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PRODUCTIVITY SPILLOVERS FROM SERVICES FIRMS IN LOW- AND MIDDLE-INCOME COUNTRIES: WHAT IS THE ROLE OF FIRM CHARACTERISTICS AND SERVICES LIBERALIZATION?

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Abstract

Using a cross-section of more than 38,000 manufacturing and 24,000 services firms in 105 low- and middle-income countries from the World Bank's Enterprise Surveys, this paper assesses whether there are productivity spillovers from services to manufacturing firms located in the same subnational region. The paper confirms positive spillovers resulting from a higher average regional productivity and technology intensity of services firms, but rejects the existence of spillovers from services firm presence alone. It also finds that the extent of the spillovers depends on a country's income status and a manufacturing firm's absorptive capacity, including its services intensity, firm size, foreign ownership status and exporting behavior.

The paper then analyzes the characteristics of services firms with higher productivity and technology intensity as these determine the services' spillover potential. Foreign ownership status and the top manager's experience are positively associated with a services firm's output per worker and technology intensity, while exporting status only shows a positive correlation with technology intensity. Finally, the paper examines whether services liberalization mediates productivity spillovers from services to manufacturing firms in a region. Using the World Bank's Services Trade Restrictions database, the results suggest that lower regulations in mode 1 and mode 3 services trade increase spillovers from services firms to manufacturing firms via a productivity-enhancing effect in the services sector.

Keywords: services firms, productivity spillovers, technology, absorptive capacity, services liberalization

JEL Classification: F1, F2

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1. INTRODUCTION

In recent years, several studies have suggested a performance-enhancing effect of services usage within sectors and firms. However, there is still a shortage of studies on the productivity spillovers from services to other sectors and firms, in particular for low- and middle-income countries. Spillovers generally refer to productivity improvements resulting from knowledge diffusion – both in the form of unintentional transmission or intentional transfer – encompassing both technology and all forms of codified and 'tacit knowledge' related to production, including management and organizational practices (Hoekman and Javorcik 2006).

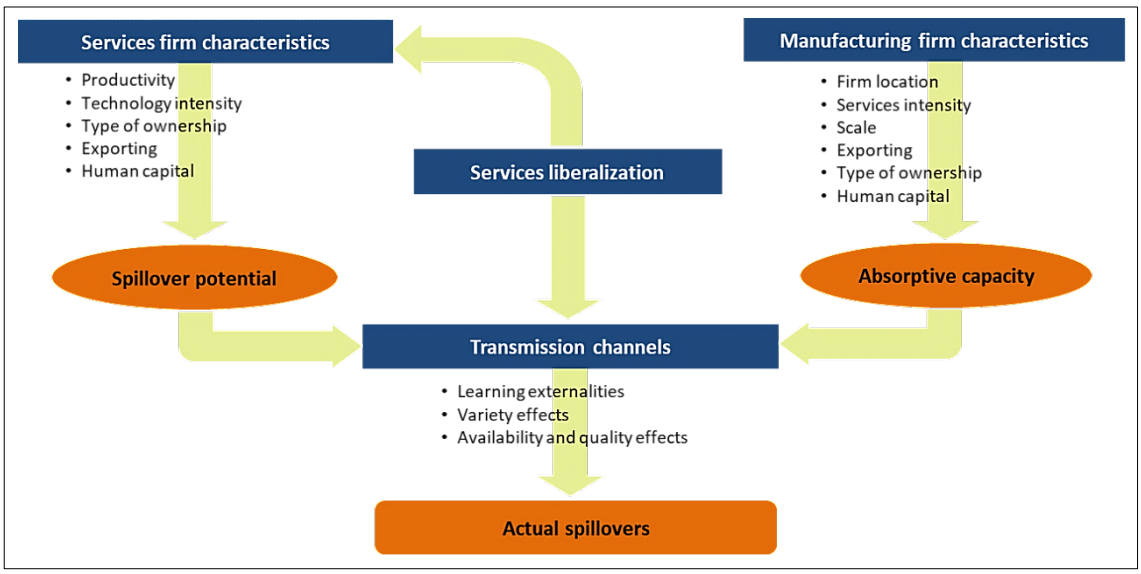
The lacuna of empirical literature on the productivity spillovers from services firms is surprising, given the relevance of services inputs to downstream industries, in particular manufacturing sectors. A recent World Bank study suggests that countries with a higher content of services in the downstream economy are also those producing more complex goods (Saez and others 2015). A recent study by the Organisation for Economic Co-operation and Development (OECD) finds that services represent at least 30% of the value added in manufacturing exports (OECD 2014). These developments are also strongly linked to the emergence of global value chains, which depend on the quality of embedded services, ranging from quality control, logistics, storage facilities, packaging, insurance, and distribution (Taglioni and Winkler 2016).

The strong dependency of firms on services inputs implies that improvements in services sectors, including the services firms' performance and services reforms, are likely to affect all downstream sectors. Second, the performance of downstream sectors depends, to a larger extent, on the quality and availability of domestic services firms due to limited cross-border tradability of services compared to material inputs. This makes services sectors a relevant source of vertical productivity spillovers (Javorcik 2008).

This study is based on the premise that the spillovers from services firms are not equally distributed among manufacturing firms. They are mediated by the characteristics of services firms, which determine the spillover potential and the absorptive capacity of manufacturing firms to internalize spillovers, as depicted in the conceptual framework shown in Figure 1. The spillover potential also depends on the extent of services liberalization in a country, which leads to market restructuring by increasing the availability of services inputs and providers, and thus magnifies the potential for productivity spillovers.

Possible transmission channels from services to manufacturing firms include learning externalities that could arise when purchased services improve the productivity of the workers, e.g. due to new software being used. Variety effects could raise productivity when various new services inputs are being used (Amiti and Wei 2009, Ethier 1982). In addition, new or better services inputs become available (availability and quality effect), which can increase spillovers via supply chain linkages (Javorcik 2008).

Figure 1: Conceptual Framework of Services Spillovers



Source: Own illustration, partially drawing on the conceptual framework on foreign direct investment spillovers by Farole, Staritz, and Winkler (2014).

The ability of manufacturing firms to access new services and invest more in services infrastructure depends on their absorptive capacity. This paper hypothesizes that manufacturing firms that have a higher absorptive capacity, i.e., that are located in closer proximity to services firms (e.g. within the same region), have a higher services intensity, are larger, export, have foreign ownership status, and show a higher share of human capital , enjoy higher spillovers from services firms. Similarly, this study predicts that the spillover potential of services firms increases for firms that are more productive, have a higher technology intensity, are foreign-owned, export and are more skill-intensive, as such services firms tend to have a higher knowledge intensity that can diffuse to manufacturing firms in downstream sectors.

Besides firm-level characteristics, this study examines the role of a country's services liberalization in influencing spillovers from services firms. Services liberalization involves eliminating barriers to entry, privatizing state-owned enterprises and abolishing monopolies, among others. More services liberalization, including in services trade, opens markets to new services providers – domestic and foreign – which forces existing services firms to increase their productivity or exit (Arnold, Javorcik, and Mattoo 2011). Services liberalization thus increases the spillover potential of services firms, and also influences the functioning of the transmission channels.

Using a cross-section of more than 38,000 manufacturing and 24,000 services firms in 105 low- and middle-income countries over the period 2010 to 2017 from the World Bank's Enterprise Surveys, this paper focuses on productivity spillovers from services to manufacturing firms, as well as the role of firm characteristics and a country's services liberalization in mediating spillovers.

This paper attempts to answer the following four questions:

1. ***Are there productivity and technology spillovers from services to manufacturing firms?***

In order to shed light onto this question, we relate a manufacturing firm's labor productivity to several measures of services spillovers using linear regression analysis. Labor productivity is measured as value added per worker. We include capital intensity as additional control variabls. The findings confirm positive spillovers resulting from a higher average regional productivity and technology intensity of services firms, but rejects the existence of spillovers from services firm presence alone.

Differentiating between income levels, the results suggest a U-shaped effect, i.e., productivity spillovers are larger in upper-middle and low-income countries than in lower-middle income countries. The results are different for technology spillovers from services firms. Here, upper-middle income countries benefit the least from spillovers, while manufacturing firm productivity in lower-middle and low-income countries is more strongly correlated with the regional technology intensity of services firms.

2. ***Which manufacturing firms benefit most from spillovers?***

In a next step, the analysis focuses on the role of manufacturing firms' absorptive capacity in mediating productivity and technology spillovers. Analytically, we assess this by including interaction terms between the spillover variable and selected manufacturing firm characteristics. The findings suggest that several manufacturing firm characteristics increase productivity and technology spillovers from services firms, including large firm size, foreign ownership status and exporting. Manufacturing firms with a larger services intensity, by contrast, show lower spillovers, while skill intensity does not matter.

