

# Integration in Global Value Chains— The Role of Service Inputs

Evidence from India

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## Abstract

This paper investigates the relationship between the use of service inputs and integration in global value chains. Using macro and detailed firm-level data (for 1990–2017), the study documents the extent of India's integration into global value chains. Older, larger, and more productive firms and firms with a higher leverage ratio are more likely to be deeply integrated into global value chains. Firms in the information technology services and electronics industries are more deeply integrated into global value chains,

compared with textiles. Services are the engine for many global value chain industries as they help coordinate the different stages of production across geographical locations. The findings suggest that both the intensity of service usage as well as the composition or type of service used are important. Firms using service inputs, particularly complex services and information technology and information technology–enabling services intensively are typically more deeply integrated into global value chains.

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# Integration in Global Value Chains - The Role of Service Inputs: Evidence from India\*

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## 1. Introduction

Global value chains (GVCs) have become one of the defining characteristics of today's patterns of international trade and production. Services have a prominent place in GVCs as they provide a "dual" function, namely as an intermediate input in production as well as coordination facilitator. In the "coordination role," they "glue" together the different stages of production across countries and allow companies to specialize further and coordinate production and trade in GVCs. Ever since the early work by Francois (1990a, 1990b) and Jones and Kierzkowski (1990), the role of services in the economy and international trade has been emphasized. With the rapid expansion of supply chain networks in recent years, services such as transport, logistics and supply chain services and ICT services have become crucial for coordinating the production spread across geographical boundaries.

Although the growth of GVC trade globally was mainly found in machinery, electronics and transportation to begin with, value addition in the services sectors has also now become increasingly fragmented and organized across borders. Improvements in transport, digital infrastructure and the dismantling of existing trade barriers in goods and services have greatly contributed to the expanding reach of GVCs in all sectors. Moreover, the fragmentation of manufacturing production has also been associated with increased outsourcing activities of not only manufacturing tasks but also services. The back office and ICT services of several EU and US firms is now done in India. Such services linkages, including consultancy services, financial services, maintenance, and repair services, are essential.

As companies specialize and grow, they tend to dedicate even more time to the coordination and organization of their core business (see among others Antràs and Chor 2012). Miroudot and Cadestin (2017) estimate that service inputs, whether domestic or foreign sourced, account for about 37 percent of the value of manufacturing exports. This number increases substantially to 53 percent when adding service activities that take place within manufacturing firms. Facilitating provision of services and thereby increasing GVC participation through backward linkages enables firms, particularly downstream manufacturing firms, to access a greater variety and quality of services at competitive prices, which in turn improves their participation in GVCs and overall productivity.

Hence, the role of services as input into production is substantial. They are the engine for many firms to integrate into GVCs. Transport, logistics, ICT services, marketing, consultancy and professional services play an important coordinating role in GVCs. Empirical evidence suggests that effective provision of services is important for downstream firm performance, including in India (Arnold et al., 2015; Arnold et al., 2011) and that imported services contribute to the export intensity of manufacturing in India (Goldar et.al 2018). Effective provision of high-quality services through removing policy barriers related to supply of services; strengthening the institutional framework and investing in human capital will support the integration of India and other developing countries into GVCs and help them reap the associated economic benefits of specialization, scale and productivity growth.

This paper explores the relationship between the use of service inputs and GVC participation and contributes to the emerging empirical literature in this area. India provides an interesting setting to study this as a fast-emerging economy where the services sector plays an important role. We document the extent of integration of India in global value chains using both macro and micro firm-level data (for the

period 1990-2017). The study finds that access to and use of service inputs seems to be an important driver for GVC integration. The depth of GVC integration depends on the intensity of services inputs. Firms which are highly productive, larger in size, pay a higher wage per value added, have a higher leverage ratio and are older are more likely to be more deeply integrated into GVCs. Firms with low service input intensities are unlikely to be integrated in GVCs. If firms not participating in GVCs increase their service input intensity, the likelihood that they begin participating in GVCs increases substantially. The probability to integrate at different levels (limited, low, medium, high) increases with the service input intensity. Moreover, the composition of services matters for GVC integration. Indian firms using complex services and IT and IT-enabling services are typically more deeply integrated into GVCs.

This paper is structured as follows. Section 2 provides an overview of the extent of India's integration in GVCs using macro data. In section 3, we describe our data and the empirical approach to analyze the relationship between GVC participation and service input use at the firm level. Section 4 presents descriptive analysis on GVC integration and service input use by firms. Section 5 presents the results of our estimation on the probability of integrating into GVCs in any mode and service input usage. Section 6 concludes.

## 2. Background

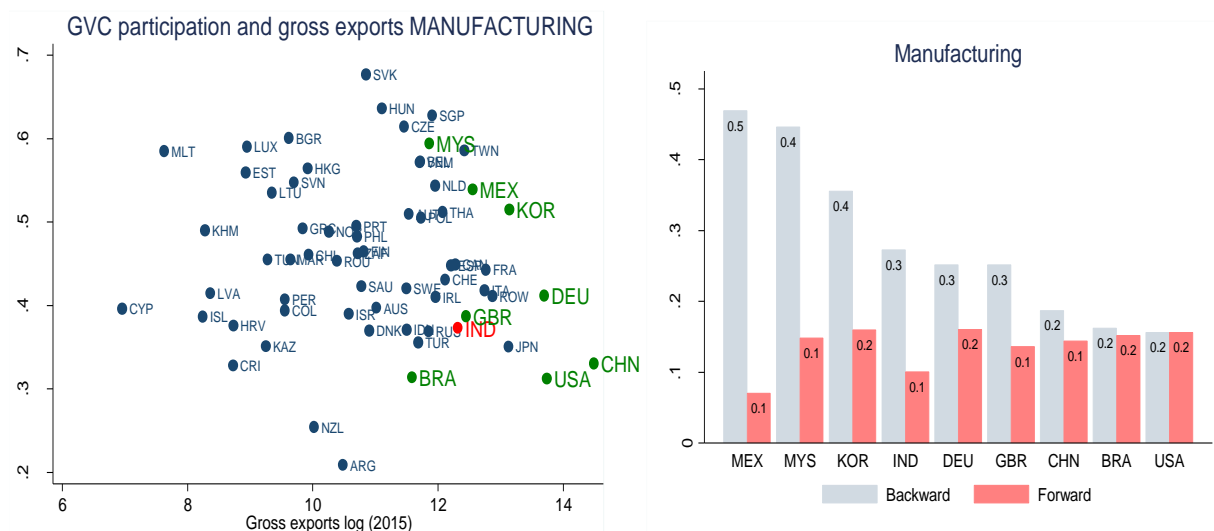
The GVC participation index as proposed by Koopman et al. (2014; 2010) and subsequently used in empirical studies is used to measure the GVC participation of India in comparison to other economies. The cross-country data used to construct the index is from the Trade in Value Added and exports database of OECD. The participation index considers two sides of GVC -backward participation or the 'sourcing' side and forward participation or the 'supply' side. GVC backward participation captures the foreign inputs a country sources into its production process for exports and is expressed as a ratio of foreign value added in gross exports to gross exports. The GVC forward participation captures the domestic inputs a country produces and used in its own production processes and exports, which are in turn not fully absorbed in the importing country but are embodied in the exports of the importing countries. This is expressed as a ratio of domestic value added in third country exports to gross exports. Countries place themselves naturally across these two types of GVC participation. For instance, countries with greater levels of natural resources are often positioned upstream in GVCs and are likely to develop strong forward linkages as input providers. Countries with larger market sizes are less likely to import intermediate goods and services because of their capacity to produce the same, while smaller countries that lack market size usually have higher backward participation rates. Similarly, countries with an abundance of low-skilled labor generally have higher backward GVC participation for producing low-skill-intense manufacturing (and services) activities. See World Bank (2020) for a more in-depth exposition.

