



# **DOES SERVICIFICATION OF MANUFACTURING INCREASE THE GVC ACTIVITIES OF FIRMS? THE CASE OF INDIA**

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## Abstract

Does greater use of services inputs in manufacturing increases the global value chain (GVC) activities of the firms? In this paper, we examine the effects of servicification on the GVC activities of manufacturing firms in India. Using the panel data of 4608 Indian manufacturing firms from 2001 to 2018, we examine the effects of servicification of manufacturing firms on their decision to participate in GVCs. The paper examines overall service inputs in the manufacturing activities and its impact on GVC activities of firms. The results indicate that servicification of manufacturing tend to have a positive impact on GVC activities of firms. We also observe positive impact on Indian SMEs to participate in the GVC through the servicification of manufacturing. Further, the results also indicates the impact of servicification tends to be different for high-tech and low-tech industries.

Keywords: Global value chains · Servicification · Manufacturing

JEL Classifications: F1 · F14 · L8

## **1. Introduction**

Over the past 2 decades years, manufacturing activities are becoming more fragmented and also ‘servicified’ due to the growing global value chain (GVC) activities. Increasingly, we are observing the servicification of manufacturing activities as production activities use greater inputs in the production process (input-side), and as well as the manufacturing output sales incorporating and bundling more services in the sales of their products (output-side). The servicification of manufacturing in terms of using of services as inputs by manufacturing firms is a key feature in the global production activities driven by global value chains (GVCs). Within the GVC framework, the importance of servicification stems from multiple avenues. Services in the form of (a) intermediate inputs such as packaging, marketing, research and development in the production; (b) service-linkages between manufacturing activities such as logistic activities; and also (c) in terms of sales of the products in terms of after-sales services provided by the firms. Recent studies also highlights the importance of servicification for manufacturing activities in the GVC in terms of differentiating their products through the bundling of their service solutions with their products. This reduces the likelihood of imitation and substitution in the market, thereby helping firms penetrate and sustain participation in GVCs (Cui and Liu, 2018; Lee, 2019; Low, 2013). Further, services also provide the service linkages for manufacturing activities as an enabler of GVCs by supplying the necessary business and logistical support, which is important for inter-firm linkages in the GVC (Heuser and Mattoo, 2017).

Several recent studies highlight the importance of servicification of manufacturing, which increase exports through improvement in productivity and service linkages to the regional and GVCs. For instance, Lodefalk (2017) highlights that in 2009, the value-added contribution of services to manufacturing exports from EU and USA was approximately 50 percent respectively. Similarly, the recent World Development Report 2020 highlight that the services contribution toward the production of goods experienced 12 percent increase from 1980 to 2009. For OECD countries, Lanz and Maurer (2015) observe that services contribution to total value-added in manufacturing exports was 35% in 2011. In a recent study, Thangavelu, Wang, and Oum (2018) show that services trade accounted for around 68% of total trade in value-added terms for East Asian countries, which point to the growing importance of services value added activities in the GVC across East Asia.

At the firm level, Lodefalk (2014) highlights that services inputs have positive impact on the export intensity of Swedish manufacturing firms through service linkages and productivity.

Lodefalk (2013), using national Input-Output tables for Sweden, highlight that between 1997-2006, the Swedish manufacturing sector produced goods as well as services and, at the same time, also increased its purchase of services from both home and abroad. Further, Marín-Odio (2014) underscores the rising value of services in domestic value-added exports as the key factors behind the regional GVC activities of Costa Rica. Miroudot and Cadestin (2017), using input-output tables (TiVA database), also highlight that services contributed 37% in manufacturing exports of 62 economies.

The impact of servicification on the manufacturing sales activities at the firm level is also highlighted by several studies. Manufacturing firms tend to bundle their products with after sales services in terms of maintenance and customer services. National Board of Trade (2010) report that the firm used forty services inputs to sustain its integration in GVCs, based on a case study of a large Swedish manufacturing firm (Sandvik Tooling). Further, Kelle (2013) highlights similar trend for Germany, with manufacturing firms exporting nearly 25% of services export. In the study by Crozet and Milet (2017) for French manufacturing firms, nearly 76% of the French manufacturing firms tend to sell services.

Along the similar lines, the importance of services in augmenting manufacturing performance is also highlighted in the literature. For instance, Francois and Woerz (2008) show that openness in service sector is a critical factor influencing the efficiency in most technology-intensive manufacturing industries. Similarly, Duggan et al. (2013) highlights that reduction in policy restrictions concerning foreign direct investment (FDI) in Indonesian service sector resulted in an 8% increase in manufacturing firm productivity. Further, Hoekman & Shepherd (2017), using firm-level data for over 100 developing economies, highlight that a 10% increase in services productivity results in a 0.3% improvement in productivity of manufacturing firms. With reference to India, Arnold et al. (2016) highlights that services reform in India increased productivity premium for domestic and foreign manufacturing firms by 11.7% and 13.2 % respectively in 1993-2005.