3. ***Which services firm characteristics increase the spillover potential?***

Due to the positive relationship between services and manufacturing firm productivity, this paper then assesses the characteristics of services firms with higher productivity and technology intensity levels as these determine the services spillover potential. We find that foreign ownership status and the extent of the top manager's experience in a sector are positively associated with services firms' output per worker and technology intensity. Exporting status only shows a positive correlation with technology intensity, but not labor productivity for services firms.

4. ***Can services trade liberalization increase spillovers?***

The paper also examines if policy mediates productivity spillovers from services to manufacturing firms in a region. It is possible that reforms in the upstream services sectors translate into a higher spillover potential and thus higher actual productivity spillovers. For this analysis, we rely on the World Bank's Services Trade Restrictions database which is based on surveys that were mostly collected in 2008. Analytically, we include interaction terms between the spillover variable and the measures of services trade restrictiveness at the country level. The results suggest that lower regulations increase productivity spillovers, but only for mode 1 services trade. We also test for the direct link between services liberalization and services firm productivity and find a positive connection across all modes of supply available in the dataset (mode 1, mode 3 and mode 4).

Our study is closest in nature to the study by Hoekman and Shepherd (2017) who find evidence for regional productivity spillovers from services to manufacturing firms using a set of 58,000 firms from the World Bank Enterprise Surveys across 119 countries for the period 2006–2011. Despite similarities with regard to the research question and database, there are also substantial differences in terms of model specification, measures and the time period being used. Importantly, our study not only includes a measure of spillovers based on the average services firm productivity in a region, but also tests for the existence of regional spillovers from a higher technology intensity and presence of services firms.

Second, borrowing from the rich literature on spillovers from foreign direct investment (e.g., Paus and Gallagher 2008; Farole, Staritz, and Winkler 2014), our study additionally examines the role of absorptive capacity in mediating spillovers and identifies characteristics of services firms that correlate with higher spillover potential. Finally, this study also assesses the role of services liberalization in shaping productivity spillovers, while Hoekman and Shepherd (2017) examine the relationship between services liberalization and manufacturing exports at the sector level using a gravity model. Reassuringly, our study confirms the general findings of Hoekman and Shepherd (2017) that a higher regional productivity of services firms is positively correlated with manufacturing firm labor productivity, while a higher services trade restrictiveness has negative implications for the manufacturing sector.

The paper is structured as follows. Section 2 reviews the relevant literature. Section 3 introduces the empirical model, data and measures being used. Section 4 reports the econometric results, while section 5 summarizes and concludes.

2. LITERATURE REVIEW

This study is related to three streams of empirical literature, namely (i) studies on the relationship between services usage and performance, (ii) studies on the role of services and services liberalization for the competitiveness of downstream sectors, and (iii) studies on the productivity spillovers from foreign direct investment and the role of mediating factors. For an extensive literature overview on the connection between services – in particular trade, foreign direct investment and liberalization – and economic performance, see Francois and Hoekman (2010).

Several studies explore the relationship between the intensity of importing services (or services offshoring) and productivity. Several studies at the sectoral level find evidence that a higher services offshoring intensity significantly increases productivity, while the effect of materials offshoring intensity is smaller or insignificant, including Amiti and Wei (2009) for United States manufacturing between 1992 and 2000, Crinò (2008) for nine EU countries between 1990 and 2004, Winkler (2010) for German manufacturing industries covering the period 1995–2006, and Michel and Rycx (2014) for Belgian manufacturing industries between 1995 and 2004. The last study also examines the impact of inter-industry spillover effects from services offshoring, but finds only little evidence.

A few studies analyze the relationship between services offshoring and productivity using firm-level data. Görg and Hanley (2003) analyze the impact of services offshoring intensity on labor productivity for Ireland using plant-level data. The effect was positive in the electronics industry between 1990 and 1995. In a more recent plant-level study, Görg, Hanley and Strobl (2008) evaluate the productivity effects of materials and services offshoring intensity for Irish manufacturing for the period 1990-1998,

differentiating between exporting and non-exporting firms. They only find a significantly positive impact of services offshoring on TFP for exporting firms.

Other studies focus on the role of services for other performance indicators. Using a sample of Swedish manufacturing firm-level data, Lodefalk (2014) studies the relationship between a firm's services intensity and its export intensity and finds that a higher share of services in in-house production raises a firm's exports share in total sales. The effect is stronger for services that are produced in-house compared to external services purchases. Debaere, Görg, and Raff (2013) examine the role of services for manufacturing firms' sourcing intensities using Irish plant-level survey data. A higher services availability, defined as number of local and foreign services firms in a region in a specific year, significantly increases a firm's share of imported materials in total sales. Interestingly, access to local services providers in this sample matters only for domestic firms, while access to foreign services providers matters only for foreign firms.

The second stream of literature focuses on the role of services for the competitiveness of downstream sectors. Rajan and Zingales (1998) relate financial sector development to the growth in downstream sectors and conclude that sectors that are more reliant on finance show higher growth in countries with well-developed financial markets. Similarly, Guiso, Sapienza, and Zingales (2004) find that local financial development in Italy enhances the likelihood of individuals to start a business and firm entry, and increases competition and growth. Focusing on spillovers at the regional level using a set of 58,000 firms across 119 countries for the period 2006–2011, Hoekman and Shepherd (2017) find evidence for productivity spillovers from services to manufacturing firms.

Focusing specifically on services liberalization, Nicoletti and Scarpetta (2003) postulate a positive link between services liberalization and productivity growth in manufacturing sectors in OECD countries. Similarly, Conway and others (2006) find that a country's manufacturing productivity catches up faster to the leading OECD country if it has a more open services market. Hoekman and Shepherd (2017) find that more services restrictions negatively affect manufacturing exports. Using firm-level data, Arnold, Javorcik and Mattoo (2011) and Arnold, Javorcik, Lipscom, and Mattoo (2015) examine its relationship with the productivity of firms in downstream manufacturing sectors. While the first study focuses on firms in the Czech Republic over the period 1998–2003, the second study covers Indian firms for the period 1993–2005. In both cases, the authors conclude that services reforms are linked to a higher performance of manufacturing firms.

A vast set of empirical studies has been undertaken on the existence and direction of foreign direct investment-generated horizontal and vertical spillovers (for a review of the literature, see for example Görg and Greenaway 2004; Lipsey and Sjöholm 2005; Smeets 2008; and Havranek and Irsova 2011). In a comprehensive meta-analysis, Havranek and Irsova (2011) take into account 3,626 estimates from 55 studies on vertical spillovers, and find evidence for positive and economically important backward spillovers from multinational corporations on domestic suppliers in upstream sectors and smaller positive effects on domestic customers in downstream sectors. However, the study rejects the existence of horizontal spillovers. Overall, the results are mixed, and suggest that the postulated spillover effects often do not materialize automatically (Farole and Winkler 2015).

As a result, more and more research has been devoted to understanding the various conditions that may explain these mixed results. Three major types of mediating factors have been identified, including (i) characteristics of foreign firms that shape spillover potential; (ii) characteristics of domestic firms that determine absorptive capacity to internalize spillovers; and (iii) differences in host country factors (Castellani and Zanfei 2003; Lipsey and Sjöholm 2005) that shape both domestic and foreign firm characteristics, as well as the transmission channels for spillovers (Paus and Gallagher 2008, Farole, Staritz, and Winkler 2014).

In summary, these studies suggest a performance-enhancing effect of services within sectors and firms, but also for downstream sectors and firms. However, most of these studies focus on industrialized countries and neglect the role of firm heterogeneity in mediating these links.

3. MODEL AND DATA

3.1 Empirical Model

We postulate the following value added function:

$$(Y\text{-}inp) = VA = F(K, L, T) \quad (1)$$

where capital *K*, labor *L* are the input factors, *VA* = (*Y-inp*) designates the value added and is the difference between output *Y* and intermediate inputs *inp*. The technology shifter *T* = *T*(*spill*) is a function services spillovers, *spill*.

We are interested in labor productivity, *lp*, defined as value added per worker, as dependent variable and estimate the following equation in log-linear form:

$$\ln lp_{isrt} = \alpha + \beta X_{isrt} + \gamma spill_{rt} + D_{cs} + D_t + \varepsilon_{isrt} \quad (2)$$

where subscript *i* stands for firm, *r* for (subnational) region, *s* for sector, *c* for country and *t* for year. α designates the constant, D_{cs} sector fixed effects, D_t year fixed effects, and ε_{isrt} the idiosyncratic error term.

X is a proxy for the firm-level determinants of labor productivity, namely a firm's capital intensity, *capint*. *spill* designates the services spillover variable, measured at the regional level. Our main spillover measures is the median output per worker (which equals productivity) of services firms in a region. We also use an alternative measure, namely the median technology intensity of services firms in a region.[1] A detailed description of the measures used can be found in section 3.3.

Since firm characteristics can mediate the capacity of manufacturing firms to internalize regional services spillovers, we also assess different types of absorptive capacities. They enter equation (2) in the form of interaction terms with the spillover variable:

$$\ln lp_{isrt} = \alpha + \beta X_{isrt} + \gamma spill_{rt} + \delta_1 spill_{rt} * AC_{isrt} + D_{cs} + D_t + \varepsilon_{isrt} \quad (3)$$

The joint effect of *spill* is the sum of γ plus δ_1*AC.* Since AC is positive, the mediating effect of the interaction term is positive for $\delta_1 > 0$.

