects of the FDI vary across countries. Second, we identify the existence of cross-border FDI spillovers. To the best of our knowledge, this is the first time that these cross-border effects have been identified. This paper fills the gap by pointing out that the spillovers exist not only through the domestic input and output linkages but also through foreign

backward linkages.[2] Third, the data that cover 61 countries and 35 sectors from 2011 to 2017 enhance the general validity of our results compared to the existing literature.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces the conceptual framework and describes recent trends in FDI, particularly in Asia. Section 4 explains details of the data. Section 5 reports the results, including the direct effects of FDI and the role GVC participation plays in shaping these effects. Section 6 expands the analysis on FDI spillovers through the domestic and foreign linkages. Section 7 concludes and summarizes future work planned to expand the paper.

2. Literature Review

This paper in some ways combines two strands of the literature: studies that look at the effects of FDI, and those that look at production links through GVCs. The relevant FDI literature focuses on the existence of FDI spillovers, and the determination of whether they are positive or negative. Following the seminal paper by Javorcik (2004), the focus turned to whether FDI in one sector could have an effect not only on firms in the recipient sector but also on those in upstream or downstream sectors. Section 2.2 reviews the research on multinational enterprises' participation in GVCs and summarizes the literature on the interaction between GVCs and FDI.

2.1 FDI Literature

Establishing FDI spillovers

A large body of literature explores FDI's contribution to host economies through capital infusion and productivity spillovers. Researchers theorize that MNE affiliates may benefit local economies by introducing more advanced technology and management practices (especially to their suppliers), increasing demand for local products, providing improved inputs, driving exports, and introducing competition (Javorcik 2004; Alfaro and Chen, 2018; UNCTAD, 2013; World Bank, 2020). Due to the data limitation, previous literature focused either on the single-country cases or cross-country

[2] An example of these cross-border spillovers from FDI is Foxconn, a company headquartered in Taipei, China which built factories and hired workers in mainland China to assemble iPhones as a contractor for US-based Apple Inc. The FDI into the processing and assembly sector in Shenzhen, China (the foreign country) enhanced not only the productivity of the electronics sector in Shenzhen, but also increased the efficiency of the upstream suppliers in the United States (the home country).

analysis for groups of advanced economies such as the EU. This raises at least two problems. First, the empirical results lack the external validity, particularly for developing countries. It is difficult for policy makers to interpret these results. Second, developing economies in Asia are large recipients of FDI, yet it is not clear how beneficial FDI is for recipient countries, especially those least inserted in GVCs.

The early research looked at the link between FDI in a sector and the performance of the recipient firm in that same sector. From a very direct point of view, relative to a counterfactual of no financing, a project is clearly better off with foreign investment. However, not all studies have found positive spillovers once other aspects are controlled for. Haddad & Harrison (1993) reject the hypothesis that FDI accelerates productivity growth using firm-level data in Moroccan manufacturing sectors. Employing panel data of Venezuelan plants, Aitken & Harrison (1999) find that the magnitude of the FDI spillovers is marginal, and the positive correlation between FDI and firm productivity is only robust for small enterprises. Evidence is mixed on the magnitude and even the direction of the FDI spillovers. Using plant-level panel data covering manufacturing firms in the United Kingdom during 1973 – 1992, Haskel et al. (2007) show that there is a robust and significantly positive correlation between the total factor productivity of a domestic plant and the foreign-affiliate's share in that sector. However, Lu et al. (2017) find negative FDI spillovers among Chinese manufacturing firms. At the same time, FDI may be harmful if local firms lose market share to foreign-backed competitors (Aitken and Harrison 1999). Smeets (2008) and Gorg et.al. (2001) review possible sources of FDI induced spillovers through an evaluation of the empirical evidence on productivity and wages, among others. These surveys note that although theory can identify a range of possible spillovers, the empirical results paint a mixed picture at best.

Linking to upstream and downstream sectors, and tax incentives for FDI

The attention has shifted from the direct FDI spillovers to those taking place through input and output linkages. In addition to the direct impact on labor productivity, FDI also generates cross-sector spillovers. As Moran (2001) points out, FDI in the downstream sectors could increase the productivity of the upstream suppliers through technical assistance, management experience, and quality assurance. FDI spillovers could also take place through forward linkages. Intermediates supplied by foreign investment embody more advanced technologies from which domestic firms can learn (Grossman & Helpman, 1991). Javorcik (2004) is the first paper to empirically confirm the FDI spillovers through the backward linkages in the steel sector in the Czech Republic.

Moreover, the paper shows how intermediates provided by foreign investment can be accompanied by services that improve the productivity of the downstream sector.

There could be technology transfers from foreign firms in the upstream (Newman et al., 2016). With evidence from 17 transition market economies in Europe, Gorodnichenko et al. (2014) confirm that positive effect of backward linkages on the productivity of domestic firms while horizontal and forward linkages demonstrate no consistent effect. Newman et al. (2015) document the existence of FDI spillovers through forward linkages in Vietnam. Javorcik and Spatareanu (2011) provides additional evidence from Romania showing that FDI spillovers take place through backward linkages. In their meta-analysis, Havránek and Iršová (2011) argue that FDI spillovers take place mainly through backward linkages to suppliers.

There is also a very broad literature on creating tax and other incentives to attract FDI, which assesses the benefits or costs of FDI from the point of view of the investor (see for example Mercer-Blackman et.al., 2020). These studies implicitly take for granted that FDI is beneficial and desirable for the host countries.

2.2 GVC Literature

GVC and MNEs

Much of the recent GVC literature has placed emphasis on the importance of GVC participation, which is a new way of considering the gains from trade at the value-added level instead of the traditional gross output level. The problem with this approach from our point of view is that it equates direct exposure to international markets as the criterion for success, ignoring the fact that indirect exposure can also improve success. In other words, a firm can receive inputs from local firms and sell to the domestic markets but may still benefit from advances and efficiencies occurring through those input-output links with other sectors. Wang et al. (2017) show a way to measure the contribution of services along the value chain and find that they frequently are part of complex value chains.

While this paper studies the impact on productivity of the sector from the foreign financing and its links, it takes a slightly different approach to that adopted by Cadestin et.al. (2018) and Meng et. al. (forthcoming, 2020). In those approaches, the inter-country input-output tables for OECD and

the BRICS countries' country-sector nodes are further disaggregated into: (i) activities carried out mostly by local firms, (ii) activities carried out by MNEs located abroad, and (iii) activities of MNE affiliates. This allows them to compare the GVC participation of MNEs with that of local firms. Their results suggest that MNEs are indeed more engaged in GVC trade, specifically in more complex GVC trade (as defined in Wang et al. 2017). In other words, most back-and-forth trade transactions are carried out between MNEs and their affiliates (although local firms still produce most value added within countries). In our paper, we are less concerned about whether the MNEs themselves are engaged in production sharing and GVC trade, and more focused on identifying the additional knock-on effects on productivity of firms in the host country- sector that receive foreign financing. In other words, we are more interested in the role of MNEs as financiers, rather than their direct participation in production.

FDI spillovers and GVC participation

The recent emergence of the multinational input-output tables and indicators derived from them allow us to understand the production process more as a network or a long chain, which is very different from the typical production function of a firm that produces just one good. In this context, a firm in an emerging market can significantly increase its productivity if it can focus on the process it is best at, and there is some sort of 'learning' by inserting into the production process with foreign firms. The hypothesis is that those firms that export and import are learning more, but few papers clarify the channels.

The World Bank's World Development Report (2020) and related background papers (see for example Fernandez et al., 2020) find that countries which have FDI, even at the broad (horizontal) level, also have greater GVC participation. But the concern tends to be on attracting FDI itself. The evidence seems to be country-specific, sector disaggregation is very broad, and the spillover mechanisms are not always clear.

Farole and Winkler (2015), in a comprehensive study of FDI spillovers in Africa, identify 'ex-post' the salient characteristics of firms that are inserted in GVCs, also using the WBES. They find that firms inserted into GVCs typically have good technology, the host country has good institutions and political stability (for non-resource-rich countries) and thus have the capacity to benefit from FDI spillovers (for example through their superior capacity to absorb new technologies). Winkler

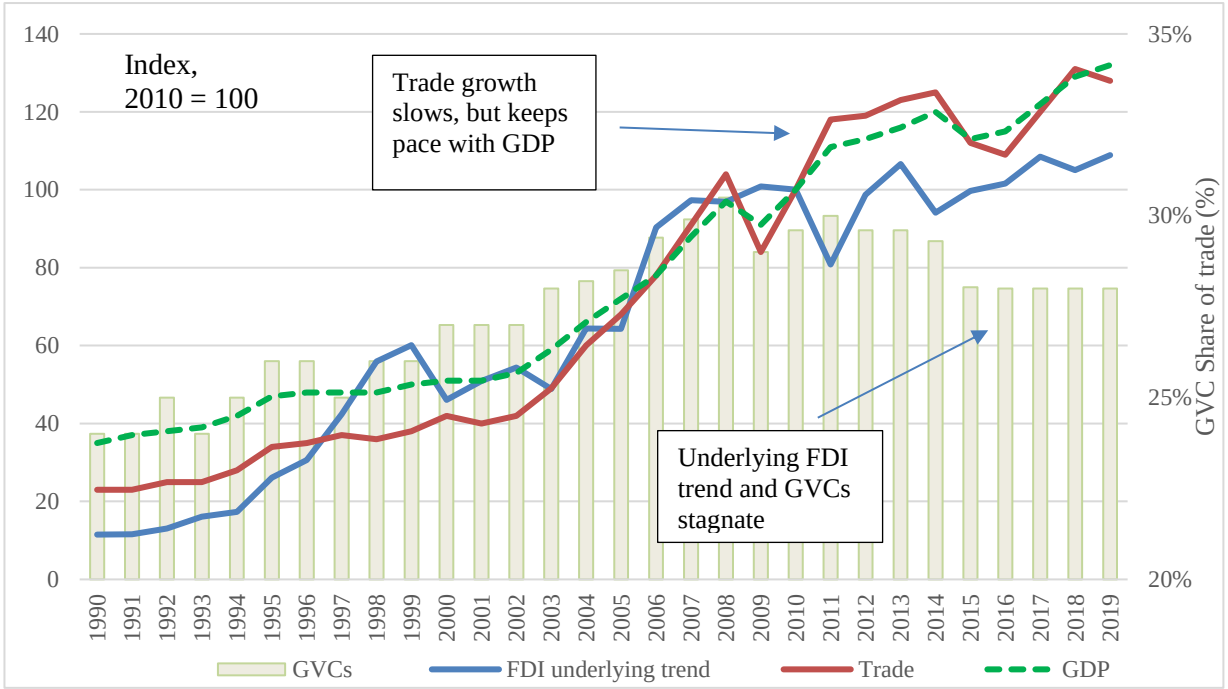
(2019) and Fernandes et.al. (2020) argue that countries with the right endowments are in a better position to participate in GVCs. However, while the authors find robust associations, the channels through which this transfer occurs—presumably through input-output linkages—are not well-developed. This happens in part because the econometric analyses are performed at the country-level. Unlike our analysis, they miss some of the inter-sector connections that define international production-sharing.