India's participation in manufacturing GVCs is lower than several countries such as Mexico, Malaysia, Vietnam, the Republic of Korea, Germany, and others. The left panel of Figure 1 shows the GVC participation in manufacturing on the y-axis, and the scale of exports in natural log scale (of million dollars) on the x-axis. The extent of GVC trade by a country is determined both by the intensity or participation index as well as by the scale of participation. While India has a slightly higher manufacturing GVC participation index compared to China and the United States, the two countries participate in GVCs at a

much larger volume, as is evidenced by the value of their gross exports. The manufacturing exports of China are almost nine times India's exports while those of the United States are over four times India's exports. The right panel of the Figure 1 breaks down the participation index into forward and backward participation. The forward participation of India in manufacturing GVCs is lower than all comparator countries with the exception of Mexico (right panel of Figure 1). Manufacturing inputs from India are not used much by countries in their production processes and exports.

The GVC participation of India in services is lower than that of Korea, Malaysia, the United Kingdom, and Germany (left panel of Figure 2). While this may seem surprising at first, given the importance of services exports in India's exports basket, the decomposition of GVC participation into forward and backward participation sheds some light on this (right panel of Figure 2).<sup>1</sup> The high GVC participation in services of countries such as Korea and Malaysia is explained by their relatively high backward participation, i.e., the use of imported inputs in their service exports. On the other hand, the forward GVC participation in India is higher than most comparator countries with the exception of the United Kingdom, the United States and Germany. This relatively high forward participation in services GVCs is because of the use of Indian services including IT and back office services in exports of third countries. Figure 3 depicts the GVC participation (backward and forward) of the IT and information services industry. India's specialization in these IT and information services explains to some extent India's relatively higher forward linkages.

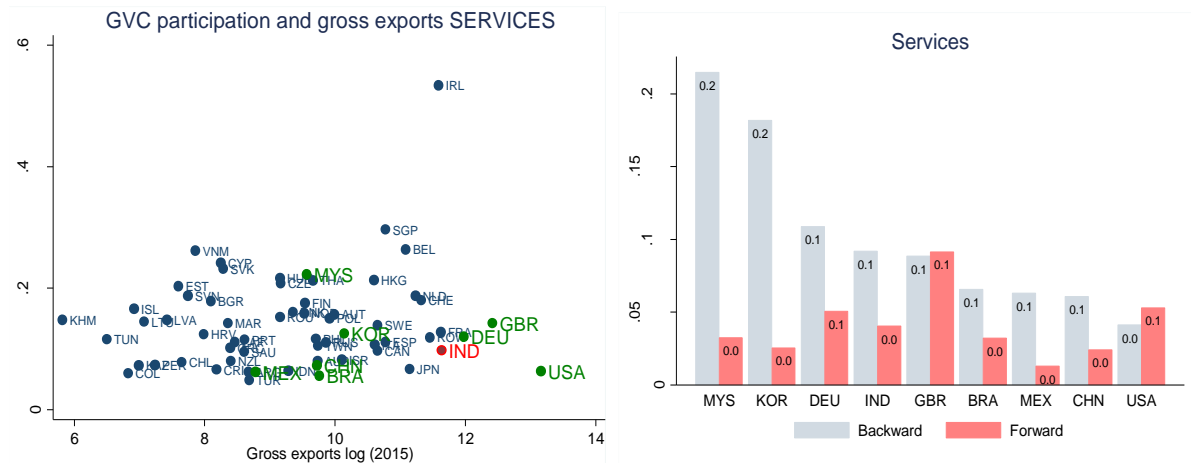
Figure 1: Manufacturing GVC participation, Gross Exports and Manufacturing GVC participation by Type



Source: OECD; own calculations

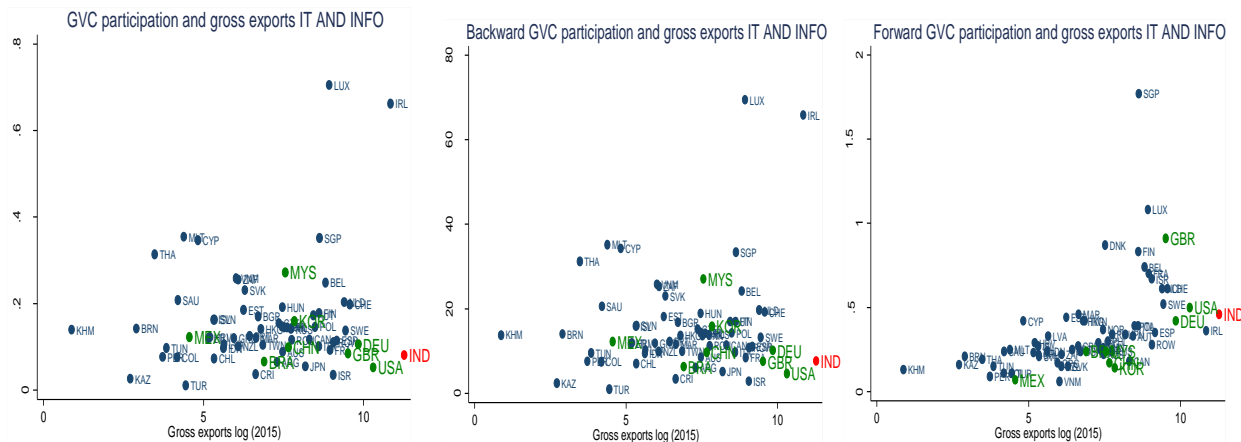
<sup>1</sup> Business services, particularly IT and other information exports constitute a large share of India's export basket (Annex **Error! Reference source not found.**). Business services includes distribution, transport, accommodation, IT-related services, financial services, real estate and other business services such as administration services. Over 40 percent of India's total gross exports takes place in business services, with IT and other information services accounting for the bulk of the exports. The share of business service exports in total exports is around 46 percent when measured in value-added terms. The IT and information services sector constitute around 22 percent of India's value-added exports. Value-added shares of business services exports are higher than observed in gross exports of services, which is in line with worldwide patterns of value-added trade. This is because services are an important input provider used by downstream industries. Services are often domestically produced and then exported indirectly into other goods (or services) at the final stages of the value chain or exported as a final good.