In this paper, we explore the impact of servicification on GVC activities for the Indian manufacturing industries. Despite being one of the fastest emerging economies in the region, the manufacturing industries in India have very weak linkages to regional and global GVC activities. Notwithstanding its weak linkages, GVC integration is touted as a strategy for achieving India's goal of USD 5 trillion economy by 2025.<sup>1</sup> According to the 2019-20

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<sup>1</sup> <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1549454>

Economics Survey report published by the Government of India, export in network products<sup>2</sup> can potentially contribute 25% of the USD 5 trillion target in value-added terms by 2025. Moreover, the report also cites GVCs as a potential channel of generating large scale employment in the Indian economy. The report estimates that greater integration into GVC can create employment for 40 million workers by 2025 and 80 million by 2030 (GOI, 2020).

In this study, we examine the GVCs activities of Indian manufacturing firms in terms of servicification of manufacturing activities and its impact on GVC participation. As opposed to current literature that suggests productivity, financial constraints, and firm size as key factors influencing the GVC participation decision of a firm (Amador and Cabral, 2016; Lu, Shi, Luo, and Liu, 2018; Minetti, Murro, Rotondi, and Zhu, 2019). However, the role of servicification of manufacturing in the participation of GVC activities has little empirical literature. Although studies have documented the pivotal role of servicification at the industry level, firm-level evidence in this context remains sparse (Lodefalk, 2013; Marín-Odio, 2014; Miroudot and Cadestin, 2017). This study tries to address this gap by examining the role of servicification on GVC participation of the firm. Further, though GVC activities have increased in Asia (Anukoonwattaka, Scagliusi, and Mikic, 2015; Thangavelu et al., 2018), much of the existing studies predominantly focus on the experience of China and East Asia, while the GVC activities in India is largely overlooked. This paper adds to the literature by examining the servicification-GVC nexus for India.

The rest of the paper is organized as follows. Section 2 documents the servicification trends for Indian manufacturing. Section 3 sheds light on the large firm-level database and the variables used for the study. Section 4 details the empirical methodology. Section 5 documents the results, and Section 6 concludes the paper.

## **2. Servicification of Manufacturing in India**

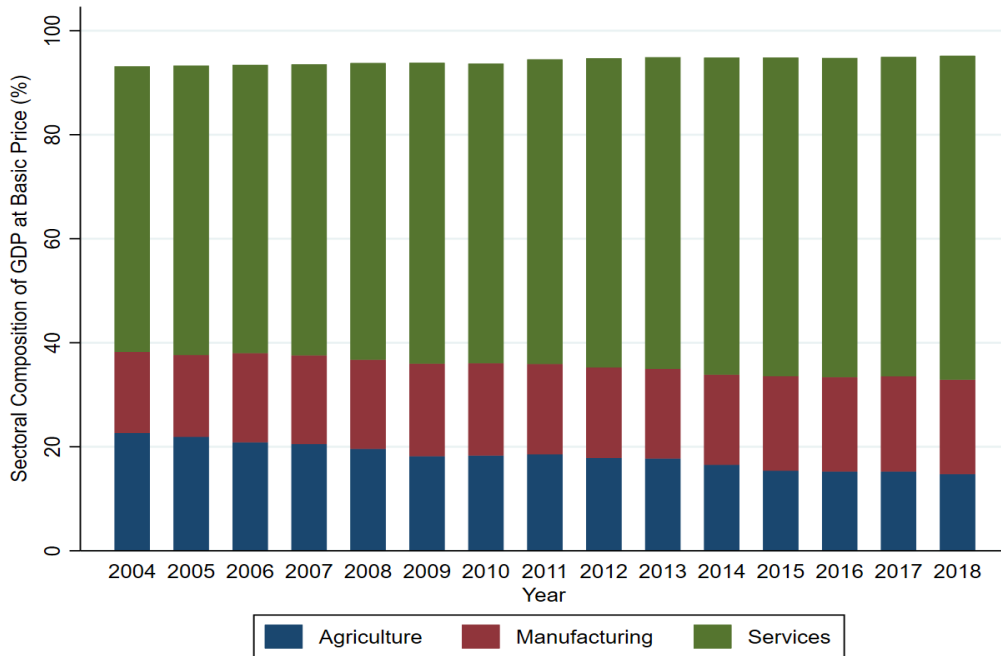
The importance of the role and contribution of services sector to GDP in Indian economy is becoming important for long-term growth of the economy. Figure 1 shows the contribution of agriculture, manufacturing and service sector to India's GDP. It is clear that the contribution of manufacturing sector to GDP in Indian economy has remained stable by contributing around 17% of GDP. While the trend of the manufacturing sector is stable, the services sector has become the key driver of Indian economy as evident from the Figure 1, where the contribution

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<sup>2</sup> The survey refers to products traded within a GVC framework as network products

of services sector has increased steadily from 54% in 2004-05 to 63% in 2018-19. Figure 2 depicts the contribution of agriculture, manufacturing and the services sectors, the services as the leading sector contributing nearly 77% in India's GDP growth in 2018-19.