[1] We also test for spillovers from the presence of services firms in the region.

Absorptive capacities, AC, include a firm's services intensity, but also foreign ownership status, exporting behavior, skill intensity and the top manager's experience. The latter have shown to mediate the productivity impacts from foreign direct investment, and it will be interesting to find out if they also matter for the absorption of services spillovers.

In a last step, we assess if policies at the country level mediate regional services spillovers. As in equation (3), policy variables enter the equation in the form of interaction terms with the spillover variable:

$$\ln lp_{isrt} = \alpha + \beta X_{isrt} + \gamma spill_{rt} + \delta_1 spill_{rt} * policy_c + D_{cs} + D_t + \varepsilon_{isrt} \quad (4)$$

Our policy variables are based on the World Bank's Services Trade Restrictiveness Index. They are available for certain sectors (telecommunications, finance, transportation, retail and professional services), but also in the aggregate form. While the measures focus on trade openess of services, we postulate that they correlate highly with a country's overall services liberalization.

3.2 Data

Our dataset draws on two underlying datasets, published by the World Bank Enterprise Analysis Unit, namely the Enterprise Surveys Global Database and the Firm-level TFP Estimates and Factor Ratios. The Enterprise Surveys Global Database covers 242 surveys in 140 countries over the period 2006 to 2017.

Enterprise surveys represent a comprehensive source of firm-level data in emerging markets and developing economies. One major advantage of the enterprise surveys is that the survey questions are the same across all countries. Moreover, the Enterprise Surveys represent a stratified random sample of firms using three levels of stratification: sector, firm size and region. Sectors are based on the ISIC Rev. 3.1 classification.

The Enterprise Surveys Global Database covers a wide range of indicators on firm characteristics, the business environment, innovation and technology and workforce and skills, among others. We merged this dataset with data on firm-level output, value added and capital stock obtained from the Firm-level TFP Estimates and Factor Ratios dataset. All local currencies have been converted into US dollars and deflated using a GDP deflator in US dollars (base year 2009). Exchange rates and GDP deflators have been obtained from the World Development Indicators.

We apply the following rules to the dataset: (i) We include only the most recent Enterprise Surveys for each country; (ii) We drop high-income countries to cover only emerging or developing countries;[2] (iii) We only cover the years 2010 to 2017, to account for the shock of the global economic crisis of 2008; (iv) We drop construction firms (ISIC 45) and restaurants and hotels (ISIC 55) and some outliers from the sample,[3] as these are not considered business services firms; (v) We drop countries with fewer than 100 firms after applying step (iii).

[2] We drop these, as the database only included 15 high-income countries which were not representative of high-income countries (eight Eastern European countries, five Caribbean islands, Israel, and Sweden).

[3] Some firms were classified non-commercial services (ISIC 75-95).

The procedure above results in more than 63,031 firms in 105 countries, of which 38,344 are manufacturing and 24,687 are services firms. The list of countries, year of the most recent survey and number of manufacturing and services firms by country can be found in Appendix 1. After computing the regional spillover measures, we focus only on the effects of productivity spillovers on domestic manufacturing firms, since TFP and LP measures are unavailable for services firms. The distribution of firms across ISIC sectors is shown in Appendix 2.

While the use of Enterprise Survey data allows us to capture dynamics at the firm-level, one downside of computing the spillover variables at the regional level is the heterogeneity of regional size. In countries where regions are defined as larger geographical entities covering more firms, spillovers may be more difficult to materialize for certain manufacturing firms due to larger geographical distances. The strong correlation between a region's median services and manufacturing firm productivity across the full sample of regions (see Figure 2 in section 4.1), however, reassures us that heterogeneity in regional size across countries does not seem to be a major concern.

Finally, we merge the firm-level data with country- level scores on services trade restrictions from the World Bank (Borchert, Gootiz, and Mattoo 2012)[4]. The database focuses on policies and regulations that discriminate against foreign services or foreign service providers, as well as other aspects of the country's regulatory environment that substantially affect trade in services. The data are based on surveys and offers comparable information on services trade policy for over 100 countries, covering five sectors (telecommunications, finance, transportation, retail and professional services). Almost all surveys were collected in 2008, which ensures that endogeneity between the dependent variable and policy is a minor issue. Scores range from 0 to 100, where 0 means "open" and 100 "closed". The database covers the most relevant "modes of supply" within each sector: commercial presence or FDI (mode 3); cross-border supply (mode 1) of financial, transportation and professional services; and the presence of individuals supplying the service (mode 4) in professional services.

3.3 Measures

We use labor productivity at the firm-level as dependent variable, which is measured as value added per employee and available only for manufacturing firms.[5] The measure is provided by the Enterprise Survey Analysis Unit and reported in 2009 US dollars.[6]

We include the following firm-level determinant of labor productivity, as suggested by theory:

- *Capital intensity, capint* = capital stock per employee in natural logarithms.

We analyze the following two spillover variables from services firms:

- ln*prod_med* = median productivity level of services firms in a region, defined as output per employee (in natural logarithms)
- *tech_med* = median technology intensity of services firms in a region. *tech* = *iso* + *tech_for* ∈ {0, 1, 2}, where *iso* = 1 if firm owns internationally-recognized quality certification and 0 otherwise, and *tech_for* = 1 if firm uses technology

[4] http://iresearch.worldbank.org/servicetrade

[5] Hoekman and Shepherd (2015) use output per worker as dependent variable.

[6] Labor productivity is part of the "Firm-level TFP Estimates and Factor Ratios" dataset.

licensed from foreign firms and 0 otherwise. This technology indicator is a narrower spillover measure and mainly captures technology spillovers.

Characteristics of manufacturing firms that can mediate productivity spillovers from services firms include:

- *Services intensity, serv_int* = services inputs as % of value added
- *fdi* = 1 if foreign private ownership >= 10% and 0 otherwise
- *exp* = 1 if direct export share >= 10%, and 0 otherwise
- *shs* = number of skilled production workers as % of total production workers as a measure of skill intensity, and
- *manager* = years of top manager's experience in the sector (in natural logarithms) as alternative measure of skill intensity.

Finally, we include services trade restrictions policy measures from the World Bank that all range from 0 to 100, where 0 means "open" and 100 "closed":

- *overall:* overall services trade restriction
- *telecom:* services trade restriction in telecommunications
- *finance:* services trade restriction in finance (banking and insurance)
- *transp:* services trade restriction in transportation
- *retail:* services trade restriction in retail distribution
- *prof:* services trade restriction in professional services (accounting and legal)

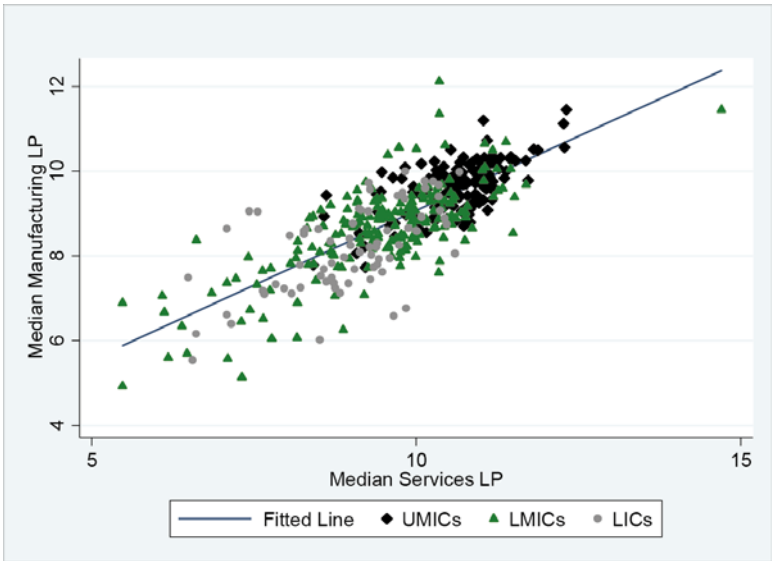
The analysis also differentiates by mode of services supply (modes 1, 3 and 4).

4. ANALYSIS OF SPILLOVERS FROM SERVICES FIRMS

4.1 Are There Productivity and Technology Spillovers from Services to Manufacturing Firms?

This section assesses whether manufacturing firms experience productivity spillovers from services firms. In order to fix ideas, we assess the relationship between the median services and manufacturing firm labor productivity visually at the subnational regional level. Figure 2 suggests that there is a clear positive relationship between the two, as shown by the bivariate regression line. In addition, it appears that both services and manufacturing labor productivity increases with higher income levels, although on the lower end of the spectrum for each, we find regions from both low- (gray circle) and lower-middle income countries (green triangle). Lower-middle income countries, in particular, appear to have a larger variation across regions with regard to their median productivity levels.