Figure 2: Services GVC participation, Gross Exports and Services GVC participation by Type



Source: OECD; own calculations

Figure 3: GVC Participation for IT and Information Services



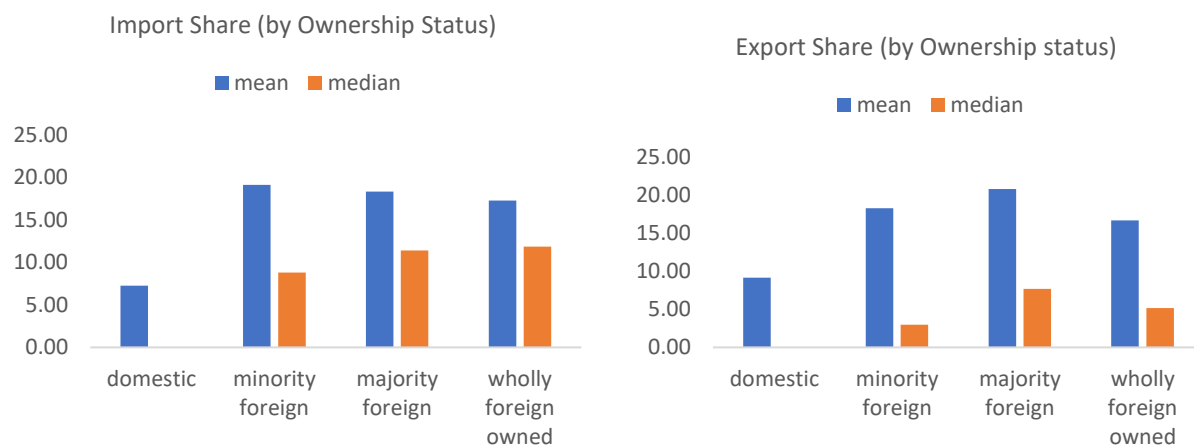
Source: OECD TiVA, Own calculations

Outward-oriented economic reforms that took place in India during the 1990s increased service imports and helped firms access the best available services inputs abroad. India eased several equity FDI restrictions in manufacturing and services. Backward GVC participation is positively associated with FDI. This is one of the conclusions that emerges from the World Development Report (World Bank 2020). Generally, inward FDI is accompanied by knowledge spill-overs and this facilitates participation in GVCs (where new knowledge is acquired). FDI also allows for upgrading of existing activities in GVCs. As can be seen in Figure 4, firms that have foreign ownership import a higher share of their inputs and export a higher share of their output than wholly domestic owned firms. While foreign ownership restrictions have been eliminated in several sectors over the years, they remain important for banking, insurance, retail

distribution, and rail transport services.<sup>2</sup> In line with many OECD countries, India has reformed its manufacturing sectors to allow for more FDI, but restrictions on foreign investments in services have remained relatively high compared to the OECD average (OECD Service Trade Restrictiveness Index).<sup>3</sup>

The liberalization of trade and FDI increased the imports of services by the manufacturing sector. The import service intensity increased from around 5 percent in 1990 up to a high of 21 percent in 2017. Imports became particularly important for the Automotive and Electronics sectors, as can be seen in the right panel of Figure 5. In 2017, imports constituted nearly one-third of all services used in the electronics industry and more than a quarter of all services used in the automobile industry. These two industries have driven a large part of the upward trend in service imports in manufacturing. In Europe, Transport equipment is also a high user of imported services, in addition to Textiles and Coke and Chemicals (Veugelers, et al. 2017). Textiles firms in India on the other hand, import relatively few services compared to other sectors.

Figure 4: Imports and Exports by Domestic Firms and Foreign owned Firms



Source: Prowess; Own calculations

The general trend across the world is that GVC trade increased rapidly until 2008 and has been declining since (World Bank 2020; Boris and Mancini 2019). Several macroeconomic reasons have been put forward to explain this. such as, lower output growth across the world, a plateau effect of the extent to which production chains can be broken up, the decelerating impact of China and Eastern European countries for

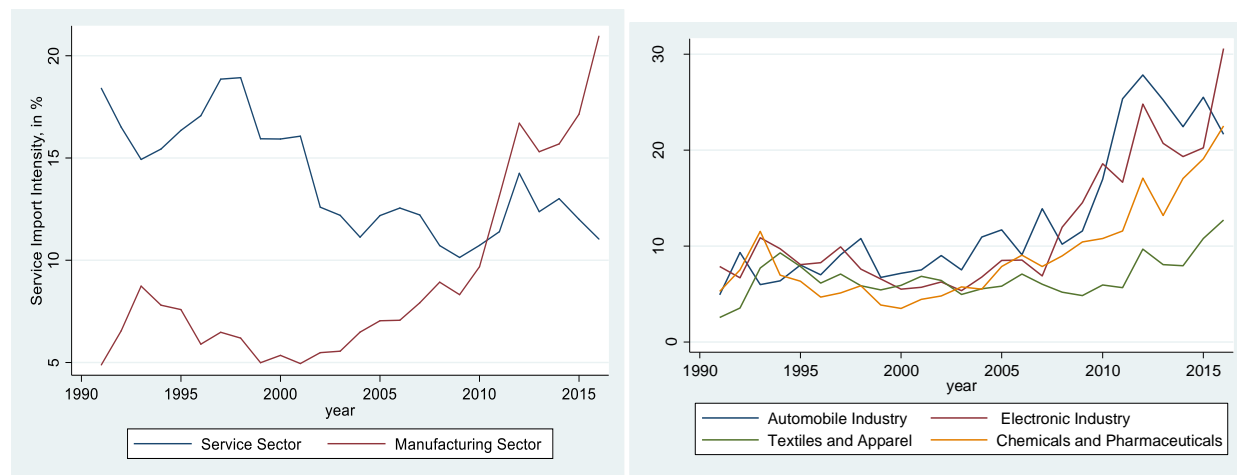
<sup>2</sup> However, foreign entry is also limited by other measures which affect foreign investors. For example, there are limits/conditions to the proportion of shares that can be acquired by foreign investors in publicly controlled firms. Also, there are specific requirements for cross-border merger conditions in several sectors. Moreover, in several sectors, there are residency requirements for at least one member of the board and the manager.