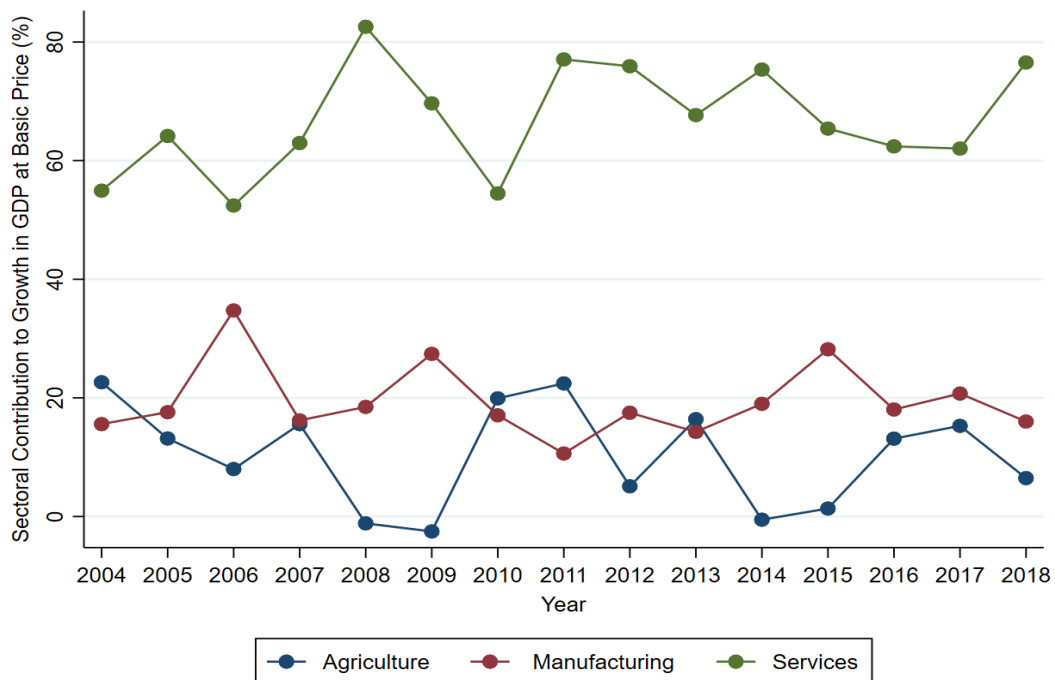
Figure 1: Sectoral Composition of India's GDP



Source: Authors' compilation based on RBI's Database on Indian Economy

Note: The Stacked graph does not cumulate to 100% since contribution of Mining & Quarrying and Electricity, Gas & Water Supply is not documented in the graph.

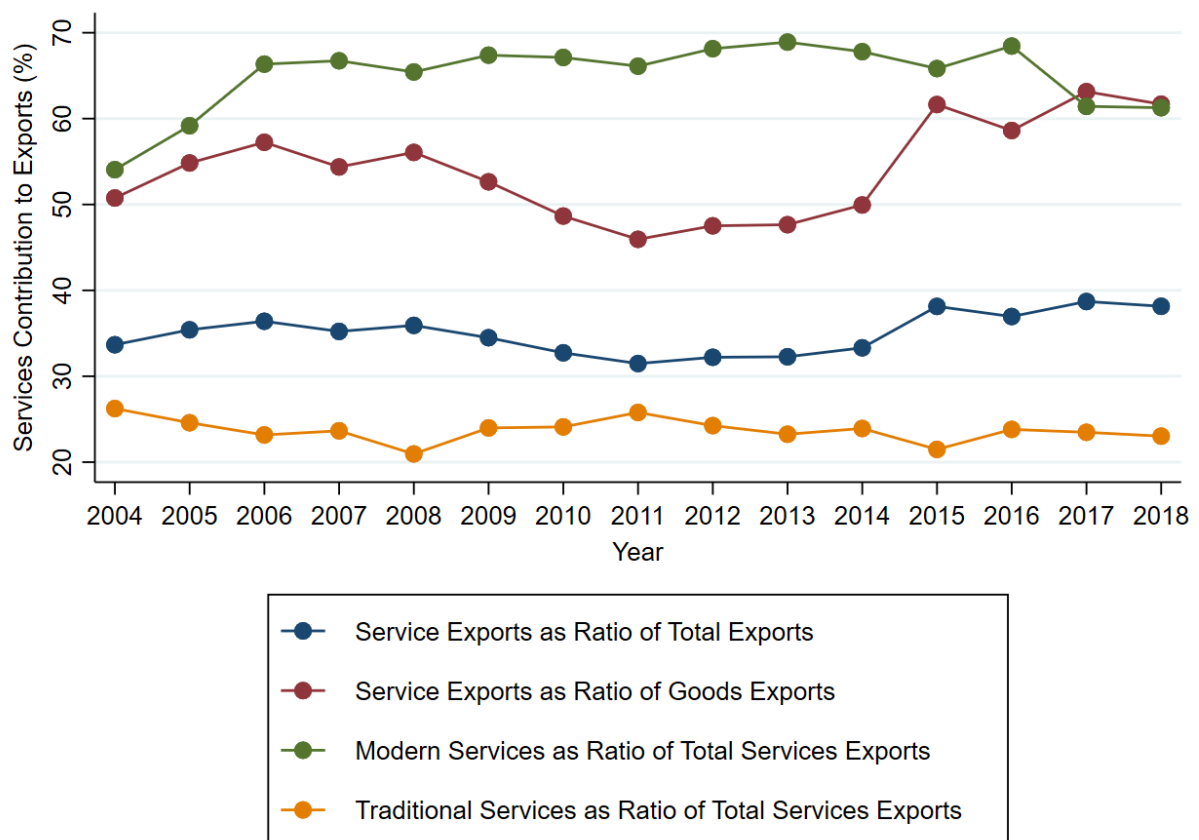
Figure 2: Sectoral Contribution to GDP Growth, Indian Economy



Source: Authors' compilation based on RBI's Database on Indian Economy

Further, Services sector also contributes significantly to India’s export performance. Figure 3 shows the key trends of services exports in India. From the Figure, we observe that services exports contributed 38% to India’s total exports and it increases to 61% relative to merchandise exports in 2018. A further breakdown of services into modern and traditional services highlight that importance of modern services in the country’s services export performance. Modern services exports that include software, business and financial services attributed 61% of overall services exports in 2018 compared to 23% of traditional services exports which includes travel and transportation services. Hence, the trends on services exports highlights the importance of services in Indian economy.