Figure 2: Median Services and Manufacturing Firm Labor Productivity, by Subnational Region



LICs = low-income countries, LMICs = lower-middle income countries, UMICs = upper-middle income countries.

Source: Own illustration. Data: Enterprise Surveys. Services labor productivity measured as output per worker. Manufacturing labor productivity measured as value added per worker.

In a first step, we assess if the presence of services firms alone is correlated with productivity gains. The summary statistics can be found in Appendix 3. All estimations produce standard errors robust to both heteroscedasticity and any form of intra-cluster correlation at the subnational level. We apply two measures of service presence, namely (i) the number of services firms as % of total number of firms by region, *serv_no,* and the output of services firms as % of total output of firms by region, *serv_out.* The latter measure follows the approach of the FDI spillovers literature where foreign presence in a sector is measured by the share of output by foreign firms in a sector's total output. The results in Appendix 4 suggest that a higher number and output of services firms as percent of the total number and output of firms in a region is uncorrelated with manufacturing firm productivity.

While the quantity or output of services firms does not matter, the productivity and technology intensity of services firms matter for spillovers. Table 1 shows that the median productivity of services firms in a region is positively associated with manufacturing labor productivity and the results are significant at the 1% level (column 1). Additionally controlling for capital intensity slightly reduces the coefficient size, but not the statistical significance (column 2). The results imply that a 1% increase of median services productivity in a region is related to a 0.23% increase in manufacturing labor productivity, confirming the general findings by Hoekman and Shepherd (2017). Using a region's median technology intensity of services firms as alternative spillover measure as robustness check confirms the findings (columns 4 to 6).[7] All estimates are significant at the 1% level.

[7] In a previous analysis, we additionally included whether a firm uses a website or email to communicate to clients into the technology spillover measure (results available upon request). While the correlation with services productivity was also positive, the coefficient was smaller, indicating that the productivity-enhancing spillover potential is higher from having an internationally-recognized quality certification and/or technology licensed from a foreign firm.

Table 1: Services Productivity and Technology Intensity in a Region and Manufacturing Firm Productivity, OLS

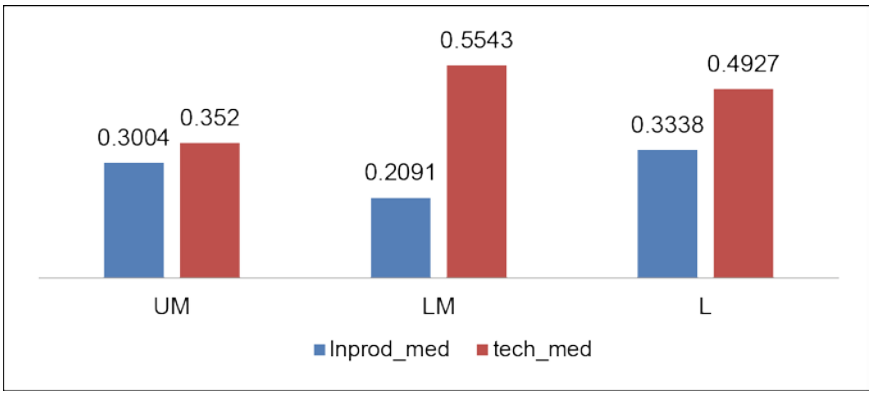
Dependent Variable: lnlp_{isrt}	ln*prod_med*		*tech_med*	
	(1)	(2)	(3)	(4)
$spill_{rt}$	0.2606***	0.2371***	0.3012***	0.4411***
	(0.000)	(0.000)	(0.000)	(0.000)
$lncapint_{isrt}$		0.2969***		0.3029***
		(0.000)		(0.000)
constant	6.8576	4.2482***	9.3558	7.0139***
	(0.998)	(0.000)	(.)	(0.000)
Observations	25,155	17,819	25,176	17,836
R-squared	0.36	0.50	0.35	0.50

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level.

In a next step, we test whether the correlations differ across countries' income levels. The full regression results are reported in Appendix 5. Figure 3 suggests a U-shaped effect using a region's median services productivity as spillover measure (blue bars). Upper-middle income countries show the highest correlation, which is somewhat higher than for low-income countries, while lower-middle income countries enjoy the lowest positive productivity spillovers. This finding may imply that upper-middle income countries rely more strongly on high-quality services inputs than countries with lower income levels (see Figure 2). The strong assocation for low-income countries, by contrast, could point to some large untapped spillover potential that services can generate.

Using a region's median technology intensity of services firms as alternative spillover measure shows different results (orange bars). Here, upper-middle income countries benefit the least from spillovers, while manufacturing firm productivity in lower-middle and low-income countries is more strongly correlated with the regional technology intensity of services firms. One explanation could be that manufacturing firms in upper-middle income countries are much closer to the technology frontier, so technology improvements in services firms have lower productivity effects.

Figure 3: Services Productivity and Technology Intensity in a Region and Manufacturing Firm Productivity, by Income, OLS



Note: All estimates significant at the 1% level. Based on regressions in Appendix 5. UM = upper-middle, LM = lower-middle, L = low.

4.2 Which Manufacturing Firms Benefit Most from Spillovers?

Since not all manufacturing firms benefit equally from services spillovers, this section studies the role of absorptive capacity to internalize such productivity spillovers. Table 2 focuses on our first spillover measure (median productivity of services firms in a region). The first absorptive capacity measure is a manufacturing firm's services intensity which interacts negatively with spillovers (column 1). That is, regional productivity spillover from services firms benefits those manufacturing firms more strongly that rely less on external services as percent of their value added. That is, the potential to absorb productivity spillovers from services firms in the same region declines for manufacturing firms that already make use of more external services relative to their value added.[8]

Table 2: Services Productivity in a Region and Manufacturing Firm Productivity, Absorptive Capacity, OLS

	Absorptive Capacity, AC					
Dependent Variable: ln*lp*$_{isrt}$	**(1)** ***serv_int***	**(2)** ***large***	**(3)** ***fdi***	**(4)** ***exp***	**(5)** ***shs***	**(6)** ***manager***
ln*prod_med*$_{rt}$	0.2314***	0.2174***	0.2329***	0.2317***	0.2247***	0.2330***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln*prod_med*$_{rt}$**AC*$_{isrt}$	–0.0374***	0.0329***	0.0301***	0.0301***	–0.0000	0.0022
	(0.000)	(0.000)	(0.000)	(0.000)	(0.640)	(0.312)
ln*capint*$_{isrt}$	0.3025***	0.2944***	0.2933***	0.2925***	0.3052***	0.2947***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	5.2047***	4.8638***	4.4042	3.3864	4.7716***	5.2119***
	(0.000)	(0.000)	(0.999)	(0.998)	(0.000)	(0.000)
Observation	17,355	17,819	17,810	17,775	15,182	17,635
R–squared	0.61	0.51	0.51	0.51	0.50	0.50
F–test[1)]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. 1) F-test of joint significance between *spill*$_{rt}$ and *spill*$_{rt}$**AC*$_{isrt}$ (Prob > F).

For other absorptive capacity measures, we borrow from the rich FDI spillovers literature and include firm characteristics that have been shown to mediate spillovers, including firm size, foreign ownership status, exporting behavior and skill intensity. The interaction term with large firm size (*large*) is positive and significant (column 2). In other words, large firms show higher spillovers (joint coefficient = 0.25) than small or medium-sized firms (coefficient = 0.22). Foreign and exporting firms also enjoy spillovers from a region's median services productivity (columns 3 and 4) which are higher (joint coefficient = 0.26) than those of domestic or non-exporting firms (coefficient = 0.23). By contrast, a higher skill intensity of manufacturing firms, measured as both the share of skilled production workers and the manager's years of

[8] The literature on services outsourcing mostly relates purchases of services inputs to either value added or total intermediate inputs (see, e.g., summary of literature in Crinò 2009 or Winkler 2013). Using total intermediate inputs, defined as the difference between sales and value added, as alternative denominator confirms the negative mediating effect. Our results differ from Hoekman and Shepherd (2017) who find a positive mediating effect of services intensity which could be related to the different measures of services intensity being used. While they relate services purchases to total costs, we use value added as denominator. Second, their services purchases include electricity, communications, transport and water, while our study additionally includes rental.

experience in the sector, does not influence the extent of spillovers individually. However, the mediating effect is jointly significant with the spillover measure, as shown by the F-test.

Focusing on our alternative spillover measure in Table 3 instead (median technology intensity of services firms in region) confirms the previous findings. A larger services intensity lowers spillovers, while technology spillovers are increased for large, foreign-owned and exporting firms. Again, skill intensity does not matter for regional services spillovers.