3 From GVC and FDI trends to conceptual framework

3.1 GVC and FDI trends

Most countries benefit from GVC participation, although fewer did so in 2019 before the pandemic compared to 2011. The level of GVC participation for almost 3 decades shows that GVCs have stopped growing at the global level since 2011, though they continued to expand in some regions. This contrasts sharply with the growth of FDI, GDP and trade (Figure 1). FDI has mostly kept pace with the growth of GDP. Trade growth has slowed but has kept pace with GDP, unlike GVC participation growth.

Figure 1: FDI, trade and GVC trends globally

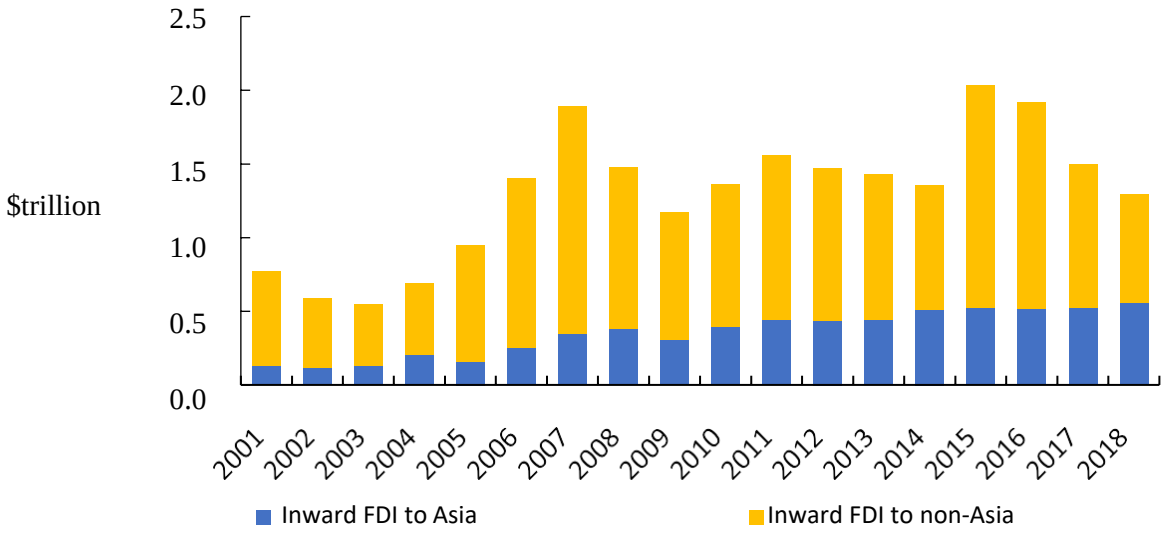


Note: Trade is global exports of goods and services. GVC share of trade is proxied by foreign value added in exports, based on the UNCTAD-Eora GVC database. The underlying FDI trend is an UNCTAD indicator capturing the long-term dynamics of FDI by netting out fluctuations driven by one-off transactions and volatile financial flows.

Foreign direct investment (FDI) worldwide has grown markedly since the 1970s, reaching $1.3 trillion in 2018 based on data from governments' balance of payments statistics (BoP) which is the standard source of recording financial flows. Asia has been one of the main destinations for FDI, receiving almost 43 percent of the global total in 2018, up from 17 percent ($132 billion) in 2000.

Despite global FDI steadily decreasing since it peaked in 2015 at $1.8 trillion – due to lower rates of FDI return, a slowdown in the expansion of international production, and the uncertainty in the global trade and investment policy environment – inflows to Asia remained relatively stable as shown in figure 2. This illustrates the region's increasingly important role in international production networks as well as strengthening intraregional trade and investment linkages. Data since the COVID-19 pandemic are not available yet, but initial signs indicate that inward FDI to Asia remains comparatively resilient compared to global trends, though mostly due to flows to India and China (UNCTAD 2020). East Asia consistently attracts just over 50 percent of the inflows largely due to investments in China followed by Southeast Asia (around 25 percent).

Figure 2: Global inward FDI, global and Asia, 2001-2018



Note: Asia here includes Australia and New Zealand

Sources: ADB calculations using data from Association of Southeast Asian Nations Secretariat. ASEANstats Database. https://www.aseanstats.org/ (accessed July 2019); and United Nations Conference on Trade and Development. World Investment Report 2018 Statistical Annex Tables (accessed June, 2020) http://unctad.org/en/Pages/DIAE/World%20Investment%20Report/Annex-Tables.aspx

In fact, intraregional investment linkages have continued to strengthen since the Global Financial Crisis – in 2007 the intraregional share of FDI inflows to Asia was around 30 percent. In 2018, over

10 years later, it was almost 50 percent. The slow pace of economic recovery, and increasing protectionism in advanced economies, has prompted Asian investors to turn towards investment opportunities within the region. This growing intra-Asian FDI is an encouraging sign for the region as the global economy heads towards a historic slowdown due to the pandemic.

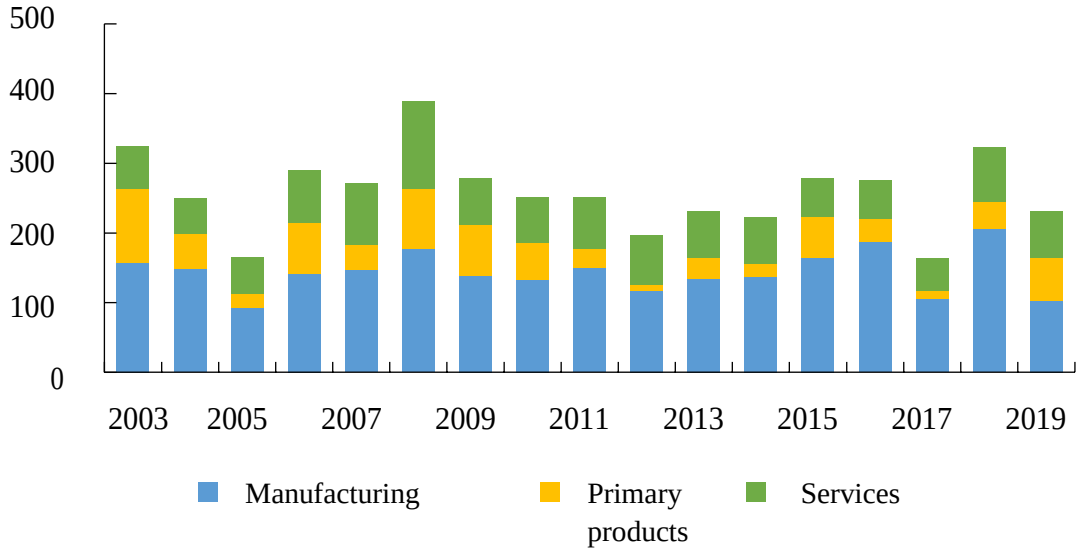
Given these trends, we look more closely at FDI trends in Asia. The surge in FDI to the region has been linked to the expansion of GVCs mainly in the manufacturing sector. It was driven by multinationals, notably from Japan and the Republic of Korea, relocating downstream parts of the production process in search of lower labor costs mainly through greenfield investments. Greenfield investments which entail building new assets--as opposed to merger and acquisitions (M&As) which refers to taking over existing assets--has been the dominant mode of entry for FDI in the region especially in the manufacturing sector and for emerging Asian economies. Empirical evidence suggests that greenfield FDI is more GVC-linked compared to M&As which are relatively more market seeking (ADB 2016). Therefore, developing countries tend to encourage and receive more greenfield FDI often through industrial policy instruments such as special economic zones.

Part of the reason that developing countries favor greenfield FDI is also because of its role as a substantial source of job creation. Between 2003 and 2018, greenfield investments created 29.5 million jobs globally, 44 percent of which were in Asia. Manufacturing remains dominant in terms of both number of greenfield jobs and jobs created per project. The share of manufacturing in total jobs created is almost 70 percent, with an average 283 jobs created per project notably in plastic, semiconductors, and automotive OEM. The share of services in total jobs created is just over 28 percent (106 jobs per project) with FDI in the primary sector playing a negligible role in job creation. South Asia, notably India, is a large recipient of services-sector FDI.

As figure 3 illustrates, the manufacturing sector has historically received the largest share of greenfield investments in Asia mainly in real estate; coal, oil, and natural gas; alternative/renewable energy; chemicals and automotive OEMs. However, after a sharp rise in 2018, greenfield FDI to the region fell sharply in 2019 to $230 billion from $323 billion the previous year. The decline was driven by a 50 percent reduction in investments in the manufacturing sectors most pronounced in chemicals and chemical products; computer, electronic, optical products and electrical equipment; and automotive OEM (figure 3). Consequently, the share of manufacturing fell to 44 percent, the lowest since fDi Markets data became available in

2003. The primary sector in fact registered a 33 percent increase in investment while FDI in services industries declined only slightly by 14 percent.