Figure 3: Sectoral Contribution to India’s GDP Growth



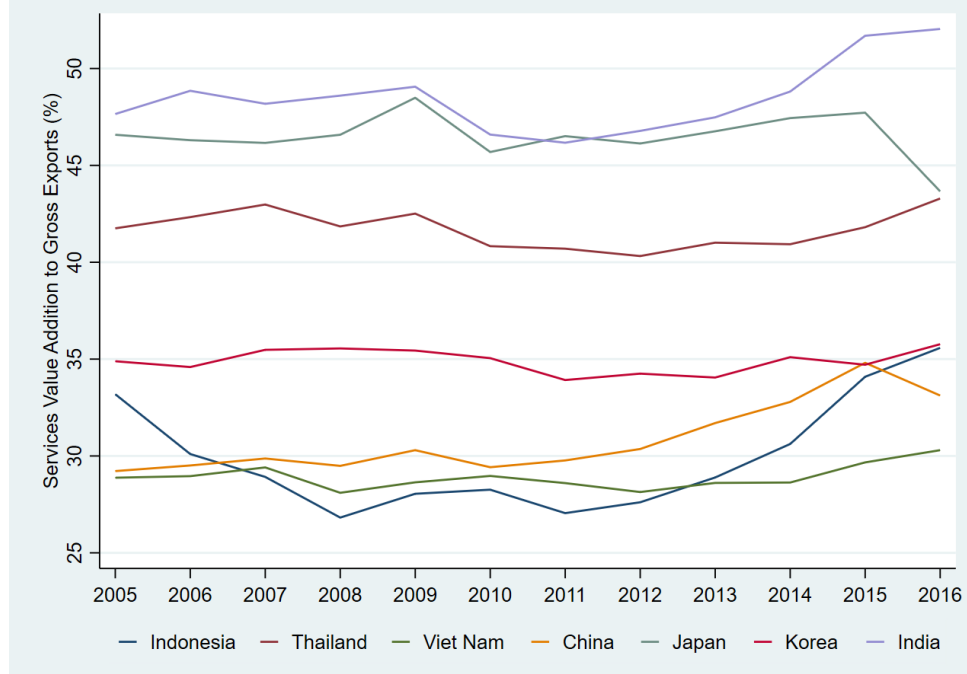
Source: Authors’ compilation based on RBI’s Database on Indian Economy

In the Figure 4, we present the services value added to gross exports, which highlights the rising trend of services contribution across the Asian economies in 2005-2016. Further, we observe that among these economies, services contribution to gross exports is the largest for India, followed by Viet Nam, and Thailand.



Further, while analyzing the services contribution, the share of service value-added in gross exports can be segregated based on the origin of the services, i.e., domestic and foreign services. This enables us to analyse India’s domestic and foreign servicification and compare it with other Asian economies (Figure 5). From Figure 5, we observe that across all the economies<sup>3</sup>, the domestic services value added to gross exports is significantly larger compared to foreign services contribution. Moreover, we also observe that compared to 2005, domestic servicification has experienced an increase across the selected Asian economies. Further, similar to the overall services contribution, India experience the highest level of domestic servicification in 2016.

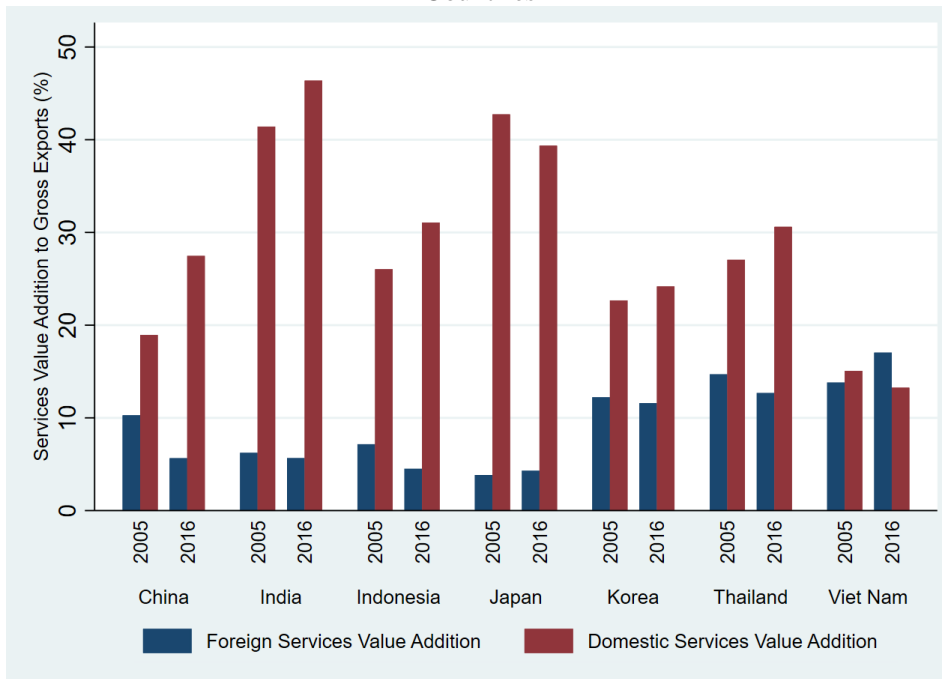
Figure 4: Services Value Addition to Gross Exports for Selected East Asian Countries