<sup>3</sup> As per the OECD Services Trade Restrictiveness Index, India is relatively restricted in services trade compared to other OECD and emerging economies. FDI restrictions in services in India are mainly related to equity restrictions, particularly for professional and business services, such as legal services, accounting services, real estate services, and insurance services. Several other services sectors still have some equity restrictions in place, such as retail, media services, as well as engineering and financial services. For all the services sectors in India, limitations on foreign entry, remain significantly higher than the OECD average. The sectors for which foreign entry is still somewhat burdensome include accounting, architecture; legal services; telecommunication; all types of transport services; logistics services; courier (due to postal services limitations); commercial banking; and insurance. Transparency-related barriers in services are the third most important category that explain India's relatively high STRIs.



outsourcing destinations, as well as structural factors such as a lower intense relationship between trade and output itself (Timmer et al. 2016; Constantinescu et al. 2015).

Figure 5: Increased services import (input) intensity in India after reforms took place (1990-2017)



Source: Prowess; Own calculations. Note: Service import input intensity is measured as share of imported services on total service inputs

### 3. Data and Empirical Strategy at the Firm Level

To systematically investigate the link between the use of service inputs in the production and a firms' involvement in GVCs, we use detailed firm-level information from the Prowess database collected by the Centre for the Monitoring of the Indian Economy (CMIE). Prowess is a panel of large and medium Indian firms and has information primarily from income statements and annual reports of publicly listed companies in India. We use data from 1990 to 2017. This data set has been used in several papers (see Goldberg et al., 2010a, 2010b) and covers approximately around 70 percent of economic activity in India's formal industrial sector. Besides financial information for each firm, the data contains information on trade activities (exports and imports of goods and services), ownership, revenue, expenditure on various inputs including the different service inputs. The wage bill is measured in relative to the size of a firm. Access to finance is proxied by financial leverage measured as the ratio of external liabilities to equity. Productivity is estimated using Akerberg, Caves and Frazer (2015). Table 1 reports average values for some key variables.

Table 1: Summary Statistics

Variable	Average	Unit
Output	2.157	in million Indian Rupees (logged and deflated)
Wage	0.544	in million Indian Rupees (logged and deflated)
Age	24.839	years
Leverage	1.473	liabilities to equity ratio
Productivity	0.002	total factor productivity
Service Intensity	15.230	relative to total expenditures
IT related service intensity	1.360	relative to total expenditures
Complex service inputs	6.590	relative to total expenditures

### ***Identifying the extent of firm integration in GVCs***

The detailed firm-level information allows us to measure the depth of GVC integration. A firm's involvement in GVCs is identified by looking at the intensity of a firm's internationalization strategy as reflected by how many international activities they use in combination, similar to the definition of Veugelers et al. (2013). The identification is based on three criteria: (1) whether a firm imports at least one-third of its total intermediate inputs (intensive importer);<sup>4</sup> (2) whether a firm exports at least two-thirds of total output (intensive exporter); and (3) whether the firm is majority foreign owned or has a majority stake in companies abroad, or belongs to an international oriented business group, i.e., total exports of the group is greater than two-thirds of total output or total imported inputs of the group is greater than one-third of total inputs (has access to international networks).

Several Indian firms belong to international business groups.<sup>5</sup> Within such business groups, technological transfers and knowledge spill-overs facilitate innovation activities, particularly if they also operate internationally. While remaining an independent enterprise, member firms of business groups have several horizontal connections such as cross-shareholding, interlocking directorates and social ties, and vertical connections through shared ownership and control. Members in such business groups are usually more deeply connected via regional or global value chains than members outside the group. Even if a firm in a business group exports or imports a small share directly, it may do so much more intensively indirectly at arm's length. Often firms form a conglomerate in which one member is a trade agency through which the firms in the respective group take part in the international market.<sup>6</sup>

Table 2 provides details on the definitions and identification strategies to categorize firms based on the depth of their GVC integration. We follow Veugelers et al (2013) and Gereffi and Fernances-Stark (2016) to define the categories and threshold values. If a firm is purely domestically owned and does not engage in exporting or importing activities, it is considered as a firm not participating in a GVC. If a firm exports only a small share of its output (exports < 2/3 of output), its intermediated imports account only for a limited fraction of total inputs (intermediate imports < 1/3 inputs) or if the firm has only limited linkages to international networks, it is defined as a firm with very low/limited access to GVCs. Firms that fulfill one of these three criteria (intensively exporting, intensively importing or being well linked internationally) are considered to be integrated into GVCs at a low depth (single mode). Firms that fulfill two of these three conditions are regarded as participating in GVCs at an intermediate depth (dual mode). Firms that export intensively, import intensively and have well established global linkages are considered as highly integrated into GVCs (triple mode of GVC integration). This implies that foreign content is used in the production, management linkages are established, and the majority of output is produced for the foreign market.

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<sup>4</sup> Intermediate inputs include material inputs and as well service inputs.

<sup>5</sup> A business group is defined by promoter stake holding, equity ownership holding of a particular individual or family or management control. However, one should note that there is no strict rule to classify a business group.

<sup>6</sup> A trade agency is defined as firm operating in the wholesale and retail sector (NIC code 45, 46 and 47) and exports more than 80 percent of its sales.