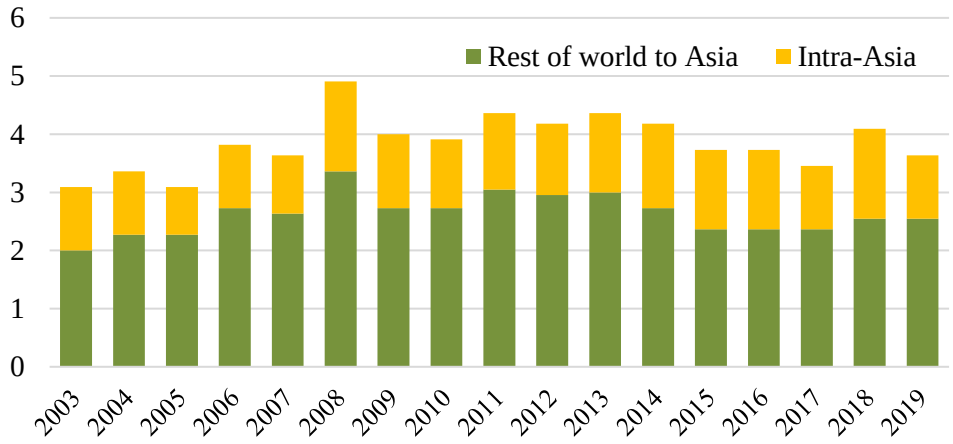
Figure 3: Greenfield FDI in Asia ($ billion)



Source: ADB calculations using Financial Times fDi Markets Database.

While the nominal value of greenfield investments fluctuates dramatically from year to year (y-o-y), the number of projects remains relatively stable (figure 4). In 2019, the number of announced projects fell only by 9 percent y-o-y almost entirely due to fewer intra-Asian projects and likely driven by the uncertainty surrounding the escalation of the US- China trade conflict. The 29 percent reduction in terms of nominal value was driven by smaller project size.

Figure 4: Number of Greenfield projects (thousands)



Note: Asia includes Australia and New Zealand

Source: author calculations using Financial Times fDI Markets Database

The manufacturing sector has traditionally attracted the largest share of greenfield investments in total, but the average size of a project is the largest in primary industries—including oil and gas extraction and mining—at $750 million per project (Table 1). The average size of a project in the manufacturing sector was $80 million, while for services it was $32 million. Hence to obtain a full picture of investment activity, it is important to also track the extensive margin.

Table 1: Average greenfield deal size ($ millions)

Period	Manufacturing	Services	Primary sector
2019	79.8	31.8	748.8
2018	127.7	38	480.8
2017	77.7	28.1	287.7

Notes: Financial Times fDi Markets Database.

Greenfield investments do not necessarily follow the same trend as FDI inflows measured by BoP. Our main data source for foreign investment, *fDi Markets* data, traces firm level investment activity (which may not be recorded in BoP), and hence identifies the ultimate investment ownership. Thus, this firm level investment activity is not mis-measured by the phenomena of transshipping or roundtripping, where FDI from a given country may be routed to the destination through intermediate countries. In 2018 for example, the nominal value of greenfield investments and M&As (data which similarly traces firm level investment activity) spiked more sharply than the value of FDI recorded by BoP, suggesting that many countries in the region may have acted as a conduits for FDI ultimately directed outside Asia. Therefore, in addition to the fact that greenfield investment data is disaggregated at the sector level, it is also a more accurate measure of origin and destination of FDI flows. With this in mind, we turn to how this financing may impact productivity.

3.2 Conceptual framework

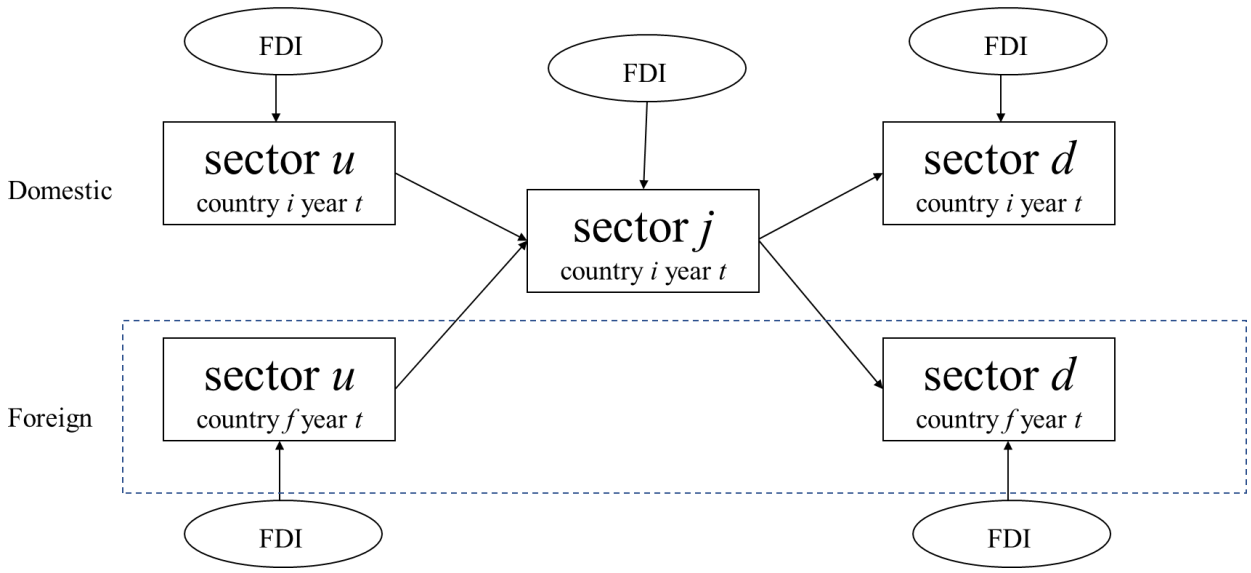
To guide the empirical analysis, this section introduces the conceptual framework. The first subject of interest is establishing a *direct* impact of FDI on the labor productivity of the recipient sector. FDI could generate spillovers since workers from multinational firms are mobile and can bring

knowledge to the domestic firms in the same sector, and incumbents can observe and absorb more advanced technologies and the better management.

Furthermore, the effects of FDI might vary when the level of GVC participation differs.[3] One reason may be that to integrate more in GVCs, the sector already had to improve on various fronts to survive fierce competition from other firms, so there is less room for improvement once it inserts into the GVC. It is also possible that sectors with higher GVC participation generate less domestic competition since they compete more in foreign markets. Moreover, sectors with higher GVC participation acquire and sell fewer intermediate inputs and products in the domestic market (by definition), so there are fewer domestic competitors to able to imitate their production model, but also fewer FDI spillovers.

To better understand this, the diagram in Figure 5 illustrates the concept. A sector *j* in country *i* could use intermediate inputs supplied by an upstream sector *u* in either the same country or in a foreign country *f*; sector *j* could also supply intermediates to its downstream sector *d* in the same country or in a foreign country (in the lower quadrant of Figure 5). The effects of FDI on sectors with different levels of GVC participation may vary.

Figure 5: Conceptual Framework



Source: authors.

Indirect FDI spillovers could exist through input and output linkages, as shown in the outer ellipses of Figure 5. There could be FDI spillovers through both domestic and foreign forward linkages.

[3] GVC participation is defined in detail in Section 4.2

- FDI in sector *u* could generate indirect effects on sector *j* through forward linkages. Javorcik (2004) and Newman et al., (2015) show that a foreign firm in the upstream sector *u* can also transfer improved technologies to the domestic affiliate in the downstream sector *j*. In our conceptual framework, there is no reason to believe that country border matters. Therefore, FDI in the sector *u* in a foreign country *f* might also have effects on sector *j* in the country *i*.

- FDI spillovers could also take place through backward linkages. FDI in sector *d* could affect sector *j*. Javorcik (2004) provides an anecdotal case of the Czech producer of aluminum alloy castings and its multinational customer. In this case, the staff from the multinational firm would visit the domestic suppliers two days in each month, and the domestic suppliers applied these improvements to its other production lines. FDI in the foreign downstream sector *d* in country *f* might also generate spillovers to sector *j* in country *i*.

In the next section we want to test the strength and causal relations of the arrows depicted in Figure 5 in the last decade.

4 Data and Metrics

4.1 Data

To implement the empirical analysis, we link data on FDI flows across countries available since 2003 with data on input and output linkages. The main sources are fDi Markets data monitored by the Financial Times and the MRIOT compiled by the Asian Development Bank.

- The fDi Markets is the most comprehensive online database of cross-border greenfield investments; the database covers all countries and sectors. For a specific FDI project, it documents the source and destination country, the destination sector, the number of jobs, the amount of investment, and the industry classification.
- For the measure of the GVC participation of a sector in a country, we need a data set on international input-output tables (IOTs). The Asian Development Bank's Multi-regional input-output tables (MRIOT) version published in 2019 covers 61 individual economies--and the rest of world as one group for a total of 62--and 35 sectors. It is the most appropriate dataset because it has the broadest coverage of countries (especially for developing Asia)

and is frequently updated.[47] The classification rule adopted by the fDi Markets is different from that by the MRIOT. We first aggregate the FDI data at the project level to the country-sector level, and then we do the concordance manually.

To explore the mechanism through which the GVC participation affects the strength of FDI spillovers, we use the *World Bank Enterprise Survey* data. This data set provides rich firm- level information with firms classified into the same sector levels as the MRIOT. We leverage the firm-level data to test if FDI is positively associated with firm R&D propensity and whether a firm with lower GVC participation engages less in the R&D faced with FDI in its sector.

4.2 Metrics and variable definitions

The main GVC measures of a country-sectors are constructed using the derivations in Wang, Wei and Zhou (2017). The variables are defined as follows, with the label in parenthesis. We first calculate the forward and backward GVC participation separately.

Forward GVC participation (GVC_forward) is defined as the share of the value-added created by a country-sector used for intermediate exports. It reflects the strong links that a sector has with buyers abroad, and generally tends to be in the upstream segment of the production process.