Source: Authors’ compilation based on TiVA Database

<sup>3</sup> With the exception of Viet Nam, where the contribution of both domestic and foreign servicification has been on the same wavelength. Further, in 2016 Viet Nam experienced a slightly higher foreign servicification of 17% compared to domestic servicification of 13.3%.

Figure 5: Domestic and Foreign Services Value Added to Gross Exports Across Major ASEAN+6 Countries



Source: Authors' compilation based on TiVA Database

Figure 6: Servicification of Indian Manufacturing Firms Over 2001-2018

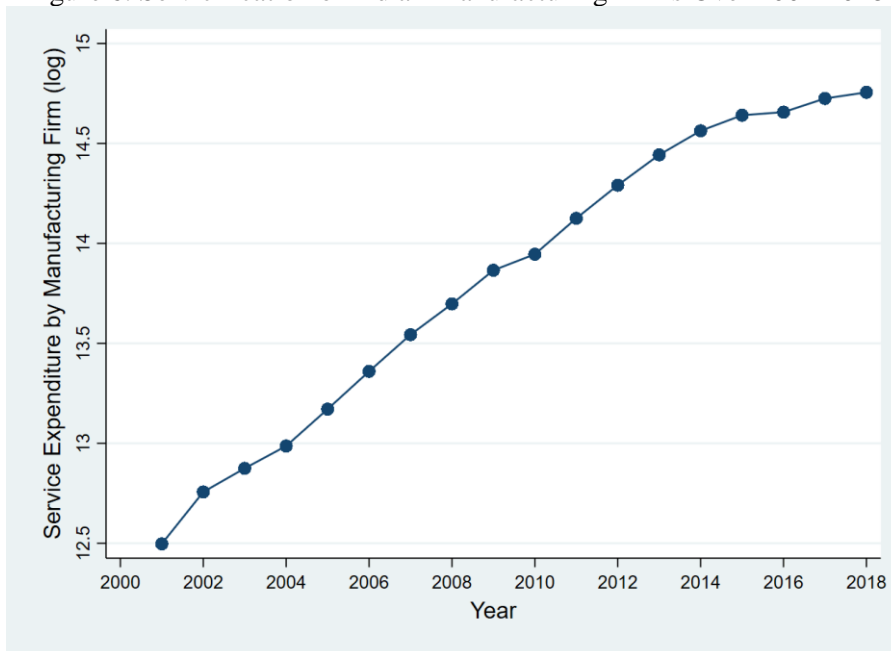


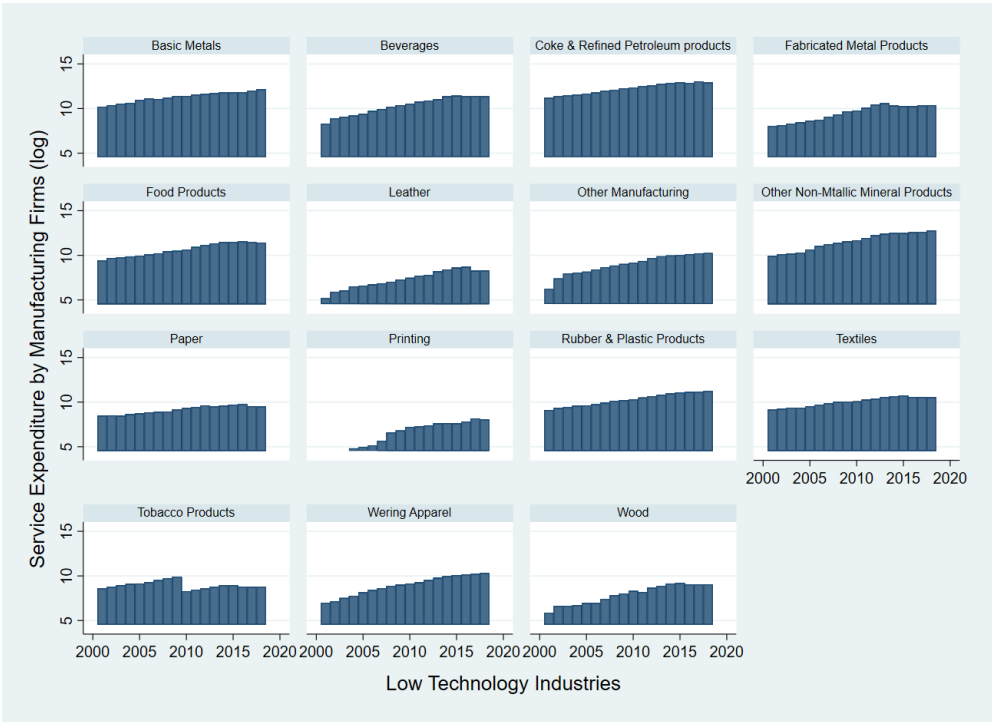
Figure 6: Servicification of Indian Manufacturing Firms Over 2001-2018