Table2: Overview and Identification of GVC modes for Indian Firms in 2015

<b>Mode of participation</b>	<b>Description</b>	<b>Identification</b>	<b>Share of firms</b>
High / Triple	Domestic or foreign firms that are linked to GVCs with high Import-Content-of-Export (ICE) and also developed international production networks (high level of inter firm-linkages).	The firm needs to fulfil all three requirements: (1) Total value of imported inputs > 1/3 of total inputs, (2) the firm exports > 2/3 of total sales and (3) is majority foreign owned, has a majority stakes in companies abroad, or belongs to an international orientated business group (total exports of the group > 2/3 of total output or total imported inputs of the group >1/3 of total inputs).	1.64%
Intermediate/ Dual	Domestic or foreign firms that are actively part of GVC via trade linkages. These firms have a significantly high Import-Content-of-Export (ICE) or have established inter-firm linkages via investment activities.	The firm needs to fulfil two out of the three requirements: (1) Export share of total sales > 2/3 (2) Total value of imported > 1/3 of total production costs. (3) majority foreign ownership, majority stakes in companies abroad, or belonging to an international orientated business group (total exports of the group > 2/3 of total output or total imported inputs of the group >1/3 of total inputs)	6.04%
Low/ Single	Domestic or foreign firms whose engagement in GVCs is limited to a single internationalization mode.	The firm needs to fulfil one out of the three requirements: (1) Export share of total sales > 2/3 (2) Total value of imported inputs > 1/3 of total input cost (3) majority foreign ownership, majority stakes in companies abroad, or belonging to an international orientated business group (total exports of the group > 2/3 of total output or total imported inputs of the group >1/3 of total inputs)	23.18%
Very Low/ Limited	Domestic or foreign firms whose engagement in GVCs is limited in terms of intensity with respect to exporting, importing, inter-firm linkages. These firms with are mainly orientated towards the domestic market.	The firm exports share is < 2/3, imported inputs < 1/3 and it has no majority foreign ownership or majority stakes in companies abroad and no international orientated business group linkages (total exports of the group < 2/3 of total output or total imported inputs of the group < 1/3 of total inputs)	32.45%
No	Domestic or foreign firms with no engagement in GVCs not belonging to the four types described above. These firms are only oriented toward the domestic market.	Residual category of intermediate good producing firms.	36.69%

### **Drivers of GVC Participation**

We estimate the probability that a firm chooses a certain mode of internationalization as a function of a set of firm characteristics, including services usage, and fixed industry and time characteristics. The intensity of service input usage as well as the composition of services is likely to influence the depth of integration into GVCs. Thus, the probability of choosing a certain depth of GVC integration is estimated by:

$$Pr(GVC\ mode_{ist}) = \phi(\beta_0 + \gamma_1 service\ input\ intensity_{ist-1} + \Gamma_1(Z_{ist-1}) + \delta_t + \delta_s) \quad (1)$$

where  $GVC\ mode_{ist}$  is the chosen depth of GVC integration of firm  $i$  operating in sector  $s$  at time  $t$ .

The mode of GVC integration is a function of firm characteristics  $Z$  including a firm's size measured by its (log) output level, age, the (log) wage per value added, (log) total factor productivity and (log) financial leverage as a proxy for access to finance. With the help of these control variables, we take into account that larger, more established, more productive firms are usually more deeply engaged in GVCs. Further, we take into account the degree of servicification of the firm by including the expenditures on service inputs.

To account for potential reverse causality and endogeneity issues, we use the lag values of the respective service inputs and control variables to identify the correlation between the use of service inputs and the likelihood to integrate in a specific depth in GVCs. Moreover, sector fixed effects ( $\delta_s$ ) are included to account for sector-specific heterogeneity and year fixed effects ( $\delta_t$ ) to capture unobserved aggregated shocks. This selection equation is estimated using an ordered logit model. Since fixed effects controlling for time invariant firm characteristics cannot be directly included in this type of nonlinear estimation, an alternative specification included a demeaned version, following Mundlak (1978) and Chamberlain (1980), and a differenced version of the equation is estimated.<sup>7</sup>

## **4. Descriptive Analysis of GVC Participation and Service Usage**

We present a brief descriptive analysis of the characteristics of firms in India focusing, in particular, on their GVC integration and their use of service inputs.

### **GVC participation at the firm level**

In our sample, only a small share (1.6 percent) of firms are triple mode firms (high GVC involvement) and around 6 percent are dual (intermediate) mode firms. Single (low) mode firms make up 23.18 percent of the total firms. The largest shares of firms belong to the category of limited GVC participation (32.45 percent) and no GVC participation (36.69 percent).

The extent to which firms are integrated into international markets and GVCs varies across sectors and locations.<sup>8</sup> Figure 6 and Figure 7 show the distribution of firms across sectors and industries for different

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<sup>7</sup>Differentiating reveals underlying trends. Age and dummy variables are used in levels.

<sup>8</sup> One should note that firms tend to cluster in economic centers in India. Large and medium sized firms can mainly be found in Gujarat, Maharashtra, NCT of Delhi, Tamil Nadu, West Bengal, Telangana, and Karnataka.

levels of international market integration and GVC participation for the year 2015. In general, the share of firms, which are active in exporting and importing, is higher in the manufacturing sector than in the service sector.<sup>9</sup> Electronics and IT-services are two industries which are deeply integrated into GVCs, i.e., these two sectors have a relatively larger share of double and triple mode firms (firms integrated at an intermediate and high level).

The automobile industry is highly engaged in regional and global value chains. More than three-quarters of all firms in the automobile industry engage at least with a single mode in international markets. Around half of all firms in the automobile sector are exporters only. However, many of them export only a smaller fraction of their total sales and are as such only integrated at a limited degree in GVCs. In contrast, in the electronics industry, nearly half of all firms are exporters and importers, and 15 percent of them are deeply integrated into GVC (intermediate and high GVC integration). More than two-thirds of the firms in the industry participate in international markets by exporting or importing, or both. The industry is also well connected in international distribution networks. Firms in the textile and apparel industry are highly active in exporting activities and typically export a substantial share of their sales, directly or at arms-length. However, less than 5 percent of the firms are deeply integrated into GVCs. Nearly half of all firms in the chemical and pharmaceutical industry both export and import. However, since only a small fraction of these firms are foreign owned or own foreign affiliates abroad, only around 10 percent of these firms are deeply integrated into GVCs.

In the service sector, around 54 percent of all firms participate in international markets, half of them export and import some of their services and are deeply integrated into GVCs. One-quarter of all firms in the Business Service Sector are active exporters and importers, while one-quarter of all firms in the Business Service Sector only engages in importing activities.<sup>10</sup> In particular, firms in the IT service industry engage heavily in export and import activities.<sup>11</sup> Around 50 percent of all firms in the IT service sector export and import and more than 15 percent of them are deeply integrated into GVCs.

Table 3 presents the average values of some key variables by the mode of GVC integration. As can be seen from the table, firms deeper integrated in GVCs (intermediate and high GVC participation) are typically larger (as measured in terms of output and wage bills) and more productive. They are generally older and more established in terms of having more years of experience in the market. Moreover, they have a higher financial leverage ratio, i.e., they have a relatively higher share of loans or credit purchases from external sources.

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<sup>9</sup> Note that in general many firms in the service sector drop out of the sample due to the lack of information on many essential variables, in particular for approximating productivity. In particular, many smaller service firms, which potentially operate only domestically drop out of the sample, leading to a potential overestimation of GVC participation/ international market integration. The reporting is particularly good for firms in the business service sector, including the IT service sector such that the shares in these sectors seem to be reliable.

<sup>10</sup> Firms in the Business Service sector include firms in the telecom, information service, finance and insurance, real estate, renting of machinery, computer and related activities, IT services, auditing activities, legal, accounting book-keeping and auditing services, tax consultancy, market research, advertising and marketing activities, and management services.