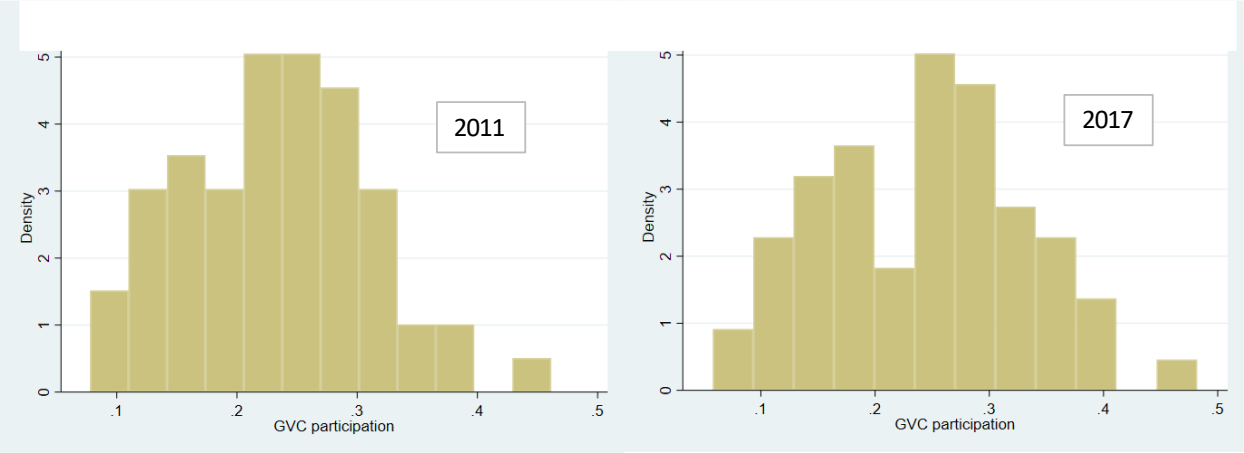
Backward GVC participation (GVC_backward) is defined as the ratio of the domestic and foreign value-added in intermediate imports over the total output of a country-sector. It reflects strong links as a purchaser of foreign goods and thus is as a sector more likely to be located in the downstream segment of the production process**.**

GVC participation (GVC) is defined as the simple average of the ***GVC_forward*** and ***GVC_backward.***

Figure 6 shows the variation of GVC participation across all 61 countries. The mean value has not changed much in the eight years to 2017, it remains around 2.5 though the skewness has led to higher values of more sectors in 2017 (bottom panel of Figure 6). Appendix table 1 lists the classification of sectors.

[4] There are four major sources most frequently used: The World Input-Output Database (WIOD), the Organization for Economic Co-operation and Development's (OECD) IOT database and ICIO database, the Eora Multi-Regional Input-Output database, and the ADB's MRIOT database. The WIOD only covers 40 economies including 6 Asian economies and goes to 2015; the OECD IOT and ICIO data covers 61and 74 economies, respectively, but the latest available data goes to 2015. The Eora database has a wider coverage of countries, but the structure of smaller countries is derived from similar countries, and not from country-specific national accounts. Moreover, sectoral data are highly aggregated.

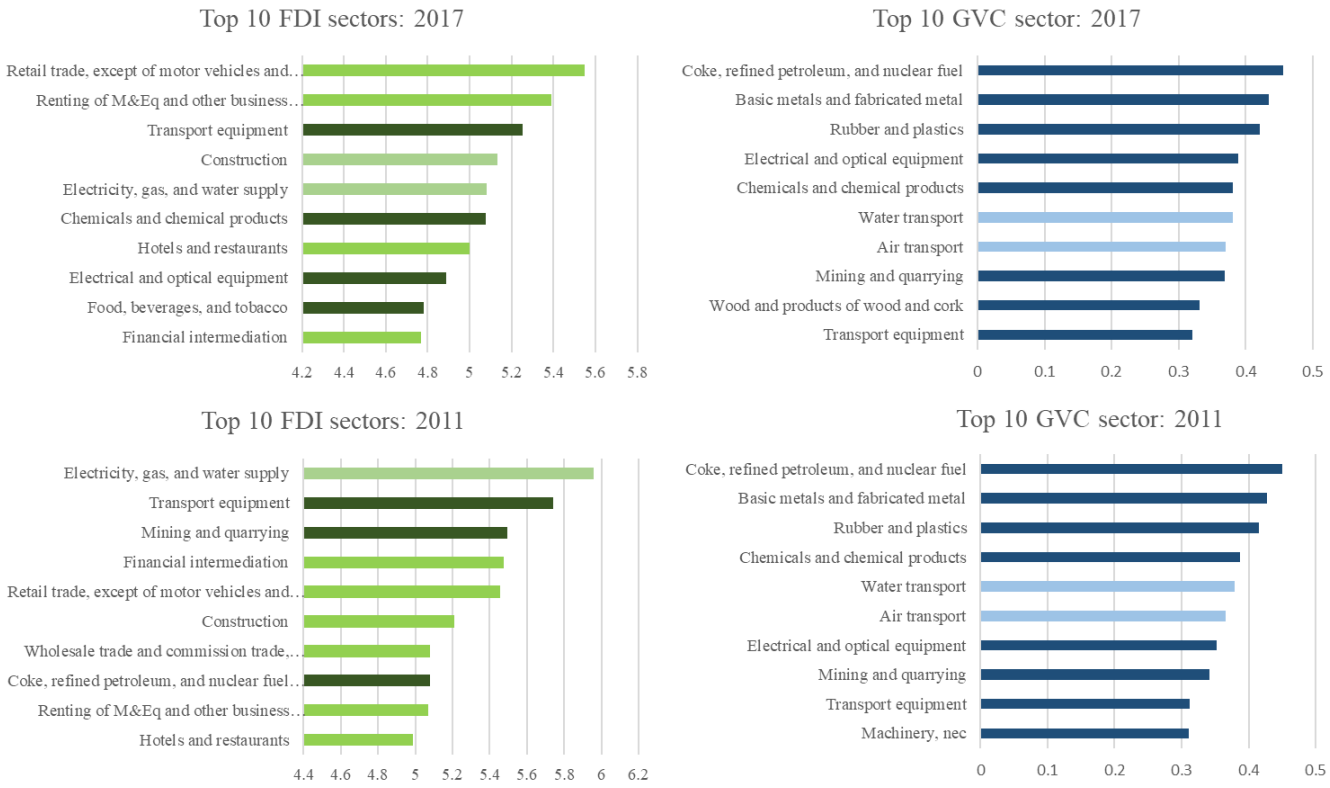
Figure 6: Country Distribution of the GVC Participation in 2011 and 2017



Source: Asian Development Bank estimates based on Wang et al. (2017) using Asian Development Bank Multi-Regional Input Output Tables (2011 and 2017)

At the global level, there is no discernable relationship between FDI and GVC participation. Figure 7 shows the sectors with high GVC participation and dollar FDI in 2017 (latest available year) and 2011 (shortly after the global financial crisis). The top three sectors in terms of GVC participation all produce raw and basic materials. The electronics sector is prominent and has become more integrated in GVCs between 2011 and 2017. Only air and water transport, used to transport goods and passengers, have high overall global GVC participation. In contrast, with the notable exception of transport equipment, the top positions for sectors receiving greenfield FDI are taken by mostly services sectors, in particular sectors considered 'non-traded' such as electricity, gas and water, and retail trade (which became the sector receiving the most FDI in 2017). It is clear from both panels that, while there have been changes in the rankings of FDI and GVC between 2011 and 2017, there seems to be no relationship between the ranking of a sector's GVC participation and dollar-value FDI.

Figure 7: Sectors with high GVC participation and high FDI inn 2011 and 2017: no obvious match.



Note: FDI unit of measurement is log FDI where FDI is US$ millions. GVC participation is as index between 0 and 1. Agriculture and manufacturing are in darker tone. Services sectors, including utilities and construction sector generally supplied domestically, are in lighter tone.

Source: Asian Development Bank estimates based on Wang, Wei, Yu and Zhu (2017) using Asian Development Bank Multi-Reginal Input Output Tables (2011 and 2017) and Financial Times fDi Markets Database

For every country-sector, we will need to derive a metric of productivity based on its position either upstream or downstream, as well as the level of GVC participation. The metrics used to determine the productivity of sectors in this framework using the MRIOT are the following:

Domestic value-added (DVA) is defined as the sum of the domestic value-added in domestically used final products and in final exports.

Foreign value-added (FVA) is defined as the domestic and foreign value-added in intermediate imports.

Domestic value-added share (DVA_share) is the ratio of *DVA* over total output.

Value-added for domestic markets (VA_D) is defined as the value-added in production of final products to the domestic market directly**.**

Value-added for GVC (VA_GVC) is the value-added in production of intermediate exports, in other words, exports used as inputs abroad.

Share of value-added for domestic markets (VD_share) is defined as the ratio of ***VA_D*** over the total value added (*VA)* created by the country-sector.

Labor productivity of country i in sector j (Y_{ij}) is defined as the value-added of the country-sector per worker in that country sector.

Appendix table 1 shows that a heterogeneous set of mostly capital-intensive sectors (Real estate activities, Electricity and water, Mining and quarrying) have the highest values of ***Y***. Summary statistics for other variables are reported in Table 2.

Table 2: Summary Statistics

Variable	Number of Observations	Mean	Standard deviation.
ln FDI	15,090	4.06	2.283
ln labor productivity	7,848	3.76	1.462
DVA share	15,090	0.76	0.162
GVC_backward	15,090	0.24	0.162
GVC_forward	15,089	0.25	0.314
Logoutput	14,954	8.62	2.282
ln DVA	14,953	8.31	2.388
ln FVA	14,943	6.94	2.079
ln VA	15,089	8.76	2.23
ln VA_GVC	15,087	6.83	2.305
ln V_D	14,944	8.04	2.846
VD_share	15,089	0.60	0.424

Notes: Asian Development Bank estimates based on Wang, Wei, Yu and Zhu (2017) using Asian Development Bank Multi-Regional Input Output Tables (2011 - 2017) and Financial Times fDi Markets Database.

5 Direct FDI Effects and GVC Participation

5.1 Empirical strategy

To identify the direct effects of FDI on the labor productivity of a country-sector, we specify the regression equation as follows:

$$lny_{ijt} = \beta_0 + \beta_1 \times lnFDI_{ijt} + \gamma_{it} + \theta_{jt} + \mu_{ij} + \epsilon_{ijt}, \quad (1)$$

where the y_{ijt} refers to the labor productivity of country *i* sector *j* in year *t*, FDI_{ijt} the amount of FDI at the same level and the error term obeying the standard normal distribution. To control for the country-level factors such as the institutional quality, financial development, market size and policy environment etc., we include the country-year fixed effect γ_{it}. The sector-year fixed effect is θ_{jt} is included as a control to exclude the effects of price volatility and sectoral shocks. The comparative advantage of a country varies, and it determines the production cost of a sector in each country. Government subsidies and taxes for the same sector in different countries could differ. To take care of these issues, we control for the country-sector fixed effect μ_{ij}.