Source: Authors' compilation based on CMIE-PROWESS Database

Figures 4 and 5 discuss the rising trend of servicification in the manufacturing activities in India, using the TiVA database. In Figure 6, we provide the rising servicification<sup>4</sup> at the firm-level for Indian manufacturing firms. In Figure 6, we observe a steady rise in the level of expenditure by manufacturing firms on services inputs, which underscores the rising contribution of services input for manufacturing firms. Further, we also examine the servicification activities based on the type of technological activities at the industrial level. Given that the technology underlying production varies across industries, we group firms into technology-intensive and low-technology-intensive industries<sup>5</sup> (Parameswaran, 2009). Figure 7 plots the servicification trend for all the two-digit NIC industries in our firm level sample. Further, panel (a) depicts the trend for low technology industries, and panel (b) for technology-intensive industries. From the figure, we observe a rising trend in servicification across all the industries. Moreover, firms from technology-intensive industries experiencing a higher level of servicification compared to low-technology industries.

Figure 7: Servicification of Indian Manufacturing Firms based on Technology classification

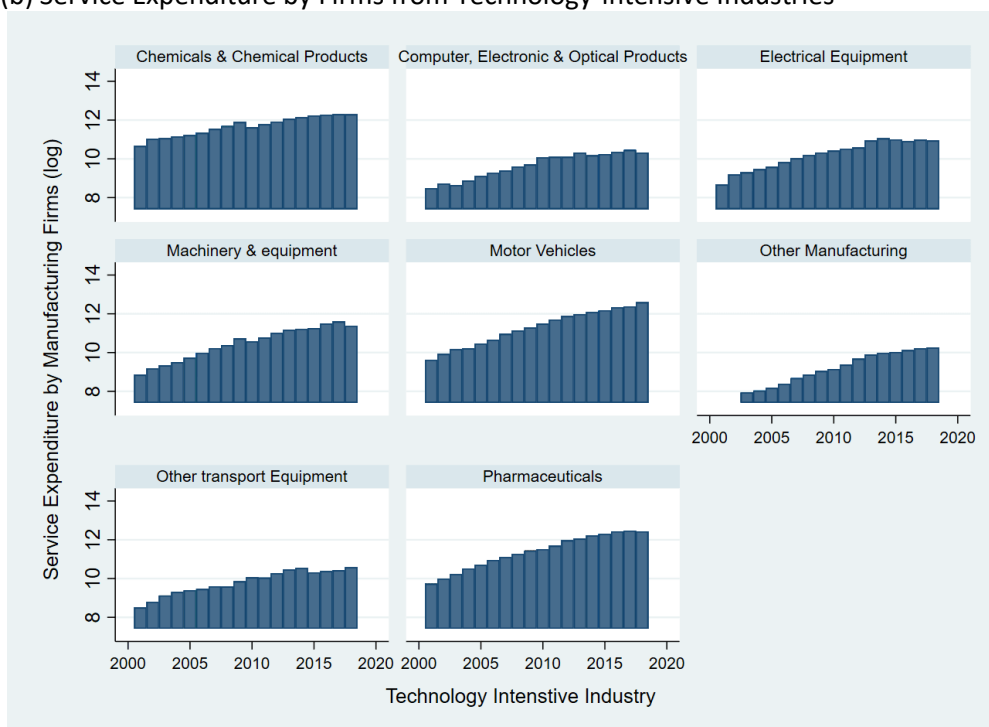
(a) Service Expenditure by Firms from Low Technology Industries



<sup>4</sup> Servicification is measured as the sum of firm expenditure on R&D, communication, outsourced professional jobs and selling & distribution expenses. For a detailed explanation refer to section 3.

<sup>5</sup> Technology intensive industries are: NIC - 20, 21, 26, 27, 28, 29, 30 & 32. Low tech industries are: NIC- 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25 & 31.

(b) Service Expenditure by Firms from Technology-intensive Industries



Source: Authors' compilation based on CMIE-PROWESS Database

### 3. Data and Variables

We explore the servicification of Indian manufacturing firms and GVC activities based on an unbalanced panel of 4806 firms for 2001-2018. The firm level data is obtained from the PROWESS database maintained by the Centre for Monitoring Indian Economy (CMIE). The PROWESS database provides firm-level information on firm sales, wages, capital, R&D, exports, imports, and ownership of the firm, among other such variables compiled from the firm's annual reports.<sup>6</sup> To develop a consistent data, we dropped all firms with missing information on sales, total assets, and firms with less than three years of continuous observations.

In the empirical analysis, the key variables of interest in our study are GVC participation and firm servicification. Based on the literature, we captured the GVC participation of a firm using a binary variable which equals 1, if a firm engages in both exporting and importing activities simultaneously (Antras, 2021; Baldwin and Lopez-Gonzalez, 2015; Dosis and Zaki,

<sup>6</sup> For more information, refer to <https://prowessiq.cmie.com/>

2020; Ehab and Zaki, 2021; World Bank, 2020). Further, to identify the firms with deeper linkages in GVCs, we restrict the GVC definition to a firm which import and export at least 10% of its sales. This enables us to distinguish extensive GVC participation of firms in the GVCs.