Table 3: Services Technology Intensity in a Region and Manufacturing Firm Productivity, Absorptive Capacity, OLS

	Absorptive Capacity, AC					
Dependent Variable: ln*lp*$_{isrt}$	**(1)** ***serv_int***	**(2)** ***large***	**(3)** ***fdi***	**(4)** ***exp***	**(5)** ***shs***	**(6)** ***manager***
tech_med$_{rt}$	0.3109***	0.3730***	0.4346***	0.4183***	0.3777**	0.4362**
	(0.006)	(0.000)	(0.000)	(0.000)	(0.018)	(0.034)
tech_med$_{rt}$**AC*$_{isrt}$	–0.1528***	0.1736**	0.1693	0.1637**	0.0013	0.0008
	(0.000)	(0.024)	(0.412)	(0.035)	(0.496)	(0.991)
ln*capint*$_{isrt}$	0.3030***	0.3034***	0.3029***	0.3030***	0.3120***	0.3013***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	9.1836***	7.0117***	9.1858***	7.0132***	5.1599	9.2061***
	(0.000)	(0.000)	(0.000)	(0.000)	(.)	(0.000)
Observation	1,7372	17,836	17,827	17,791	15,199	17,652
R–squared	0.50	0.50	0.50	0.50	0.49	0.50
F–test[1)]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. 1) F-test of joint significance between *spill*$_{rt}$ and *spill*$_{rt}$**AC*$_{isrt}$ (Prob > F).

4.3 Which Services Firm Characteristics Increase the Spillover Potential?

In order to understand which types of services firm characteristics have the potential to increase the spillover potential, we rerun the labor productivity model specified in equation (2) on the sample of services firms only. Due to data constraints on services firms in the Enterprise Surveys, we have to make several amendments to the model.

First, our dependent variable becomes output per worker, rather than value added per worker, since value added data are unavailable for services firms. Using output as left-hand side numerator requires us to control for intermediates. We therefore add services expenses as percent of a firm's output, *serv_int*, as additional control variable. Note that services intensity in the previous section was measured relative to value added. Second, we cannot directly control for capital intensity as determinant of labor productivity, as such data are only available for manufacturing firms. We therefore add a firm's technology intensity to proxy for a firm's technology and skill intensity.

Despite these amendments, the model can give us some insights into which firm characteristics are correlated with services firm productivity. Besides the share of intermediate services in output, we also add several firm-level characteristics as independent variables which have been shown to be correlated with firm-level productivity, including exporting status,[9] foreign ownership status, and skill intensity as proxied by the years of top manager's experience in the sector (in natural logarithms). The summary statistics for services firms can be found in Appendix 6.

The results are shown in Table 4 (column 1). A higher share of intermediate services in output is negatively correlated with output per worker. Focusing on the predictors of labor productivity, the results show that foreign ownership status is positively and strongly associated with labor productivity, while exporting status does not matter, which is surprising given the strong connection between exporting and productivity for manufacturing firms. Finally, a higher skill intensity as proxied by the years of experience of the top manager, is positively correlated with labor productivity.

Table 4: Determinants of Services Firm Productivity, OLS

Dependent Variable: ln*prod*$_{isrt}$	**(1) All**	**(2) UM**	**(3) LM**	**(4) L**
ln*serv_int*$_{isrt}$	–0.4889***	–0.4776***	–0.4602***	–0.5833***
	(0.000)	(0.000)	(0.000)	(0.000)
fdi$_{isrt}$	0.3084***	0.2148***	0.2873***	0.3713***
	(0.000)	(0.001)	(0.000)	(0.000)
exp$_{isrt}$	0.0422	0.0556	–0.0620	0.2476***
	(0.286)	(0.318)	(0.341)	(0.008)
manager$_{isrt}$	0.0691***	0.0638***	0.0452*	0.1062***
	(0.000)	(0.008)	(0.051)	(0.003)
constant	7.2392***	9.3961***	7.2174***	4.7523***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	13,902	4,531	6,681	2,220
R-squared	0.57	0.53	0.52	0.53

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector and year fixed effects.

Columns 2 to 4 replicate the model by income status and finds differences across groupings. It seems that labor productivity of services firms in low-income countries is more sensitive to changes in other firm-level factors. A higher services intensity is most negatively correlated with labor productivity in low-income countries compared to middle-income countries. By contrast, FDI status and a longer experience of the top manager in the sector are more positively associated with labor productivity in low-income countries. Interestingly, exporting only shows a positive correlation with labor productivity for low-income countries which also explains the lack of statistical significance in the overall sample (column 1). There are also slight differences between upper-middle and lower-middle income countries. FDI status matters more strongly for productivity gains in lower-middle income countries. On the other hand, services productivity in upper-middle income countries benefits more strongly from a longer experience of the top manager.

[9] Rather than using direct exports to compute the export dummy, we use total exports as indirect exports (via an intermediary agent) may be more a more common export channel for services firms.

Table 5 replicates the analysis using a services firm's technology intensity as dependent variable. The overall findings from the labor productivity regressions are supported, suggesting that a higher services intensity is negatively correlated with technology intensity, whereas foreign ownership status, managerial experience and now also exporting status show a positive relationship with technology intensity (column 1). Focusing on the determinants by income category in columns 2 to 4 suggets that the negative correlation with services intensity is solely driven by low-income countries. Similarly, managerial experience only matters positively for technology intensity in low-income countries, but not in middle-income countries. In addition, the richer a country the stronger is the role of FDI as predictor for services firm technology intensity. Finally, there seems to be a U-shaped effect of exporting, which matters more strongly for upper-middle and low-income countries compared to lower-middle income countries. In summary, this section suggests that improving the business environment with regards to skills building, trade and investment can boost labor productivity and technology intensity of services firms, and thus magnify the spillover potential of services firms for manufacturing productivity.

Table 5: Determinants of Services Technology Intensity, OLS

Dependent Variable: ln*tech*$_{isrt}$	**(1) All**	**(2) UM**	**(3) LM**	**(4) L**
ln*serv_int*$_{isrt}$	–0.0051***	–0.0045	–0.0032	–0.0136***
	(0.008)	(0.260)	(0.198)	(0.007)
fdi$_{isrt}$	0.1258***	0.1641***	0.1300***	0.0713***
	(0.000)	(0.000)	(0.000)	(0.003)
exp$_{isrt}$	0.1459***	0.1826***	0.1087***	0.1372***
	(0.000)	(0.000)	(0.000)	(0.000)
manager$_{isrt}$	0.0118**	0.0155	0.0056	0.0226**
	(0.011)	(0.109)	(0.377)	(0.018)
constant	–0.1180***	–0.0541*	0.9758***	–0.1624***
	(0.000)	(0.061)	(0.000)	(0.000)
Observations	14,582	5,049	6,789	2,266
R-squared	0.21	0.18	0.21	0.19

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector and year fixed effects.

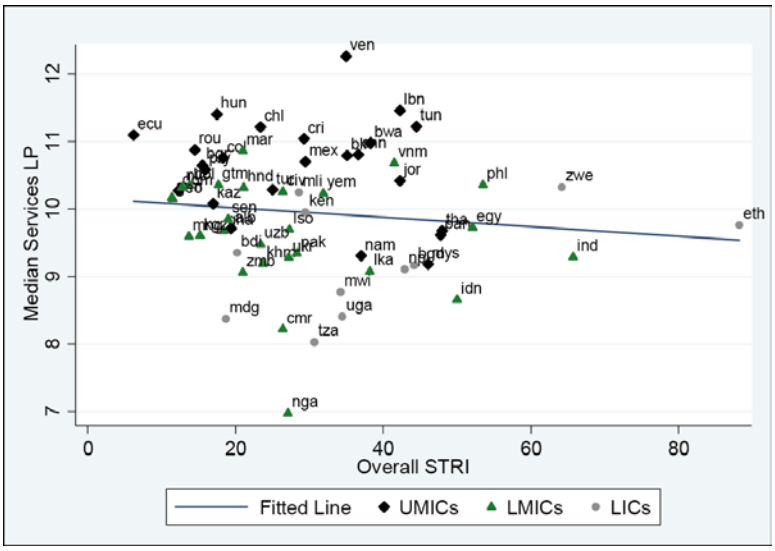
4.4 Can Services Trade Liberalization Increase Spillovers?

In summary, we find that a higher median productivity and technology intensity of services firms in a region is positively associated with manufacturing firm productivity levels. We also showed that several manufacturing firm characteristics increase spillovers, including large firm size, foreign ownership status and exporting status. Due to the positive relationship between services and manufacturing firm productivity, we assessed which firm characteristics determine services firm productivity and technology intensity. We found that foreign ownership status and the top manager's experience are positively associated with services firms' output per worker and technology intensity. Exporting status only shows a positive correlation with technology intensity, but not labor productivity for services firms.

This raises the question of whether policy can influence the spillover potential and ultimately increase manufacturing firm productivity? In particular, we are interested in the role of services trade liberalization in mediating services spillovers.

As a first step, we plot the overall services trade restrictions index on the x-axis against a country's median services output per worker on the y-axis (Figure 4). The graph confirms the hypothesis that a more liberal services trade environment is associated with a higher median labor productivity of services firms in a country. The scatterplot also confirms that countries with higher income levels tend to have a higher median services productivity. The highest median services productivity levels are found in upper-middle income countries. In addition, high services trade restrictiveness is less common for upper-middle income countries.