To explore how GVC participation shapes the effects of FDI, we include an interaction term to equation (1) and the specification becomes:

$$lny_{ijt} = \beta_0 + \beta_1 \times lnFDI_{ijt} + \beta_2 \times lnFDI_{ijt} \times GVC_{ijt} + \beta_3 \times GVC_{ijt} + \gamma_{it} + \theta_{jt} + \mu_{ij} + \epsilon_{ijt}, \quad (2)$$

where GVC_{ijt} is the GVC participation of country *i* sector *j* in year *t*.

5.2 FDI has higher spillovers for sectors with lower GVC participation

This section reports the empirical results to show the direct effect of FDI on a sector's productivity and the role of GVC participation in shaping this effect. The main results consider average labor productivity at the 35-sector level according to the MRIOT (see appendix table).

Main results

The main empirical results are reported in Table 3, where the dependent variable is log of sector labor productivity. In column 1, the coefficient of *ln FDI* is positive yet statistically insignificant. This result is consistent with most of the previous literature, in which there is ambiguity on the direct effect of FDI. When we include the interaction term to investigate how the GVC participation shapes FDI effects (column 2), the coefficient of *ln FDI* is positive and statistically significant, and the coefficient of the interaction term (*ln FDI*$\times$*GVC*) is negative and statistically significant. The results suggest that the average FDI spillover effect is positive, *and* a sector with lower GVC participation receives higher benefits from FDI than a sector with higher GVC participation. For a

non-tradable sector--meaning it has zero GVC participation--doubling the FDI leads to an increase in the labor productivity by 0.7 percenr; for a sector with average GVC participation, i.e., GVC being equal to the coefficient value of 0.24, doubling the FDI will increase the average labor productivity of firms in that sector by 0.2 percent. In columns (3) and (4), we further investigate how forward GVC participation and backward GVC participation influence the effects of FDI on labor productivity, and the results are qualitatively similar. As a variant, we use median GVC participation in the data sample as a cut-off by dividing the full sample into two samples: a sample with low GVC participation sectors and high GVC participation sectors. Column (5) shows that--for the sectors with low GVC participation--the overall effect of FDI on labor productivity is positive and statistically significant, while doubling the FDI gives rise to a productivity growth by 0.4 percent. For the sectors with high GVC participation there is no effect: the correlation between the FDI and the labor productivity is negative but not significant.

Table 3: FDI has Higher Spillovers on Labor Productivity for Sectors with Lower GVC Participation

Dependent. Variable: ln labor productivity (***ln Y***)	Full sample				Low GVC	High GVC
	(1)	(2)	(3)	(4)	(5)	(6)
ln FDI	0.001	0.007***	0.006**	0.005	0.004**	-0.005
	-0.493	-2.693	-2.329	-1.517	-2.32	(-1.594)
ln FDI × GVC		-0.021**				
		(-2.215)				
GVC		-2.089***				
		(-6.490)				
ln FDI × GVC_forward			-0.017**			
			(-2.056)			
GVC_forward			-0.559**			
			(-2.127)			
ln FDI × GVC_backward				-0.014		
				(-1.363)		
GVC_backward				-1.934***		
				(-7.009)		
Constant	3.697***	4.198***	3.831***	4.155***	3.508***	3.902***
	-421.651	-53.448	-57.435	-63.315	-356.135	-341.925
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-sector	1,719	1,719	1,719	1,719	929	918
Observations	7,848	7,848	7,848	7,848	3,948	3,900
R-squared	0.513	0.56	0.523	0.569	0.629	0.529

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-sector, country-year and sector-year fixed effects are included. Column (5) focuses on sectors with GVC participation lower than the median of the sample, while column (6) GVC participation higher than or equal the median of the sample. *** p<0.01, ** p<0.05, * p<0.1.

Sensitivity analysis

Next, we break down GVC participation to backward and forward types. We show that a sector with either low forward or low backward GVC participation benefits more from the FDI spillovers. We run regression specification in the column (1) of Table 3 on different subsamples. The results are reported in Table 4. In column (1), the sample consists of country-sectors with both low forward and backward GVC participation. The positive correlation between FDI and the labor productivity is qualitatively the same as in column (5) of Table 1. Column (2) reports the regression results for the sectors with both high forward and backward GVC participation. The labor productivity is negatively correlated with the FDI. In columns (3) and (5), we run the regression specified in equation (1) on sectors with low forward GVC participation and low backward GVC participation, respectively. The positive correlation between the FDI and labor productivity survives in these two subsamples. For subsamples of high forward GVC participation in column (4) and high backward GVC participation in column (6), the association between FDI and the labor productivity remains negative and statistically insignificant.

Table 4: Sensitivity Analysis: The FDI has Higher Spillovers on Labor Productivity for Sectors with Lower GVC Participation

Dependent. Variable: ln labor productivity (***ln Y***)	Low forward and low backward GVC part.	High forward and high backward GVC particip..	Low forward GVC particip.	High forward GVC particip.	Low backward GVC particip.	High backward GVC particip.
	(1)	(2)	(3)	(4)	(5)	(6)
ln FDI	0.005*	-0.007*	0.006***	-0.005*	0.005**	-0.004
	(1.96)	(-1.884)	(2.72)	(-1.765)	(2.39)	(-1.343)
Constant	3.531***	4.021***	3.397***	3.998***	3.627***	3.765***
	(275.66)	(308.60)	(264.01)	(340.77)	(309.95)	(346.82)
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-	692	669	933	884	922	942
Observations	2,878	2,850	3,947	3,901	3,929	3,919
R-squared	0.651	0.562	0.581	0.535	0.639	0.549

Note: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-sector, country-year and sector-year fixed effects are included. Column (1) uses the subsample of sectors with low backward and low forward GVC participation, column (2) sectors with high backward and forward GVC participation, column (3) sectors with low forward GVC participation, column (4) sectors with high forward GVC participation, column (5) sectors with low backward GVC participation, column (6) sectors with high backward GVC participation. *** p<0.01, ** p<0.05, * p<0.1.

Robustness check

We are aware that it could take more than a year to complete the foreign investment, and the investment might have lagged spillover effects in future years. Therefore, the preliminary results might only demonstrate the partial effect of FDI. To address this issue, we use the two-year moving average of the FDI instead of the contemporaneous one as our explanatory variable in columns (1) and (2) of Table 5. Column (1) shows that the positive correlation between labor productivity and the FDI still exists with the coefficient of similar magnitude as in our main results on Table 3. The correlation becomes negative *and significant* for the high GVC participation subsample (Table 5, column (2)). Therefore, the main conclusions in the previous analysis still hold even after considering lagged effects. For columns (3) and (4), we exclude the oil extraction and mining sector from the sample because it may be difficult to compare measures of labor productivity in sectors that use or produce raw and refined commodities with manufacturing: the pricing is highly volatile so that it is difficult to disentangle whether the coefficient is capturing the real effect or the

nominal effect. Moreover, these sectors have extremely high GVC participation and high FDI which may distort the general pattern in the data. The results are qualitatively and quantitatively the same if this sector is excluded from the sample.

Table 5: Robustness checks on main specifications

Dependent. Variable: *ln labor productivity* ***(ln Y)***	Two-year moving average		Non-mining sectors		Full sample	
	Low GVC participation	High GVC participation	Low GVC participation	High GVC participation	Lower 30%	Higher 30%
	(1)	(2)	(3)	(4)	(5)	(6)
ln FDI_MA	0.007*	-0.016**				
	(1.79)	(-2.341)				
ln FDI			0.003*	-0.001	0.005*	-0.006
			(1.96)	(-0.725)	(1.94)	(-1.455)
Constant	3.495***	3.952***	3.510***	3.804***	3.744***	4.357***
	(193.14)	(141.29)	(369.83)	(490.28)	(56.82)	(37.18)
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-sectors	929	918	912	796	583	564
Observations	3,948	3,900	3,890	3,411	2,380	2,310
R-squared	0.628	0.532	0.635	0.556	0.693	0.607

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level Country-sector, country-year and sector-year fixed effects are included. Columns with odd number report the results for sectors with low GVC participation, while the rest of the columns is for sectors with high GVC participation. Column (1) and (2) use two-year moving average of the FDI in the log form as the main independent variable; column (3) and (4) exclude all mining sectors; column (5) uses the sectors with the bottom 30 percent GVC participation as the subsample, while column (6) uses the top 30 percent. *** p<0.01, ** p<0.05, * p<0.1.

We also test for threshold sample effects and find that the main results hold. Taking the median of the GVC participation in the sample as the cut-off is *ad hoc*, so we try different cut-offs. In column (5), we focus on the sectors with lower 30 percent GVC participation, and the positive correlation still survives. In column (6) of table 5, we implement the analysis on the sectors with high 30 percent GVC participation, and still, the correlation between the FDI and the labor productivity is negative and statistically insignificant.

To check for additional robustness, in Table 6, we use a rich set of dependent variables to see whether our basic metric of labor productivity impacts the results. The alternatives are domestic value added per worker (DVA) and foreign value added per worker (FVA). Using either measure to proxy for sector productivity maintains the positive spillover effects of FDI

Table 6: FDI has Positive Effects on a Rich Set of Outcome Variables

Dependent variable (per worker)	*ln output*	*ln DVA*	*ln FVA*	*ln VA*	*ln VAD*	*ln VA_GVC*
	(1)	(2)	(3)	(4)	(5)	(6)
ln FDI	0.008**	0.008**	0.006*	0.004***	0.004	0.008*
	(2.41)	(2.41)	(1.75)	(2.98)	(1.36)	(1.86)
Constant	8.434***	8.144***	6.677***	8.716***	6.427***	7.618***
	(45.65)	(43.40)	(36.58)	(128.98)	(59.09)	(32.54)
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-sector	1,872	1,872	1,871	1,875	1,875	1,869
Observations	14,846	14,846	14,835	14,953	14,951	14,663
R-squared	0.361	0.376	0.265	0.583	0.365	0.193

Notes: The standard errors are clustered at the country-sector level. Country-year, sector-year and year fixed effects are included. The dependent variable in column (1) the total output, column (2) the domestic value-added, column (3) the foreign value-added, column (4) total value added, column (5) the value-added served for domestic markets, column (6) the value-added for GVC. All dependent variables are in the log form. *** p<0.01, ** p<0.05, * p<0.1.

In Table 7, we use the domestic value-added share as the dependent variable instead of labor productivity. This variable may capture not only how productive a sector is, but whether it is capturing most of the value added in the production process. We find that the FDI has positive effects on it that raise the domestic component of productivity. Moreover, GVC participation plays a similar role to what was seen in the main results in shaping these effects. This is consistent with the fact that some specific services like inland transport and business services--which have very high domestic value added but very low GVC participation--can benefit from FDI spillovers.