Our measure of firm servicification is similar to Nordwal (2016), which defined the servicification as firms' expenditure on services inputs relative to its total inputs. To capture the firm level servicification, we used the information on the firm's expenditure on R&D, communication expenditure, outsourced professional jobs, and selling and distribution expenditure normalized to the firm's total sales. The decision to account for these four specific factors is driven by the notion of the GVC activities in services (represented by a GVC '*smile curve*'<sup>7</sup>). The GVC '*smile curve*' broadly segregates the GVC activities into three categories; (i) upstream segment, which includes R&D, design, and branding; (ii) downstream segment, which relates to distribution, sales, and after-sales services; and (iii) midstream segment, where manufacturing and assembly take place (Mudambi, 2008). In this regard, activities in the upstream and downstream segments are services in nature and are pivotal inputs in manufacturing (Lodefalk, 2014). In this study, we use the firm's expenditure in R&D and outsourcing of professional jobs to factor in the upstream expenditure of the firm, and we capture the downstreamness of the firm in terms of selling and distributional services. We used the firm level expenditure on communication to proxy for the service linkages between manufacturing firms.

We also control for the self-selection issues in the firm productivity since more productive firms find it easier to participate in global markets (Melitz, 2003; Lu et al., 2018). We measure the firm productivity using the semi-parametric approach of Levinsohn & Petrin (2003). For measuring TFP, we used the firm output as firm sales adjusted for change in inventory and capital is measured following a perpetual inventory method which revaluates the gross fixed assets (GFA) at historical costs to replacement costs. Labour is measured using firm information on wage bill and expenditure on energy and fuel is used to proxy for intermediate inputs. All variables are deflated using industry specific wholesale price index.

Further, participation in international markets requires substantial cost, where a financially constrained firm may find it challenging to undertake (Lu et al., 2018; Minetti et al., 2019). Hence, to account for the financial constraints, we controlled for firm level financial leverage

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<sup>7</sup> The concept of smile curve was introduced by Stan Shih, the founder of ACER.

in the estimation. We also control for firm size to account for the scale effect. In addition, we control for firm age, and the presence of foreign ownership. Inclusion of firm age as a control is driven by the literature which highlights that older firms have better networks in foreign market and also experience lower sunk cost (Minetti and Zhu, 2011). The literature also highlights that younger firms are more adaptable to international markets, given their need of survival (Upward et al., 2013). In addition, foreign-owned firms also reap the benefits of improved access to resources and technical know-how (Dovis and Zaki, 2020). Table 1 in Annex details the construction of the variable used and provides a summary of the same.

From Table 1, we observe that 14% of the sample firms are GVC firms, where firms that export and import at least 10% of their sales. Table 1 reports the test of mean equality between GVC and non-GVC firms. The t-test reported highlights statistically significant different firm characteristic of GVC and non-GVC firms. Specifically, from Table 1, we observe that GVC firms are more productive, older, larger in size, less leveraged, and more servicified. To further underscore the difference in the level of servicification of GVC and non-GVC firms, we present the key differences in terms of the mean tests in Table 2. All the four test statistics reject the null of equal average servicification of GVC and non-GVC firms at 1% significance level.

**Table 2: Difference in means tests**

	Statistic	F(df1, df2)	= F	Prob>F	
Wilks' lambda	0.994	1.0	50096.0	309.73	0.0000
Pillai's trace	0.006	1.0	50096.0	309.73	0.0000
Lawley-Hotelling trace	0.006	1.0	50096.0	309.73	0.0000
Roy's largest root	0.006	1.0	50096.0	309.73	0.0000

Note: This table tests hypothesis of equal average servicification for GVC and Non-GVC firms

#### 4. Empirical Strategy

We employ a probit model to examine the servicification-GVC nexus for the sample firms. The selection of the probit model is driven by the binary nature of the dependent variable, GVC.

$$Pr(GVC_{it}) = \Phi(\beta_1 Servicification_{i,t-1} + \mathbf{Z} + \gamma_t + \delta_j + \epsilon_{it}) \quad (1)$$

Equation 1 depicts the probit model specification where  $\Phi$  is the standard normal cumulative distribution. Servicification is the main variable of interest.  $\mathbf{Z}$  is a vector of control variables, which includes TFP, leverage to account for the financial constraint of the firm, size of the firm proxied by assets, age of the firm, and foreign ownership. We also account for time ( $\gamma_t$ ) and industry fixed effects ( $\delta_j$ ) in the model. Further, we lag the explanatory variables in the model to control for the endogeneity issues in the model.

## 5. Results

### 5.1 Servicification and GVC participation

Table 3 presents the results of the baseline model as specified in Equation 1. Column (1) documents the relationship between servicification and GVC in the absence of firm-specific controls. We introduce control variables in Column (2), while we introduced industry and time-fixed effects in Columns (3) and (4). In Table 3, we observe positive and significant impact of servicification on the GVC participation of the firm. The results shows that an increase in firm expenditure on services is associated with a 23% to 30% higher probability of participating in GVCs<sup>8</sup>. The results also indicates a positive and significant impact of TFP on GVC participation, highlighting that more productive firms participate in GVCs (Melitz, 2003). The coefficient of firm size is also positive and significant across all specifications highlighting that larger firms find it easier to participate in GVCs. As expected, the coefficient of the leverage is negative, accentuating that more financially constrained firms find it difficult to integrate into GVCs. Further, younger firms and foreign ownership of the firm is associated with greater GVC integration. The coefficient of foreign ownership, however turns insignificant in the presence of year and industry fixed effects. The results of the control variables are in line with existing literature (Lu et al., 2018; Minetti et al., 2019; World Bank, 2020).