Figure 4: Overall Services Trade Restrictions Index and Median Services Labor Productivity



Source: Own illustration. Data: Enterprise Surveys. Services labor productivity measured as output per worker. A lower *stri* indicates more services liberalization. UMICs = upper-middle income countries, LMICs = lower-middle income countries, LICs = low-income countries.

Table 6 sheds further light on the question of whether services trade liberalization is beneficial for productivity spillovers from services to manufacturing firms. The findings suggest that higher services trade restrictions in a country – both overall and at the sector level – interact negatively with productivity spillovers, although none of the interaction terms is individually significant. These surprising results could be related to the measure of STRI which does not differentiate between the modes of services supply.[10]

[10] Under the GATS, one can differentiate between four modes of services trade: cross-border trade (mode 1), consumption abroad (mode 2), Commercial presence abroad (mode 3), and presence of natural persons (mode 4). The STRI differentiates between mode 1, mode 3 and mode 4.

Table 6: Productivity Spillovers from Services to Manufacturing Firms and the Role of STRI, OLS

	STRI, All Modes					
Dependent Variable: ln*p$_{isrt}$*	**(1)** ***overall***	**(2)** ***telecom***	**(3)** ***finance***	**(4)** ***transp***	**(5)** ***retail***	**(6)** ***prof***
lnprod_med$_{rt}$	0.3942***	0.4024***	0.4119***	0.2650***	0.3465***	0.3520***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)
*lnprod_med$_{rt}$*AC$_{isrt}$*	–0.0033	–0.0041	–0.0046	–0.0008	–0.0024	–0.0018
	(0.173)	(0.106)	(0.111)	(0.721)	(0.103)	(0.361)
ln*capint$_{isrt}$*	0.2980***	0.2984***	0.2983***	0.2992***	0.2977***	0.2986***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	3.8346***	3.1561***	2.3312***	6.2419***	3.5126***	4.1532***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observation	15,325	15,325	15,325	15,325	15,325	15,325
R–squared	0.48	0.48	0.48	0.48	0.48	0.48
F–test[1)]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. 1) F-test of joint significance between ln*prod_med$_{rt}$* and ln*prod_med$_{rt}$*stri$_c$* (Prob > F). A lower *stri* indicates more services liberalization.

Rerunning the analysis for STRI for mode 1 services only (cross-border trade) shows negative interaction terms, which are statistically significant for STRI in all sectors, but also in finance, transporation and professional services (Table 7, columns 1 to 4). That is, a higher restrictiveness in mode 1 services trade translates into lower productivity spillovers for manufacturing firms. In contrast, less restrictiveness in mode 4 services trade (presence of natural persons) overall and in professional services increases the productivity spillovers overall (columns 5 and 6). In these regressions, however, the spillover variable is no longer significant. Finally, running the analysis with the STRI measures for mode 3 services (commercial presence abroad) shows negative interaction terms which are individually insignificant, but jointly significant with the spillover variable (Appendix 7).

Table 7: Productivity Spillovers from Services to Manufacturing Firms and the Role of STRI, modes 1 and 4, OLS

	STRI, Mode 1				*STRI, Mode 4*	
Dependent Variable: ln*p$_{isrt}$*	**(1)** ***overall***	**(2)** ***finance***	**(3)** ***transp***	**(4)** ***prof***	**(5)** ***overall***	**(6)** ***prof***
lnprod_med$_{rt}$	0.4274***	0.3592***	0.4609***	0.3587***	–0.1288	–0.1288
	(0.000)	(0.000)	(0.000)	(0.000)	(0.456)	(0.456)
*lnprod_med$_{rt}$*AC$_{isrt}$*	–0.0040**	–0.0029*	–0.0059*	–0.0023**	0.0050**	0.0050**
	(0.023)	(0.092)	(0.057)	(0.021)	(0.034)	(0.034)
ln*capint$_{isrt}$*	0.2975***	0.2991***	0.2978***	0.2971***	0.2996***	0.2996***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	5.0125***	6.0387***	1.7671	2.9029***	4.8576***	4.8576***
	(0.000)	(0.000)	(0.150)	(0.000)	(0.000)	(0.000)
Observation	15,325	15,325	15,325	15,325	15,325	15,325
R–squared	0.48	0.48	0.48	0.48	0.48	0.48
F–test[1)]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. 1) F-test of joint significance between ln*prod_med$_{rt}$* and ln*prod_med$_{rt}$*stri$_c$* (Prob > F). A lower *stri* indicates more services liberalization.

Replicating the analysis for our alternative measure of technology spillovers shows no significant results on the individual interaction terms, but the F-tests suggest joint significance between the spillover variable and the interaction term across all specifications. This also holds for the different modes of services supply (results not shown). We conclude that higher services trade restrictiveness reduces productivity spillovers from services firms, except for restrictiveness in mode 4 services, which seems to be beneficial to labor productivity, while its impact on technology spillovers is ambiguous.

The previous analysis examined the effects of services trade liberalization on services firm productivity. The way the estimation equation was specified allowed for direct effects (on services firms in the same sector) and indirect effects (on services firms in other sectors) due to services liberalization. In this section, we test for the direct effects of sectoral services liberalization on the productivity of firms in the same sector. We first narrow down the data sample to the five sectors for which we have country-sector measures of services trade restrictions: telecommunications (ISIC 64), finance (ISIC 66), transportation (ISIC 60-63), retail (ISIC 52) and professional services (ISIC 71-74). In a next step, we add the sectoral measure of services trade restriction, *stri*, as independent variable to the labor productivity regressions.

Table 8: STRI and Services Firm Productivity, OLS

Dependent Variable: ln*prod*$_{isrt}$	**(1) Overall**	**(2) Mode 1**	**(3) Mode 3**	**(4) Mode 4**
stri$_{cs}$	–0.0262***	–0.0263***	–0.0171***	0.0077***
	(0.000)	(0.000)	(0.000)	(0.007)
lnserv_int$_{isrt}$	–0.4256***	–0.3743***	–0.4256***	–0.4143***
	(0.000)	(0.000)	(0.000)	(0.000)
fdi$_{isrt}$	0.3105***	0.0465	0.3105***	–0.1477
	(0.000)	(0.681)	(0.000)	(0.283)
exp$_{isrt}$	0.0497	0.3273**	0.0497	0.4183*
	(0.650)	(0.016)	(0.650)	(0.060)
manager$_{isrt}$	0.1064***	0.0943	0.1064***	0.2011*
	(0.000)	(0.175)	(0.000)	(0.064)
constant	9.7979***	9.0388***	8.7574***	8.0632***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	6,906	1,778	6,906	625
R-squared	0.54	0.56	0.54	0.56

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector and year fixed effects and are clustered at the country-sector level. A lower *stri* indicates more services liberalization.

The results in Table 8 confirm our earlier findings that more services trade liberalization (a lower *stri*) increases the productivity of services firms (column 1). This holds for the overall STRI measure as well as modes 1 and 3 services supply (cross-border trade and commercial presence abroad). By contrast, more restrictions in mode 4 services trade (presence of natural persons) seems to be beneficial to the labor productivity of services firms. Replicating the results using technology intensity as dependent variable in Table 9 mostly confirms those findings. While more services trade liberalization overall, and specifically in mode 3 services, are associated with productivity gains, more liberalization in mode 4 services seems to be correlated with productivity losses of services firms.

Table 9: STRI and Services Technology Intensity, OLS

Dependent Variable: $tech_{isrt}$	(1) Overall	(2) Mode 1	(3) Mode 3	(4) Mode 4
$stri_{cs}$	–0.0052***	–0.0007	–0.0048***	0.0015*
	(0.000)	(0.384)	(0.000)	(0.068)
$lnserv\_int_{isrt}$	–0.0066*	–0.0122	–0.0066*	0.0026
	(0.053)	(0.149)	(0.053)	(0.883)
fdi_{isrt}	0.1279***	0.1822***	0.1279***	0.1092
	(0.000)	(0.000)	(0.000)	(0.181)
exp_{isrt}	0.1010***	0.0750**	0.1010***	0.1213***
	(0.000)	(0.038)	(0.000)	(0.000)
$manager_{isrt}$	0.0118	0.0563	0.0118	0.1582**
	(0.298)	(0.170)	(0.298)	(0.028)
constant	0.0725**	–0.1647	–0.0674**	–0.5595***
	(0.025)	(0.315)	(0.049)	(0.004)
Observations	7,258	1,892	7,258	663
R-squared	0.21	0.27	0.21	0.27

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector and year fixed effects and are clustered at the country-sector level. A lower *stri* indicates more services liberalization.

5. SUMMARY AND CONCLUSIONS

In recent years, several studies have suggested a performance-enhancing effect of services usage within sectors and firms. However, there is still a shortage of studies on the productivity spillovers from services firms to downstream sectors and firms, in particular for low- and middle-income countries. Using a cross-section of more than 38,000 manufacturing and 24,000 services firms in 105 low- and middle-income countries over the period 2010 to 2017 from the World Bank's Enterprise Surveys, this paper focuses on productivity spillovers from services to manufacturing firms, as well as the role of firm characteristics and a country's services liberalization in mediating spillovers.