Table 7: FDI has Positive Spillovers on the Sectoral Domestic Value-added Share

Dependent variable: domestic value-added share ***(VD_share)***	Full sample		Low GVC	High GVC
	(1)	(2)	(3)	(4)
ln FDI	0.008***	0.001***	0.00049**	0
	(3.46)	(2.95)	(2.35)	(0.69)
ln FDI × GVC	-0.029***			
	(-3.310)			
GVC_forward	-0.412***			
	(-4.013)			
ln FDI × GVC_forward		-0.004***		
		(-2.872)		
GVC_forward		-0.034***		
		(-2.767)		
Constant	0.862***	0.781***	0.876***	0.637***
	(40.39)	(95.80)	(87.01)	(27.59)
Country-sector FE	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes
Number of country-sector	1,875	1,875	1,200	930
Observations	14,953	14,953	8,645	6,308
R-squared	0.565	0.39	0.464	0.496

Notes: The dependent variable is the sectoral domestic value-added share. The standard errors are clustered at the country-sector level. Country- year, sector-year and year fixed effects are included. Column (3) focuses on sectors with GVC participation lower than the median of the sample, while column (4) GVC participation higher than or equal the median of the sample. *** p<0.01, ** p<0.05, * p<0.1.

Does FDI accelerate productivity growth?

We find some evidence of the enabling effect that FDI may exert on firms and sectors that have low GVC participation. As noted earlier, FDI in sectors that cater to the domestic market--sometimes referred to as market-seeking FDI--is increasingly common in non-traded services or sectors that tend to be in the downstream so have low forward GVC participation. FDI may also lead to these firms' labor productivity increasing faster. We use the first difference of labor productivity as the dependent variable to investigate whether FDI enhances the productivity growth further (see Table 8). Columns (1) to (4) analyze the sectors with low GVC participation, and the rest of the columns focus on sectors with high GVC participation. Columns (2) and (4) show that, for sectors with low forward GVC participations, there is a positive and significant association between FDI and productivity growth. There is no statistical significance for sectors

with high GVC participation and for sectors with low backward GVC participation (columns 3 and 5 to 8).

Table 8: The FDI Facilitates the Productivity Growth of the Sectors with Low Forward GVC Participation

Dependent. Variable: ln diff in labor productivity (d***ln Y***)	Low GVC participation combinations				High GVC participation combinations			
	Low GVC particip.	Low forward GVC partic.	Low backward GVC particcip..	Low forward and backward GVC particip.	High GVC particip.	High forward GVC particip.	High backward GVC particip.	High forward and backward GVC particip.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln FDI	0.003	0.006**	0.003	0.005**	0.002	0.002	0.002	0.004
	(1.45)	(2.16)	(1.48)	(2.19)	(0.64)	(0.93)	(0.78)	(1.53)
Constant	-0.019	-0.038	-0.06	-0.024	-0.184**	-0.159*	-0.123*	-0.163**
	(-0.581)	(-1.109)	(-1.596)	(-0.695)	(-2.140)	(-1.844)	(-1.682)	(-2.082)
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-sector	1,011	621	790	460	896	907	896	670
Observations	3,770	2,178	2,857	1,587	3,292	3,402	3,224	2,431
R-squared	0.547	0.676	0.641	0.721	0.475	0.49	0.511	0.545

Notes: The dependent variable is the first difference of the log of labor productivity. The standard errors are clustered at the country-sector level. Country-year, sector-year and year fixed effects are included. Column (1) - (4) report the results for sectors with low GVC participation, while the rest of the columns is for sectors with high GVC participation. *** p<0.01, ** p<0.05, * p<0.1.

When does the FDI effect peak?

In Table 9, we include 1-year, 2-year and 3-year lag of FDI. In columns (1), (3) and (5), we report the results for the low GVC participation sectors. Column (3) includes the 2-year lag in addition to the 1-year lag in column (1), and column (5) further includes the 3-year lag. The results suggest that the FDI effect peaks one year after a country sector receives the FDI. The rest of the columns report the results for high GVC participation sectors, and the results are insignificant, which is consistent with what we have found previously.

Table 9: FDI Effects peak in the following year

Dependent. Variable: ln per worker labor productivity (***ln Y***)	1-year lag		2-years- lag		3-year lag	
	Low GVC participation	High GVC participation	Low GVC participation	High GVC participation	Low GVC participation	High GVC participation
	(1)	(2)	(3)	(4)	(5)	(6)
ln FDI	0.008***	0.001	0.011***	0.003	0.013***	0.004
	(3.34)	(0.34)	(3.50)	(0.79)	(4.37)	(1.04)
1-year lag ln FDI	0.010***	0.001	0.012***	0.002	0.015***	0.004
	(4.28)	(0.37)	(4.27)	(0.59)	(4.88)	(1.18)
2-year lag ln FDI			0.006	0.003	0.011***	0.004
			(1.46)	(1.15)	(3.55)	(1.63)
3-year lag ln FDI					0.004	0.003
					(1.24)	(1.47)
Constant	3.602***	4.075***	3.589***	4.090***	3.543***	4.072***
	(185.53)	(195.75)	(93.87)	(130.96)	(77.19)	(94.38)
Country-sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of country-sector	799	769	700	693	643	644
Observations	3,388	3,328	3,079	3,038	2,885	2,844
R-squared	0.095	0.237	0.103	0.26	0.119	0.267

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-sector, country-year and sector-year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.

Testing for endogeneity: Does FDI increase sector-labor productivity?

The results so far show a clear positive association between FDI and labor productivity at the sector level and how this association is weaker in sectors with high GVC participation. To establish causality between higher FDI flow and a higher productivity level, we must address potential endogeneity issues. We use a *shift-shar*e IV to instrument for the sectoral FDI. Specifically, we first use the FDI share of each country-sector within a country as the base-year value. We then multiply the base- year share by the growth rate of aggregate FDI in each corresponding country to obtain the instrumental variable for the realized country-sector FDI.

The results are reported in Table 10. In the first column, we use the instrument for FDI and its interaction term to replace the original FDI variable and the interaction term, respectively. The results are qualitatively the same as the main results: FDI has a positive effect on productivity, and the effect is mitigated by GVC participation. Quantitatively, the effect of FDI on labor productivity at the sector level becomes higher. In other words, given an average GVC participation level of 0.24, doubling FDI will lead to a 3 percent increase in the sector's labor productivity.

Table 10: IV regressions

Dependent variable: ln labor productivity (***ln Y***)	Full Sample		Low GVC participation	High GVC participation
	(1)	(2)	(3)	(4)
ln FDI (IV)	0.058***	0.154***	0.126***	0.02
	(0.02)	(0.04)	(0.03)	(0.02)
ln FDI (IV) × GVC	-0.132**	-0.322***		
	(0.05)	(0.11)		
GVC	-3.410***	-1.545***		
	(0.41)	(0.54)		
Kleibergen-Paap rk LM Stats		63.78	36.42	47.01
Kleibergen-Paap rk Wald F		28.47	33.27	50.10
Country-sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of country-sector	1,241	1,206	628	625
Observations	6,494	6,459	3,203	3,202
R-squared	0.266			

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-sector and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

Using an IV that includes past years strengthens our result. In columns (2) – (4), we run two-stage least square regressions. The Kleibergen-Paap LM and Wald F-statistics suggest that the instrumental variable is valid; the IV passes the over-identification and weak-identification test since the values of the statistics are larger than 10. In column (2), the interpretation of the results is consistent with the main regression results: doubling FDI will lead to an 8 percent increase in labor productivity. Column (3) demonstrates that for a sector with low GVC participation, the effect of FDI is even higher; doubling the FDI leads to a 13 percent increase in labor productivity. Column (4) shows that the FDI effect is weaker among sectors with high GVC participation both in magnitude and in statistical significance.

5.3 Establishing the transmission mechanism of FDI spillovers

In this section we try to interpret the main result found earlier and find that a lower GVC participation increases the spillover effect of FDI through greater exposure of firms to domestic competition. We thus identify the mechanism through which the FDI effect is mitigated. Recall that recent studies on FDI spillovers focus on the interpretation of the spillover effect, whether due

to crowding-in effects of firms in sectors (Farole and Winkler, 2015) or to technology transfer or domestic competition (Alfaro and Chen, 2019). Our results suggest that the spillover happens because--to survive in the fierce domestic competition fueled by FDI faced by a firm—other firms in the sector have a greater incentive to improve productivity and thus to become more competitive. To establish this argument, we leverage firm-level data from the World Bank Enterprise Survey. We first show that sectoral FDI has a positive impact on firm-level productivity, and this impact is ameliorated by the GVC participation of a firm. Second, we show that the effect of FDI on a firm's propensity to do research and development (R&D) is intensified if the firm has RELATIVELY lower GVC participation.

We use a similar empirical specification for the firm-level regression, except we can distinguish the locality further, from country to city using WBES. We use *i* to denote city, *j* firm, *s* sector, and *t* year. The regression specification follows

$$\ln y_{ijst} = \alpha_0 + \alpha_1 \ln FDI_{ist} \times GVC_{ijt} + \alpha_2 \ln FDI_{ist} + \alpha_3 GVC_{ijst} + \gamma_i + \theta_j + CX + \tau_t + \epsilon_{ijt} \quad (3)$$

where the outcome variables y_{ijst} represent labor productivity; GVC_{ijt} is GVC participation of city i firm *j* sector *s* year *t*; FDI_{ist} is FDI at time t at the sector-city level.[5] The control variables' vector $\boldsymbol{X}$ include the number of skilled workers of a firm in the previous year, foreign ownership share,[6] foreign technology adoption, firm size, sector type, and years of experience of top managers. γ_i represents city fixed effects; θ_j denotes sector fixed effects; τ_t controls for year fixed effects, while ϵ_{ijt} is the error term. Firm's GVC participation here is defined as the average of its intermediates' import share and the exporting intensity. The export intensity, in turn, is defined as the ratio of exports over sales.

Table 11 shows that sectoral FDI has a positive effect on firm-level labor productivity, and this effect is weakened by the GVC participation of the firm. This somewhat mirrors the

[5] For the measurement of FDI here, we tried both number of FDI projects and the dollar value because the fDi Markets FDI project data is more accurate for recent years than the dollar-value FDI data, which is more of an estimate for recent years. The results are qualitatively similar. Moreover, our current data goes to 2017 so revisions have likely ameliorated this problem at the time of writing.