<sup>11</sup> The IT service sector includes computer, programming and related services, IT services and information services.

Figure 6: Different stages of GVC involvement for Indian firms in 2015 (in %), by sector

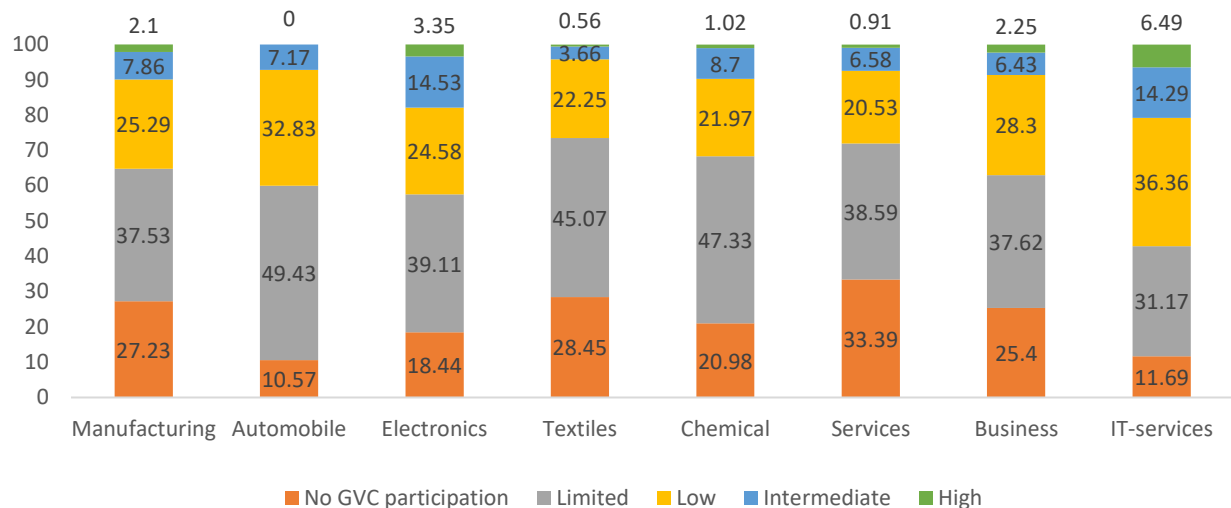


Figure 7: Different types of international market integration for Indian firms in 2015 (in %), by sector

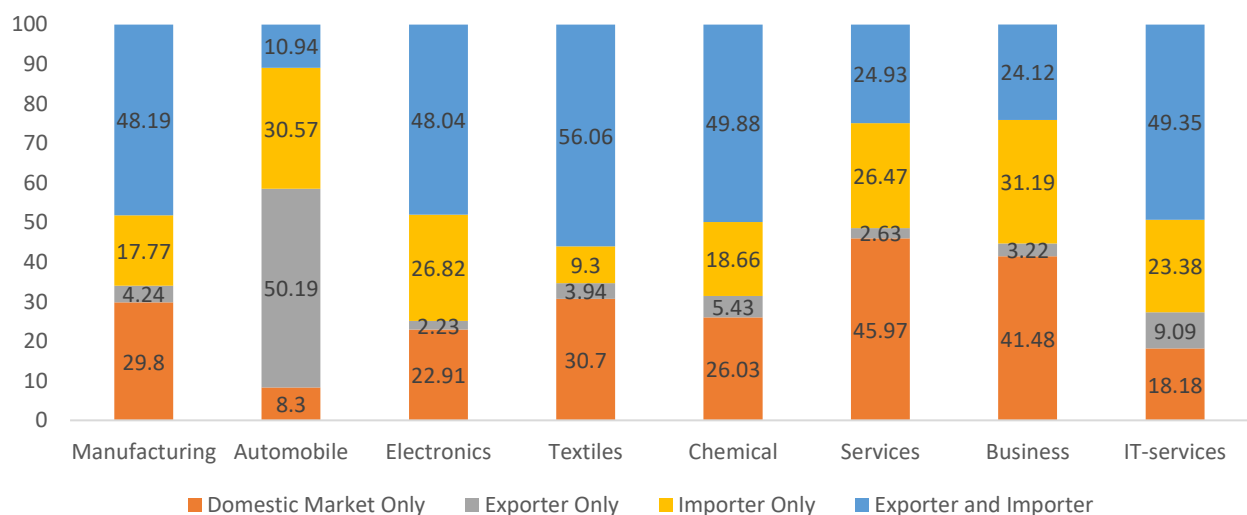


Table3: Average Output, wage, age, productivity, financial leverage by GVC mode

GVC Mode	Output	Wage	Age	Productivity	Leverage
No	1.187	0.159	20.713	-0.149	1.271
Very Low	2.277	0.550	22.609	0.040	1.562
Low	2.585	0.739	25.525	0.059	1.502
Intermediate	3.087	0.989	25.947	0.094	1.616
High	3.019	0.867	25.931	0.189	1.656
No of observations	73098	73098	72836	73098	72411

Note: Calculation based on all years. Output and wage are in million Indian Rupees (logged and deflated). Productivity is measured by TFP constructed following the methodology of Akerberg, Caves and Frazer (2015). Financial leverage is measured as liabilities to equity ratio

## ***Service usage***

Table 4 shows the share of services in the total expenses of Indian firms. Service inputs include expenditures incurred for royalties, technical know-how, license fees, research and development, rent & lease rent, selling & distribution, finance and insurance, outsourced manufacturing and outsourced professional jobs, travel and communication expenses, and repair and maintenance. The service intensity measures the intensity of services used in the production, i.e., the share of expenditures on service inputs relative to total expenditures.

On average, firms only focusing on the Indian domestic market, spend 14.7 percent of their total expenditures on services, while firms highly integrated into GVCs spend, on average, 16.4 percent of their expenditure on services. Complex service inputs, in particular, expenditures on outsourced professional jobs and financial services make up nearly half of the average spending on service inputs for firms. The use of complex services, which are services that are considered as having a greater level of production complexity because of its higher fixed training costs (Costinot, 2009), are much greater for firms with high levels of GVC participation or triple mode firms, although the relationship is less strong for the other GVC types. An independent t-test (accounting for different variances across firms participating in GVCs) was run to determine if there are statistically differences in the respective service intensities between firms not participating in GVCs and firms participating in GVCs in different stages of integration, and among firms participating in GVCs at different stages of integration. The results show that firms deeper integrated into GVCs have statistically significant higher shares of expenditures on services, have a significant higher share of spending on R & D, use higher IT related services and have a significant higher import service intensity. Considering that firms participating in GVCs dominate the manufacturing output in India, this statistically significant difference, even if it seems small, has economic significance.