The paper confirms positive spillovers to manufacturing firms resulting from a higher average regional productivity and technology intensity of services firms, but rejects the existence of spillovers from services firm presence alone. This finding is of high policy relevance, as it suggests that the number of services firms in a region and their share in a region's total output are not sufficient to generate spillovers – what matters is the quality of services firms. This paper assesses two characteristics of services firms that are associated with a higher manufacturing firm productivity, namely their output per worker and technology intensity.

The analysis also shows that the extent of spillovers varies and depends on the characteristics of manufacturing firms (which determine their absorptive capacity), the characteristics of services firms (which determine their spillover potential), and country characteristics, including income status and services trade liberalization efforts. The findings suggest that certain types of manufacturing firms benefit more strongly from productivity and technology spillovers of services firms, in particular large, foreign-owned and exporting manufacturing firms. Manufacturing firms with a larger services intensity, by contrast, have lower spillovers, while skill intensity does not matter.

Regarding the spillover potential of services firms, the results show that foreign ownership status and the top manager's experience in a sector are positively associated with services firms' output per worker and technology intensity. Exporting status only shows a positive correlation with technology intensity, but not labor productivity for services firms. This implies that policies aiming at skills and technological upgrading can not only increase the spillover potential of services firms, but also help manufacturing firms absorb spillovers. In addition, policies facilitating the growth of manufacturing firms can generate higher productivity and technology spillovers.

Country characteristics, including a country's income status, also matter. The results suggest a U-shaped effect for productivity spillovers from services firms, i.e. spillovers are larger in upper-middle and low-income countries than in lower-middle income countries. The results are different for technology spillovers where lower-middle and low-income countries benefit more strongly. Similarly, the results find that labor productivity of services firms in low-income countries is more sensitive FDI status and the experience of the top manager in the sector. In addition, exporting and labor productivity are positively associated in low-income countries only. This implies that policy interventions to improve the productivity of services firms or the absorptive capacity of manufacturing firms have a larger impact in low-income countries.

In a last step, the paper examines whether policy mediates productivity spillovers from services to manufacturing firms in a region. It is possible that reforms in the upstream services sectors translate into higher spillover potential and thus higher actual productivity spillovers. The results suggest indeed that lower regulations in mode 1 services trade (cross-border trade) increase productivity spillovers, whereas a lower restrictiveness in mode 4 services trade (presence of natural persons) seems to reduce them. We also test for the direct link between services liberalization and services firm productivity and find a positive connection overall and for mode 1 and mode 3 (commercial presence abroad) services trade, but not for mode 4 services trade. Linking services restrictiveness to technology intensity of services firms confirms the positive correlation overall and for mode 1 services, as well as the negative association for mode 4 services. In summary, the findings suggest that more liberalization in mode 1 and mode 3 services trade increases spillovers from services firms to manufacturing firms via a productivity-enhancing effect in the services sectors.

While there has been substantial empirical work in the area of services spillovers, much promising ground for research remains. Our findings suggest two areas in particular. First, this paper highlights the importance of firm heterogeneity in mediating spillovers, both from the perspective of manufacturing firms and services firms. Improving our understanding of the underlying transmission channels of services spillovers can help guide policies to strengthen services firms and promote spillovers to manufacturing firms.

Finally, research should focus more on understanding the services spillover potential, particularly in the context of global value chain dynamics. Recent research suggests that services play an important role in economic upgrading within global value chains, as they add value to a given unit of output. In the apparel global value chain, for instance, countries can increase their value added by moving from the lower value-added cut, make and trim segment into original design manufacturing or original brand manufacturing. This is particularly important for small and low-income countries that rely increasingly on global value chain participation.

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APPENDIX 1: NUMBER OF FIRMS BY COUNTRY AND SECTOR

Country	Year	Total	Mfg	%	Services	%
Afghanistan	2014	337	139	41.2%	198	58.8%
Albania	2013	292	111	38.0%	181	62.0%
Angola	2010	195	78	40.0%	117	60.0%
Argentina	2017	931	650	69.8%	281	30.2%
Armenia	2013	297	111	37.4%	186	62.6%
Azerbaijan	2013	320	121	37.8%	199	62.2%
Bangladesh	2013	1,360	1,179	86.7%	181	13.3%
Belarus	2013	337	117	34.7%	220	65.3%
Belize	2010	111	72	64.9%	39	35.1%
Benin	2016	134	70	52.2%	64	47.8%
Bhutan	2015	144	83	57.6%	61	42.4%
Bolivia	2017	327	118	36.1%	209	63.9%
Bosnia and Herzegovina	2013	324	117	36.1%	207	63.9%
Botswana	2010	226	85	37.6%	141	62.4%
Bulgaria	2013	251	111	44.2%	140	55.8%
Burundi	2014	127	60	47.2%	67	52.8%
Cambodia	2016	294	135	45.9%	159	54.1%
Cameroon	2016	309	102	33.0%	207	67.0%
Central African Republic	2011	131	37	28.2%	94	71.8%
Chile	2010	1,012	780	77.1%	232	22.9%
People’s Republic of China	2012	2,406	1,686	70.1%	720	29.9%
Colombia	2010	917	708	77.2%	209	22.8%
Costa Rica	2010	473	322	68.1%	151	31.9%
Côte d'Ivoire	2016	325	106	32.6%	219	67.4%
Dem. Rep. Congo	2013	466	241	51.7%	225	48.3%
Djibouti	2013	216	62	28.7%	154	71.3%
Dominican Republic	2016	326	111	34.0%	215	66.0%
Ecuador	2017	323	103	31.9%	220	68.1%
Egypt	2016	1,613	1,173	72.7%	440	27.3%
El Salvador	2016	678	405	59.7%	273	40.3%
Ethiopia	2015	723	383	53.0%	340	47.0%
Georgia	2013	302	111	36.8%	191	63.2%
Ghana	2013	631	377	59.7%	254	40.3%
Guatemala	2013	559	356	63.7%	203	36.3%
Guinea	2010	125	27	21.6%	98	78.4%
Guyana	2016	141	71	50.4%	70	49.6%
Honduras	2010	303	92	30.4%	211	69.6%
India	2016	8,686	7,163	82.5%	1,523	17.5%
Indonesia	2014	1,251	1,069	85.5%	182	14.5%

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Appendix 1 *table continued*

Country	Year	Total	Mfg	%	Services	%
Iraq	2015	618	475	76.9%	143	23.1%
Jamaica	2011	336	121	36.0%	215	64.0%
Jordan	2010	531	335	63.1%	196	36.9%
Kazakhstan	2013	523	202	38.6%	321	61.4%
Kenya	2013	717	414	57.7%	303	42.3%
Kosovo	2013	170	71	41.8%	99	58.2%
Kyrgyz Republic	2013	207	104	50.2%	103	49.8%
Lao People's Democratic Republic	2013	286	110	38.5%	176	61.5%
Latvia	2016	293	117	39.9%	176	60.1%
Lebanon	2013	489	239	48.9%	250	51.1%
Lesotho	2013	134	76	56.7%	58	43.3%
Liberia	2016	131	75	57.3%	56	42.7%
Lithuania	2017	233	107	45.9%	126	54.1%
Macedonia	2013	288	125	43.4%	163	56.6%
Madagascar	2013	358	264	73.7%	94	26.3%
Malawi	2014	455	171	37.6%	284	62.4%
Malaysia	2015	928	585	63.0%	343	37.0%
Mali	2016	166	99	59.6%	67	40.4%
Mauritania	2014	129	52	40.3%	77	59.7%
Mexico	2010	1,440	1,171	81.3%	269	18.7%
Moldova	2013	310	110	35.5%	200	64.5%
Mongolia	2013	279	115	41.2%	164	58.8%
Montenegro	2013	129	50	38.8%	79	61.2%
Morocco	2013	339	187	55.2%	152	44.8%
Myanmar	2016	536	367	68.5%	169	31.5%
Namibia	2014	456	181	39.7%	275	60.3%
Nepal	2013	413	242	58.6%	171	41.4%
Nicaragua	2016	281	110	39.1%	171	60.9%
Niger	2017	134	41	30.6%	93	69.4%
Nigeria	2014	2,377	1,427	60.0%	950	40.0%
Pakistan	2013	1,188	1,086	91.4%	102	8.6%
Panama	2010	331	119	36.0%	212	64.0%
Paraguay	2017	334	117	35.0%	217	65.0%
Peru	2017	932	551	59.1%	381	40.9%
Philippines	2015	1,271	1,037	81.6%	234	18.4%
Romania	2013	468	175	37.4%	293	62.6%
Russian Federation	2012	3,624	1,380	38.1%	2,244	61.9%
Rwanda	2011	178	81	45.5%	97	54.5%
Senegal	2014	450	249	55.3%	201	44.7%
Serbia	2013	325	118	36.3%	207	63.7%