[6] This control variable is important because it captures the direct firm-level effect of being the recipient of foreign financing—and at the same time whether the firm is mostly a foreign-owned affiliate (share over 50 percent) or a local firm. Recall that the key result of our regressions is the effect of the indirect 'spillover' effects. Direct financing to one firm in that city/sector, for worker training or machines for example, is thus captured by the foreign ownership share variable.

specification in table 2, but since it is at the firm level, we can bring in more firm-level control variables to rule out other possible effects. The coefficients of the interaction term are statistically significant with negative signs. Other control variables are statistically significant and of the expected sign: the higher the share of ownership of the firm that is foreign; and the higher the number of skilled workers in the firm in the previous period, the greater the firm's labor productivity. We find that services firms tend to be more productive, but this may be marred by the very low proportion of firms in the WBES sample that are in the services sectors.[7] We believe that the enabling characteristics of services in the productivity of other firms is better captured in the sectorial regression results (tables 2-8).

Table 11: Sectoral FDI has a positive impact on firm productivity

Dependent Variable: ln labor productivity **at the firm level**	(1)	(2)	(3)	(4)	(5)	(6)
ln (FDI)	0.038***	0.038***	0.051***	0.061***	0.061***	0.059***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln (FDI) × GVC				-0.052**	-0.058**	-0.059***
				(0.02)	(0.02)	(0.02)
GVC			0.880***	0.940***	0.856***	0.832***
			(0.10)	(0.11)	(0.11)	(0.11)
Foreign ownership share					0.433***	0.465***
					(0.04)	(0.04)
Log (# skilled workers at t-1)		0.113***	0.079***	0.079***	0.069***	0.064***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln (years of top mgmt)						0.146***
						(0.02)
Service						3.097***
						(0.12)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
City-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	50,884	35,855	31,311	31,311	30,866	30,415
R-squared	0.137	0.145	0.173	0.173	0.182	0.185

Notes: The dependent variable is the log of labor productivity at firm level. FDI is at sector level. GVC is at firm level. GVC is defined as the average of intermediates import share and the exporting intensity.

The latter defines as the ratio of exports over sales. Ln (# skilled workers at t-1) is the log of the number of skilled workers of a firm in the previous year. Ln (years of top management) is the log of years of experience of the top managers. We divide firms into two sectors: manufacturing and services. The standard errors are clustered at the country-sector level. City-year, sector-year and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

[7] We tried these specifications only looking at the services firms, but they are very few and scattered so the power of the tests is lower. Moreover, there are major conceptual problems with measuring the performance of services firms by looking at labor productivity or total factor productivity.

We also want to use two additional firm-level variables that represent the strength of forward links of a firm as an exporter (exporting intensity); and the strength of backward-level links abroad (import share).[8] Table 12 further decomposes the GVC participation into import share and exporting intensity. We find that the mitigation of the FDI spillovers is mainly due to higher exporting intensity rather than import share. In column (2), the coefficient of the interaction term is negative and statistically significant, while in column (3) the statistical significance disappears.

Table 12: Sectoral FDI, export, import, and firm productivity

Dependent Variable: ln labor productivity at the firm level	(1)	(2)	(3)
ln(FDI)	0.057***	0.041***	0.051***
	(0.01)	(0.01)	(0.01)
ln(FDI) × GVC	-0.061***		
	(0.02)		
ln(FDI) × Exporting intensity		-0.035**	
		(0.02)	
ln (FDI) × Import share			-0.024
			(0.02)
GVC	0.728***		
	(0.12)		
Exporting intensity		0.460***	
		(0.08)	
Import share			0.397***
			(0.06)
Foreign ownership share	0.418***	0.482***	0.472***
	(0.04)	(0.04)	(0.04)
ln (# skilled workers at t-1)	-0.130***	-0.142***	-0.127***
	(0.02)	(0.01)	(0.02)
ln (years of top mgmt)	0.139***	0.135***	0.139***
	(0.02)	(0.01)	(0.02)
ln (firm size)	0.241***	0.254***	0.258***
	(0.02)	(0.02)	(0.02)
Services	3.167***	0.942***	3.071***
	(0.12)	(0.10)	(0.12)
Year FE	Yes	Yes	Yes
City-year FE	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes
Observations	30,415	34,860	30,451
R-squared	0.196	0.181	0.192

[8] These two variables are not quite the same as the GVC participation of the firm, but very much capture the same concept. We are limited by the variables in the WBES.

Notes: The dependent variable is the log of labor productivity at firm level. FDI is at sector level. GVC is at firm level. GVC is defined as the average of intermediates import share and the exporting intensity. The latter defines as the ratio of exports over sales. Ln (# skilled workers at t-1) is the log of the number of skilled workers of a firm in the previous year. Ln (years of top management) is the log of years of experience of the top managers. We divide firms into two sectors: manufacturing and services. The standard errors are clustered at the country-sector level. City-year, sector-year and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

Another way of measuring the productivity of a firm could be its likelihood of engaging in research and development. In Table 13, we test to see if a firm in a sector with higher FDI is more likely to engage in R&D activities if its GVC participation is higher or lower. The results show that a firm with a higher exporting intensity or a higher import share is more likely to engage in R&D. However, its R&D propensity will be less affected by sectoral FDI. In fact, higher FDI in the sector conditional on high exporting intensity can lead to less R&D spending. The results remain qualitatively the same whether we use OLS, Logit and Probit models.

Table 13: Sectoral FDI has a positive impact on firm R&D propensity

	OLS	Logit	Probit
Binary Dependent variable: R&D (=1)	(1)	(2)	(3)
ln (FDI)	0.010***	0.056***	0.034***
	(0.00)	(0.01)	(0.01)
ln (FDI) × exporting intensity	-0.012**	-0.068***	-0.040***
	(0.01)	(0.02)	(0.01)
Exporting intensity	0.174***	0.973***	0.574***
	(0.02)	(0.08)	(0.05)
ln (FDI) × foreign import share	-0.007	-0.044*	-0.027*
	(0.01)	(0.03)	(0.02)
Import share	0.078***	0.477***	0.286***
	(0.01)	(0.05)	(0.03)
Foreign ownership share	0.013	0.047	0.032
	(0.01)	(0.05)	(0.03)
Foreign tech adoption (=1)	0.146***	0.743***	0.445***
	(0.01)	(0.03)	(0.02)
ln(years of experiences of top	0.023***	0.136***	0.078***
	(0.00)	(0.02)	(0.01)
Services dummy	-0.222***	0.48	0.302
	(0.02)	(0.95)	(0.54)
Year FE	Yes	Yes	Yes
City-year FE	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes
Observations	42,616	42,541	42,541
R-squared	0.144		

Notes: The dependent variable is the R&D dummy at firm level. FDI is at sector level. GVC is at firm level. GVC is defined as the average of intermediates import share and the exporting intensity. The latter is defines as the ratio of exports over sales. Ln (years of top mgmt) is the log of years of experience of the top managers. We divide firms into two sectors: manufacturing and services. The standard errors are clustered at the country-sector level. City-year, sector-year and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

These results suggest that a firm with higher GVC participation is faced with less domestic competition brought about by FDI. With less domestic competition, the firm has less incentive to perform R&D and is likely to have less improvement in its productivity down the line. Note that the firms may be subject to competition in foreign markets, as the coefficients on export intensity and foreign technology adoption are positive and statistically significant. Moreover, it is likely that R&D may be targeted towards improvements in the local markets where the competition is fierce. Interestingly, the share of foreign ownership of the firm is not statistically significant, so local firms are on equal footing. Finally, being a service firm all else equal is associated with less R&D (in the OLS regression), although as explained earlier the sample of services firms in WBES is too small to allow clear conclusions.

5.4 Interpretation of results

The finding that higher GVC participation in a sector—which could be considered as its exposure to export markets--reduces the strength of the positive spillover effects of FDI may seem counterintuitive but is a robust result and consistent with related literature. Lu et al. (2014) find that a Chinese firm with higher exporting intensity is less affected by FDI into its industry. We find similar patterns using cross-country firm-level data. The intuition for this would be that to integrate more in the GVC, the sector has already had to improve on various fronts to survive from the fierce competition, so there is less room for improvement once it inserts into the GVC. It is also possible that sectors with higher GVC participation generate less domestic competition since they compete more in the foreign markets. Moreover, sectors with higher GVC participation acquire and sell fewer intermediate inputs and products in the domestic market; it is harder for domestic competitors to imitate, and thus there are fewer FDI spillovers.

The finding that FDI generates domestic competition in the recipient sector, and that firms with higher export intensity engage less in R&D compared to those with low export intensity is similar to the result in Farole et.al. (2018), which finds that GVC participation increases labor demand,

but conditional on this increase, labor demand is higher when GVC participation is lower. We also believe it is consistent with the different behavior of low-cost-seeking FDI versus market-seeking FDI documented in ADB (2015). The former type of FDI would tend to be more interested in investing just enough in a firm to complete a section of the production process at the lowest possible cost and is more likely to be spread out globally. The recipient sectors of this type of FDI tend to have high GVC participation. The latter financier will need to invest more in understanding the intricacies of the sector and the local economy, and by doing so it is likely to have a bigger impact on productivity than the firm that is more integrated into GVCs.

To understand our findings, suppose that a foreign investor finances a local transport company which distributes its imported goods and invests some amount to upgrade the fleet of trucks. This could have important spillover effects: other firms in the local logistics sector in theory could benefit. However, if the foreign firm had purchased the local logistics firm instead, the new, vertically integrated firm would be considered--according to National Accounts ownership criteria--a merged large firm with high GVC participation. Yet there has not necessarily been an increase in overall labor productivity. In fact, if the firm receiving the foreign investment remains local, it could make decisions using local know-how while also benefiting from foreign technology know-how and generate competition within the sector. This may partially also explain our result that having higher GVC participation dampens the spillover effect. In this example, it is more beneficial for foreign investors to let the local firm with the local know-how make the local decisions. Similarly, other firms linked across the value chain (in upstream or downstream sectors) may also still benefit from this FDI because it has made the local transport sector more efficient.