Firms deeply integrated in GVCs have a higher intensity of use of IT service inputs. IT and IT enabling services include services related to technical knowhow and licenses, outsourced professional IT jobs and IT related research and development. On average, the intensity of IT services is 1.19 for firms with no GVC participation. This increases to 1.52 for firms with low GVC participation, 1.86 for firms with intermediate GVC participation and is the highest for the high GVC integrated firms at 2.33. The composition of service expenditure also confirms the pattern on the importance of IT service inputs for GVC integration. While considering the share of IT service expenditure in total services expenditure, the data reveals that IT services make up 6.33 % of the total expenses on services for firms not participating in GVCs. This share of IT expenses in total services expenses becomes 8.50% for firms with low GVC participation and 10.78% for intermediate GVC integrated firms. Firms highly integrated into GVCs spend on average, 11.7% of their expenditure of services on IT services. Note that this pattern is not driven by IT firms. See Table A.2 in the Annex for more details on sectoral differences in the use of IT services.

Similar patterns are observed for the R & D intensity of service use. Firms not participating in GVCs have an average R & D intensity of 0.31. This doubles to 0.62 for intermediate GVC integrated firms and is 1.13 for firms that are highly integrated into GVCs. This finding is also in line with the findings for European firms. In Veugelers et al. (2013), the authors find that their indicator of product innovation is positively associated with higher levels of GVC participation of firms across the different modes. Therefore,

consistent with European firms, in India, firms that are more involved in GVCs are also most likely to be active in innovative activities. The overall share of imported services in total expenses also increases with the depth of integration into GVCs as can be seen in the last column of the table.

Table 4: Services as Share of Total Expenses (in %) for Indian Firms

	Service Intensity	R & D intensity	IT related service intensity	Complex service inputs	Imported service intensity
No GVC participation	14.68	0.31	1.19	7.00	0.00
Very Low	15.16	0.4	1.28	6.28	12.94
Low	15.81	0.45	1.52	6.53	14.74
Intermediate	16.00	0.62	1.86	6.39	21.3
High	16.36	1.13	2.33	7.33	26.42
Average	15.23	0.4	1.36	6.59	9.96

Note: Service intensity is defined as service inputs relative to total expenditures.

There are differences across sectors in the intensity with which they use service inputs, as can be seen in Annex Table A.2. The electronics industry uses service inputs (as well more complex service inputs) more intensively compared to other manufacturing industries. The electronics industry imports more than 16 percent of their service inputs. The Sector not only heavily sources service inputs from international markets (around 43 percent of total service inputs), it also earns mainly from their services exports to international markets. Around 53.22 percent of total income are earned from service exports and 97 percent of exports are services. The automobile sector also imports a larger fraction of their service inputs compared to other manufacturing industries. The chemical and pharmaceutical industry uses a large share of complex services (6.35% of all service are complex services) like the electronics and car industry, but predominantly sources its service inputs domestically. The industry however provides services along with goods. Nearly a quarter of the exports of the chemical and pharmaceutical industry are service exports. The relatively low share of imported services for textiles is notable and is consistent with the low share of “importers only” firms in this sector. This sector also has the lowest use of IT-related services as well as R&D services.

## 5. Service Inputs and the Extent of GVC Integration

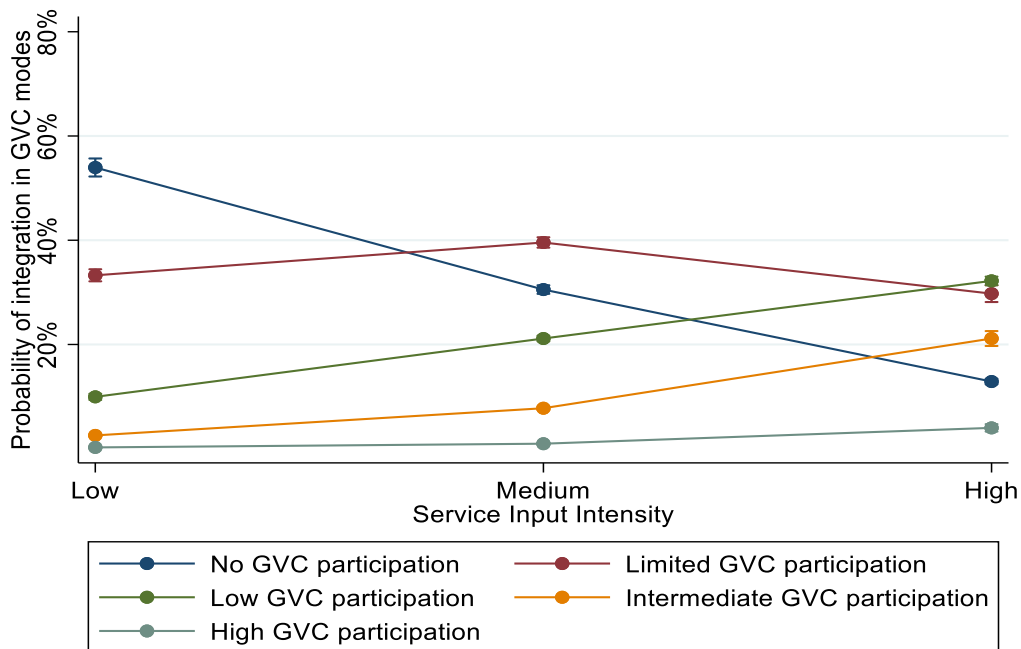
The intensity of service input usage as well as the composition of services determine the depth of integration into GVCs. The probability that a firm chooses a certain mode of internationalization is a function of a set of firm characteristics, including services usage, and fixed industry and time characteristics. The results from estimating Equation 1 are presented in Table 5. The baseline is presented in column (1), the demeaned version in Column (2) and the differenced version in Column (3). Firms that are highly productive, larger in size, pay a higher wage per value added, and are older are more deeply integrated into GVCs. Further, firms that are financially more open and less restricted in obtaining external finance, which is reflected in a higher external debt to equity ratio, are more deeply integrated into GVCs.



Moreover, the estimation reveals that Indian firms using service inputs intensively are typically more deeply integrated into GVCs. The results in Columns (4), (5) and (6) suggest that this seems to be driven by complex and IT and IT-enabling services. Thus, the use of more sophisticated service inputs is associated with a higher probability of being integrated into GVCs at a deeper mode.