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Appendix 1 *table continued*

Country	Year	Total	Mfg	%	Services	%
Sierra Leone	2017	131	77	58.8%	54	41.2%
Solomon Islands	2015	133	42	31.6%	91	68.4%
South Sudan	2014	588	89	15.1%	499	84.9%
Sri Lanka	2011	562	362	64.4%	200	35.6%
St. Lucia	2010	112	63	56.3%	49	43.8%
Vincent and the Grenadines	2010	128	49	38.3%	79	61.7%
Sudan	2014	606	84	13.9%	522	86.1%
Suriname	2010	126	75	59.5%	51	40.5%
Swaziland	2016	131	75	57.3%	56	42.7%
Tajikistan	2013	284	122	43.0%	162	57.0%
Tanzania	2013	648	440	67.9%	208	32.1%
Thailand	2016	956	726	75.9%	230	24.1%
Timor-Leste	2015	100	60	60.0%	40	40.0%
Togo	2016	117	45	38.5%	72	61.5%
Tunisia	2013	536	329	61.4%	207	38.6%
Turkey	2015	1,911	1,139	59.6%	772	40.4%
Uganda	2013	650	378	58.2%	272	41.8%
Ukraine	2013	951	737	77.5%	214	22.5%
Uruguay	2017	333	114	34.2%	219	65.8%
Uzbekistan	2013	332	133	40.1%	199	59.9%
Venezuela	2010	287	85	29.6%	202	70.4%
Viet Nam	2015	906	694	76.6%	212	23.4%
West Bank and Gaza	2013	384	158	41.1%	226	58.9%
Yemen	2013	302	117	38.7%	185	61.3%
Zambia	2013	578	364	63.0%	214	37.0%
Zimbabwe	2016	529	289	54.6%	240	45.4%
Total		63,031	38,344	60.8%	24,687	39.2%

APPENDIX 2: NUMBER OF MANUFACTURING FIRMS BY SECTOR

ISIC Rev. 3	Sector Name	No. of Firms	%
15	Manufacture of Food Products and Beverages	7,147	18.6%
16	Manufacture of Tobacco Products	193	0.5%
17	Manufacture of Textiles	2,428	6.3%
18	Manufacture of Wearing Apparel; Dressing and Dyeing of Fur	3,791	9.9%
19	Tanning and Dressing of Leather; Manufacture of Luggage, Handbags, Saddlery, Harness and Footwear	816	2.1%
20	Manufacture of Wood and of Products of Wood and Cork, except Furniture	1,138	3.0%
21	Manufacture of Paper and Paper Products	589	1.5%
22	Publishing, Printing and Reproduction of Recorded Media	1,615	4.2%
23	Manufacture of Coke, Refined Petroleum Products and Nuclear Fuel	132	0.3%
24	Manufacture of Chemicals and Chemical Products	2,725	7.1%
25	Manufacture of Rubber and Plastics Products	2,795	7.3%
26	Manufacture of Other Non-Metallic Mineral Products	2,955	7.7%
27	Manufacture of Basic Metals	1,380	3.6%
28	Manufacture of Fabricated Metal Products, except Machinery and Equipment	3,271	8.5%
29	Manufacture of Machinery and Equipment N.E.C.	2,151	5.6%
30	Manufacture of Office, Accounting and Computing Machinery	20	0.1%
31	Manufacture of Electrical Machinery and Apparatus N.E.C.	1,399	3.6%
32	Manufacture of Radio, Television and Communication Equipment and Apparatus	200	0.5%
33	Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks	296	0.8%
34	Manufacture of Motor Vehicles, Trailers and Semi-Trailers	940	2.5%
35	Manufacture of Other Transport Equipment	143	0.4%
36	Manufacture of Furniture; Manufacturing N.E.C.	1996	5.2%
	Undefined*	224	0.6%
	Total	38,344	100.0%

Note: ISIC classification based on most important product of firm. *Some firms were classified Manufacturing in the Enterprise Surveys, but their largest product was a service.

APPENDIX 3: SUMMARY STATISTICS, MANUFACTURING FIRMS

Variable	Obs	Mean	Std. Dev.	Min	Max
lnlp_{isrt}	26,033	9.108	1.418	0.131	16.684
ln$capint_{isrt}$	20,719	8.182	1.960	–8.814	18.745
$serv\_no_{rt}$	36,758	31.063	17.727	0.000	97.468
$serv\_out_{rt}$	36,755	26.118	23.553	0.000	99.980
ln$prod_med_{rt}$	35,342	9.760	1.109	5.472	14.706
$tech\_med_{rt}$	36,755	0.061	0.237	0.000	2.000
ln$serv_int_{isrt}$	24,244	0.810	2.731	–11.220	11.273
$large_{isrt}$	35,619	0.252	0.434	0.000	1.000
fdi_{isrt}	35,601	0.096	0.295	0.000	1.000
exp_{isrt}	35,080	0.187	0.390	0.000	1.000
shs_{isrt}	28,432	70.651	29.963	0.000	100.000

APPENDIX 4: SERVICES PRESENCE IN A REGION AND MANUFACTURING FIRM PRODUCTIVITY, OLS

Dependent Variable: lnlp_{isrt}	*serv_no*		*serv_out*	
	(1)	**(2)**	**(3)**	**(4)**
$spill_{rt}$	–0.0010	0.0041	–0.0022	0.0000
	(0.777)	(0.219)	(0.102)	(0.996)
$lncapint_{isrt}$		0.3014***		0.3015***
		(0.000)		(0.000)
constant	9.3451	7.5690***	10.2647***	7.6401***
	(.)	(0.000)	(0.000)	(0.000)
Observations	25,179	17,839	25,176	17,836
R-squared	0.35	0.50	0.35	0.50

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level.

APPENDIX 5: SERVICES PRODUCTIVITY AND TECHNOLOGY INTENSITY IN A REGION AND MANUFACTURING FIRM PRODUCTIVITY, BY INCOME, OLS

Dependent Variable: lnp_{isrt}	ln*prod_med*			*tech_med*		
	(1)	(2)	(3)	(4)	(5)	(6)
	UM	LM	L	UM	LM	L
$spill_{rt}$	0.3004***	0.2091***	0.3338***	0.3520***	0.5543***	0.4927**
	(0.000)	(0.000)	(0.001)	(0.006)	(0.000)	(0.031)
ln$capint_{isrt}$	0.2749***	0.2989***	0.3157***	0.2842***	0.3049***	0.3191***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	3.5587***	4.5128***	2.3450***	7.1043***	6.6121***	6.2758***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)
Observations	6,041	8,772	2,687	6,041	8,789	2,687
R-squared	0.38	0.41	0.52	0.37	0.41	0.51

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. UM = upper-middle, LM = lower-middle, L = low.

APPENDIX 6: SUMMARY STATISTICS, SERVICES FIRMS

Variable	Obs	Mean	Std. Dev.	Min	Max
ln$prod_{isrt}$	17,536	9.893	1.774	0.866	20.261
ln$serv_int_{isrt}$	14,960	–4.736	1.960	–19.773	5.886
$tech_{isrt}$	22,169	1.293	1.035	0.000	4.000
ln$empl_{isrt}$	21,975	2.974	1.275	0.000	14.511
fdi_{isrt}	21,396	0.100	0.300	0.000	1.000
exp_{isrt}	22,169	0.105	0.307	0.000	1.000
$manager_{isrt}$	20,761	2.548	0.764	0.000	4.970

APPENDIX 7: PRODUCTIVITY SPILLOVERS FROM SERVICES TO MANUFACTURING FIRMS AND THE ROLE OF STRI, MODE 3, OLS

	STRI, Mode 3					
Dependent Variable: ln*lp$_{isrt}$*	**(1)** ***overall***	**(2)** ***telecom***	**(3)** ***finance***	**(4)** ***transp***	**(5)** ***retail***	**(6)** ***prof***
lnprod_med$_{rt}$	0.3660***	0.4024***	0.3883***	0.2476***	0.3465***	0.3081***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
ln*prod_med$_{rt}$*stri$_c$*	–0.0027	–0.0041	–0.0039	–0.0004	–0.0024	–0.0011
	(0.205)	(0.106)	(0.128)	(0.823)	(0.103)	(0.374)
ln*capint$_{isrt}$*	0.2981***	0.2984***	0.2985***	0.2993***	0.2977***	0.2985***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
constant	2.6121***	3.1561***	3.9556***	6.4076***	3.5126***	4.4366***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	15,325	15,325	15,325	15,325	15,325	15,325
R-squared	0.48	0.48	0.48	0.48	0.48	0.48
F-test[1)]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: p*<0.1, p**<0.05, p***<0.01 (p-values in parentheses). All regressions include country-sector, and year fixed effects and are clustered at the subnational level. 1) F-test of joint significance between ln*prod_med$_{rt}$* and ln*prod_med$_{rt}$*stri$_c$* (Prob > F). A lower *stri* indicates more services liberalization.