A specific example of local and foreign know-how increasing a productivity is the case of ridesharing in South Asia. Uber Technologies invested early in Southeast Asian countries, and at the time competed with GRAB, a local ride-sharing company. While Uber's app had superior technology, it was unable to make inroads into the local market because it did not have the local know-how of GRAB. For example, GRAB accepted cash and linked rewards to popular local retailers. As a result, Uber then left the South Asian market but decided instead to purchase a share of GRAB. GRAB's app consequently became more accurate as it benefitted from Uber's technology, in addition to its local market know-how. The FDI-led technology adoption generates competition in the local ridesharing sector. In response to the competition, firms in local sector

increase their R&D to upgrade their technology. As of 2020, many countries have introduced their own ridesharing and delivery modalities.

6 Extension of the Framework: FDI spillovers through input and output linkages

In addition to the direct effects of FDI, spillovers may take place through input and output linkages, which allows us to look at the effect of FDI in other countries. Note that previous studies at the country level investigate the cross-sector FDI spillovers, yet they are not able to capture the cross-border spillovers. We thus bring in a measure of 'backward FDI' and 'forward FDI' in the following section.

6.1 Definitions of backward and forward FDI

Domestic backward FDI: Following Javorcik (2004), the domestic backward FDI can be defined as the weighted sum of the FDI in the downstream sectors. Formally,

$$FDI\_dom\_backward_{ijt} = \sum_{k \neq j} \alpha_{jkt} FDI_{ijt},$$

where α_{jkt} is the proportion of sector *j*'s output supplied to sector *k* in year *t*. The foreign backward FDI is defined as

$$FDI\_for\_backward_{ijt} = \sum_{c \neq i} \sum_{k \neq j} \alpha_{jkt} FDI_{cjt}.$$

where FDI_{cjt} is the FDI from all countries except for country i.

Domestic forward FDI is defined as the weighted sum of the FDI in upstream sectors. Specifically,

$$FDI\_dom\_forward_{ijt} = \sum_{m \neq j} \sigma_{jmt} FDI_{ijt}.$$

Likewise, the ***foreign forward FDI*** is defined as

$$FDI\_for\_forward_{ijt} = \sum_{c \neq i} \sum_{m \neq j} \sigma_{jmt} FDI_{cjt},$$

where FDI_{cjt} is the FDI from all countries except for country i.

6.2 FDI spillovers take place through domestic input and output linkages

We revert to the sector-level regressions used in the main results to extend this concept, with sector-level labor productivity as the dependent variable. In column (1) of Table 14, the coefficient of the *ln FDI_dom_backward* is positive and statistically significant, which suggests that FDI spillovers take place through the domestic backward linkages. The results in column (2) also demonstrate a positive correlation between the domestic forward FDI and labor productivity. In column (3), the coefficient of the domestic backward FDI is still positive and statistically significant, yet the significant correlation between the domestic forward FDI and the labor productivity disappears. The backward FDI has a more pronounced effect than the forward one. In other words, FDI into downstream sectors will benefit suppliers in the upstream sectors.

Table 14: FDI Spillovers Take Place through Domestic Backward and Forward Linkages

Dependent variable: ln labor productivity (***ln Y***)	(1)	(2)	(3)
ln FDI_dom_backward	0.005***		0.005*
	(2.58)		(1.83)
ln FDI_dom_forward		0.003*	0
		(1.76)	(-0.140)
Constant	4.026***	4.035***	4.030***
	(96.47)	(98.18)	(96.54)
Country-sector FE	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes
Number of country-sector	1,706	1,705	1,701
Observations	7,731	7,752	7,711
R-squared	0.532	0.518	0.532

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-year, sector-year and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

In Table 15, the results in columns (1) and (3) suggest that FDI spillovers exist through foreign backward linkages. The FDI into a sector will improve the productivity of its foreign upstream sector. That is to say, the FDI has cross-border spillovers. Columns (2) and (3) reveal that there is no significant FDI spillovers taking place through foreign forward linkages.

Table 15: FDI Spillovers Take Place through Foreign Backward Linkages

Dependent variable: ln labor productivity (***ln Y***)	(1)	(2)	(3)
ln FDI_for_backward	0.017***		0.016***
	(3.17)		(2.70)
ln FDI_for_forward		0.007	0.004
		(0.93)	(0.54)
Constant	3.629***	3.668***	3.628***
	(92.39)	(94.62)	(90.71)
Country-sector FE	Yes	Yes	Yes
Country-year FE	Yes	Yes	Yes
Sector-year FE	Yes	Yes	Yes
Number of country-sector	2,017	2,017	2,017
Observations	11,892	11,986	11,865
R-squared	0.407	0.402	0.406

Notes: The dependent variable is the log of labor productivity. The standard errors are clustered at the country-sector level. Country-year, sector-year and year fixed effects are included. *** p<0.01, ** p<0.05, * p<0.1.

7 Concluding remarks and further research

In this paper we link a project-level FDI database with the Multi-Regional Input and Output Table (MRIOT) to build a database with investment information and GVC participation indices for 61 economies and 35 sectors from 2011 to 2017. Our analysis finds evidence that FDI has an overall positive effect on labor productivity. In our preferred IV regressions, doubling FDI will lead to an 8 percent increase in labor productivity. For a sector with low GVC participation, the effect of FDI is even higher; doubling the FDI leads to a 13 percent increase in labor productivity. Since the data has a wide coverage of countries and sectors, the results have general validity unlike earlier studies that are more narrowly focused. We also find that FDI spillovers take place more through the domestic and foreign backward linkages, suggesting that FDI also has cross-border spillovers by benefitting domestic firms whose suppliers are in foreign countries and are recipients of FDI.

The policy implication should not be to provide more tax incentives, as the cost-benefit of such a policy has been under some scrutiny in recent years. For example, the reduction in the US corporate tax rate in 2018 should have led in theory to US investors reducing their investments abroad to repatriate and invest at home. Instead, US investors engaged in share buybacks and cash

accumulation. Two years later, US FDI to developing Asia is again on the increase (see Mercer-Blackman and Camingue-Romance, 2020). Indeed, such incentives oftentimes exacerbate the wish of some MNEs with high GVC participation to engage just enough in a developing country to reduce their overall tax liabilities at their headquarters; but not really invest and engage enough to transfer technology and know-how to the domestic firms in host countries. It is the latter investment that can benefit the sector in the domestic market the most by fostering healthy competition. Hence, governments can enhance these spillovers by fostering a stable regulatory environment and attracting investors in specific downstream sectors which can transfer the right technologies for the local market to induce competition, rather than attracting financing in sectors that are already very efficient, are focused on the external market--highly inserted into GVCs--and are unlikely to bring additional benefits to the local economy.

There are at least three possible future extensions of our research.

- First, we can examine how other characteristics of GVCs impact FDI spillovers. Our results show that backward GVC participation is the most important for spillovers, which could imply that firms in upstream sectors can benefit the most from FDI spillovers. Therefore, sectors with a high 'upstreamness index' may be able to benefit more from FDI spillovers. A similar hypothesis is that the longer the global value chain, the more a firm can benefit. Cheng et al. (2015) do find that firms that capture the largest share of domestic value added of the GVC tend to be firms that have the longest distance from final demand, using measures developed in Antràs et al. (2012), after controlling for GDP per capita and complexity of the production process. Given new measures of GVC length and propagation (Wang et.al., 2017; Dietzenbacher et.al., 2005), our study can use other characteristics of GVCs such as propagation length to find whether there is an additional effect beyond the foreign financing effect.

- Another future extension is to probe more into services. It may be that some types of services benefit more from FDI in the downstream or upstream sector. Certainly, the opposite effect has been found, namely, that manufacturing firms that use certain types of services can better benefit from FDI spillovers (for example R&D services). On the other scale, Arnold et al. (2012) find that increasing reforms of the services sector in India since 1991, which attracted FDI in that sector, led to improved productivity of manufacturing firms that used those services as inputs.

- As we update the data to 2019 and 2020, we will also look at the effect of COVID-19. In particular, we can check whether sectors that require social interaction—and thus had production losses at a far greater scale due to COVID-19—were able to cope better with these losses if they were exposed to more FDI.

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Appendix table: Sector Classification of Multiregional Input–Output tables

Code	Sector	Aggregate Classification	Log (labor productivity)
1	Agriculture, forestry, fishery	Agriculture and natural resources	2.230
2	Mining and quarrying	Agriculture and natural resources	4.264
3	Food, beverages, and tobacco	Manufacturing	3.371
4	Textiles and textile products	Manufacturing	3.073
5	Leather, leather products, and footwear	Manufacturing	2.752
6	Wood and products of wood and cork	Manufacturing	2.900
7	Pulp, paper, printing, and publishing	Manufacturing	3.267
8	Coke, refined petroleum, and nuclear fuel	Manufacturing	4.154
9	Chemicals and chemical products	Manufacturing	3.838
10	Rubber and plastics	Manufacturing	3.211
11	Other nonmetallic minerals	Manufacturing	3.487
12	Basic metals and fabricated metal	Manufacturing	3.387
13	Machinery, not classified elsewhere	Manufacturing	3.469
14	Electrical and optical equipment	Manufacturing	2.712
15	Transport equipment	Manufacturing	3.284
16	Manufacturing not classified elsewhere; recycling	Manufacturing	3.164
17	Electricity, gas, and water supply	Industry	4.493
18	Construction	Industry	3.303
19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	Services	3.564
20	Wholesale trade and commission trade except for motor vehicles and motorcycles	Services	3.554
21	Retail trade except for motor vehicles and motorcycles; repair of household goods	Services	3.220
22	Hotels and restaurants	Services	3.120
23	Inland transport	Services	3.828
24	Water transport	Services	3.211
25	Air transport	Services	3.737
26	auxiliary transport activities; activities of travel agencies	Services	3.457
27	Post and telecommunications	Services	3.553
28	Financial intermediation	Services	3.993
29	Real estate activities	Services	4.938
30	Renting of machinery and equipment and other business activities	Services	3.643
31	Public administration and defense; compulsory social security	Services	3.516
32	Education	Services	3.237
33	Health and social work	Services	3.278
34	Other community, social, and personal services	Services	3.115
35	Private households with employed persons	Services	3.147

Source: United Nations International Standard Industrial Classification Revision 3.1 (see https://www.unescwa.org/sites/www.unescwa.org/files/events/files/event_detail_id_1596_revison4revison31en.pdf)