Our results show that a higher service input intensity makes it more likely that firms integrate in GVCs. Figure 8 presents the estimated margins, i.e., the probability of integrating at a certain mode into GVCs depending on the service input intensity of the respective firm in the previous periods. Firms with low service input intensities have a high probability around 55 percent of not being integrated in GVCs. If firms not participating yet in GVCs increase their service input intensity, the likelihood that they start participating in GVCs increases substantially. Firms that are not integrated in GVCs and with a high service input intensity have a 90 percent chance of joining GVCs in the subsequent periods. Firms with medium usage of services show a likelihood of around 71 percent of integrating in any mode of GVC participation. The probability to integrate at limited, single, dual, or triple GVC mode increases with the service input intensity. Firms that use service inputs more intensively, particularly sophisticated inputs such as complex and IT/ITeS services are more likely to integrate into GVCs.

Figure 8: Probability of integration into GVCs at a certain mode depending on the service input intensity



Note: The figure shows the marginal effects of integrating in a certain mode of GVC participation based on the ordered logit model described in the text using the Mundlak (1978) and Chamberlain (1980) correction method and the specification shown in Table 4, column (5). The marginal effects are evaluated for the 25th percentile of service input intensity, the 50th percentile and the 75th percentile of service input intensity, all other variables are at their mean values.

Table 5: Selection into GVC participation

VARIABLES	(1)	(2) Demeaned (Mundlak- Chamberlain correction)	(3) Differenced	(4)	(5) Demeaned (Mundlak- Chamberlain correction)	(6) Differenced
TFP	0.2030*** (0.0240)	0.0774*** (0.0228)	0.0128 (0.0173)	0.1503*** (0.0243)	0.0065 (0.0209)	0.0139 (0.0172)
Size	0.5443*** (0.0219)	0.4659*** (0.0284)	0.1167*** (0.0291)	0.6176*** (0.0227)	0.4650*** (0.0294)	0.1201*** (0.0292)
Wage Per Value Added	0.1591*** (0.0435)	0.1224*** (0.0470)	0.2068*** (0.0693)	0.0282 (0.0451)	0.1111** (0.0484)	0.2991*** (0.0693)
Financial Leverage	0.0093 (0.0191)	0.0345* (0.0199)	0.0744*** (0.0216)	0.0067 (0.0192)	0.0663*** (0.0233)	0.0739*** (0.0216)
Age	0.0027*** (0.0009)	0.0713*** (0.0045)	0.0135*** (0.0009)	0.0031*** (0.0009)	0.0745*** (0.0046)	0.0135*** (0.0009)
Service Input Intensity	0.6054*** (0.0229)	0.1243*** (0.0215)	0.0786*** (0.0183)	0.0942*** (0.0230)	0.1169*** (0.0231)	0.0806*** (0.0186)
Complex Service Intensity				0.0776*** (0.0178)	0.0810*** (0.0166)	0.0015 (0.0137)
IT Service Intensity				0.2238*** (0.0138)	0.0480*** (0.0126)	0.0172** (0.009)
Observations	106,102	106,102	84,135	106,012	106,012	84,053
R-squared	0.1323	0.1407	0.0363	0.1368	0.1458	0.0364
Number of company_code	16,417	16,417	13,695	16,114	16,114	13,952

Note: The dependent variable is the depth of GVC integration. All variables are lagged by one year. The size of a firm is measured by log annual sales. Complex services intensity is measured as log share of expenditures of complex services on total service expenditures. Industry and year fixed effects are included in all specifications. The sample includes all manufacturing and service firms and spans the years from 1995 to 2016. In column (2) all variables are demeaned at firm level to take out firm heterogeneity, column (3) accounts for firm heterogeneity by differencing the variables. Standard errors clustered at firm level in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## 6. Concluding Remarks

Indian firms in GVCs play an important role in the economy. They account for a disproportionate share of total output and exports and have a significant productivity premium over firms that do not participate in GVCs (Manghnani et. al 2021). However, there is potential to further increase the integration of Indian firms in GVCs so they may reap the benefits of specialization, scale, and access to global markets.

The intensity of service input use as well as the composition of services determine the depth of integration into GVCs. Firms that are highly productive, larger in size, pay a higher wage per value added, have a higher leverage ratio and are older are more likely to be more deeply integrated into GVCs. Firms with low service input intensities have a high probability of not being integrated in GVCs. If firms not participating in GVCs increase their service input intensity, the likelihood that they begin participating in GVCs increases substantially. The probability to integrate at limited, single, dual, or triple GVC mode increases with the service input intensity. Moreover, the composition of services matters for GVC integration. Indian firms using service inputs intensively, particularly complex and IT and IT-enabling services, are typically more deeply integrated into GVCs. Thus, the more sophisticated are the service inputs used, the more likely firms will integrate at a deeper mode into GVCs.

As services play a crucial role in GVCs, both as an input in the production process as well as a coordination facilitator, the findings in the paper point to a clear role for policy makers. Facilitating the use of high-quality services, liberalizing the service sector, removing various types of policy barriers related to services, strengthening the institutional framework including contract enforcement mechanisms, and enhancing human capital, which is crucial for the provision of more sophisticated services, will enable India to strengthen GVC participation and profit from the associated economic benefits.

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## Annex

Table A.1: India Gross and (Domestic) Value-Added Exports

Industry	Gross Exports		Value Added Exports	
	Share of total	Mean growth	Share of total	Mean growth
Total economy	100	8.7	100	9
Total manufacturing	54.8	8.8	50.3	9
Total business sector services	41.6	8.8	45.8	9.1
Chemicals and non-metallic mineral products	16.3	9.5	14	10
Textiles, wearing apparel, leather and related products	9.1	6.2	9.4	6.3
Motor vehicles and other transport	4.4	15.3	4.1	15.7
Computers, electronic and electrical equipment	3.2	11.2	2.6	11.6
IT and other information services	19.6	11	22.1	11.3
Professional services	5.2	7.1	5.7	7.3

Source: OECD TiVA, Note - average annual growth rate between 2005 and 2016; Business services includes distribution, transport, accommodation, IT-related services, financial services, real estate and other business services such as administration services.

Table A.2: Services as share of total expenses (in %) by industry

	Service Intensity	R & D input intensity	IT related service input intensity	Complex service input intensity	Imported service intensity	Export service intensity
Automobile Industry	12.91	0.44	1.41	5.15	14.52	12.91
Electronics Industry	15.31	0.72	1.93	6.94	16.60	15.31
Textiles & Apparel Industry	13.27	0.05	0.44	6.33	6.20	13.27
Chemicals & Pharmaceuticals	14.94	1.00	1.69	6.35	9.17	23.24
Business Service Sector	25.67	0.35	4.19	13.16	21.80	94.09
IT Service Sector	24.57	0.93	5.85	11.22	42.97	97.32

Source: Prowess; Own calculations.