**Table 3: Probit Model: Impact of servicification on GVC participation of the firm**

VARIABLES	(1) GVC	(2) GVC	(3) GVC	(4) GVC
L.Servicification	0.283*** (0.036)	0.269*** (0.0374)	0.212*** (0.0394)	0.229*** (0.0426)
L.LogTFP		0.00354 (0.00246)	-0.00391 (0.00258)	0.0100*** (0.00338)
L.LogSize		0.0176***	0.0309***	0.0285***

<sup>8</sup> The economic significance is measured as  $[\exp(\text{coefficient} * \text{Standard deviation of the variable}) - 1] * 100$

L.LogAge		(0.00164)	(0.00197)	(0.00213)
		-0.0465***	-0.0109**	-0.00483
		(0.00417)	(0.00471)	(0.00517)
L.Leverage		-0.0313***	-0.0431***	-0.0380***
		(0.00618)	(0.00658)	(0.00701)
Foreign		0.0148**	0.00671	0.00575
		(0.00651)	(0.00682)	(0.00712)
Year FE	No	No	Yes	Yes
Industry FE	No	No	No	Yes
Observations	44,569	44,569	44,569	44,569

All columns report marginal effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5.2 Channels of Servicification

As discussed earlier, our measure of servicification encompasses four key components: R&D, outsourced professional jobs, communication expenditure, and selling & distribution expenses. In this section, we examine the servicification-GVC nexus in terms of disentangling the channel of transmission and identifying each factor's role in shaping the firms' GVC participation. Consequently, we re-estimate Equation (1) with each component as a key explanatory variable. Table 4 reports the results of the regressions.

In Table 4, we observe a positive and significant impact of all four components on GVC participation. Further, among the four components, selling and distribution services is significant at 1% level of statistical significance, followed by communication expenses at 5%, and R&D along with outsourced professional jobs at 10% level of statistical significant. The results indicate that firm expenditure on downstream services, and services enabling smoother interaction between key market players, are crucial in promoting GVC participation of Indian manufacturing firms. Further, the results of the control variables are in line with the baseline results, where we observe larger, younger, more productive, and less leveraged firms having greater participation in GVCs.

**Table 4: Probit model: channels of servicification**

VARIABLES	(1) GVC	(2) GVC	(3) GVC	(4) GVC
L.S&D.	0.218*** (0.0520)			
L.Outsourced		0.433* (0.229)		
L.Communication			1.967** (0.917)	
L.R&D				0.265* (0.157)
L.LogTFP	0.00777** (0.00341)	0.00976*** (0.00353)	0.00984** (0.00399)	0.0191** (0.00896)



L.LogSize	0.0295*** (0.00215)	0.0294*** (0.00217)	0.0336*** (0.00249)	0.0218*** (0.00505)
L.LogAge	-0.00578 (0.00525)	-0.00436 (0.00531)	-0.00558 (0.00610)	-0.0236* (0.0122)
L.Leverage	-0.0413*** (0.00714)	-0.0409*** (0.00716)	-0.0452*** (0.00815)	-0.0360** (0.0161)
Foreign	0.00540 (0.00719)	0.00630 (0.00727)	0.0104 (0.00867)	0.00235 (0.0149)
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	43,656	43,207	32,175	12,815

Notes: (i) S&D represents selling and distribution expenditure. Outsourced represents expenditure on outsourced professional jobs. Communication is firm's expenditure on communication, and R&D is expenditure on research and development. (ii) All columns report marginal effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### 5.3 Size Classification

Our sample is heterogeneous with firms belonging to different size class. In order to account for the varied size of the firms in the sample, we classify firms as small and medium sized firms (SMEs) and large firms based in terms of median assets. Therefore, a firm is identified as a large firm if its assets are greater than the median industry assets. Alternatively, if firm assets are less than the median industry assets, we classify the firms as SME firms. Table 5 reports the estimation by firm size, where we observe a positive and significant coefficient of servicification across all specifications. However, in terms of coefficient, we observe that the positive impact of servicification is 1.3 to 1.6 times the magnitude for large firms. The results highlights the significant role of servicification in promoting GVC participation of SMEs.

**Table 5: Probit estimation: size classification**

VARIABLES	Small & Medium Firms		Large Firms	
	(1) GVC	(2) GVC	(3) GVC	(4) GVC
L.Servicification	0.293*** (0.0461)	0.306*** (0.0510)	0.219*** (0.0582)	0.191*** (0.0661)
L.LogTFP	0.0108*** (0.00249)	0.0223*** (0.00342)	0.00636* (0.00343)	0.0220*** (0.00492)
L.LogAge	-0.0109*** (0.00414)	0.000394 (0.00563)	-0.0447*** (0.00609)	0.00322 (0.00808)
L.Leverage	-0.0233*** (0.00703)	-0.0211*** (0.00762)	-0.0332*** (0.0103)	-0.0395*** (0.0116)
Foreign	0.0287*** (0.00957)	0.0243** (0.00995)	0.000926 (0.00959)	-0.00624 (0.0105)
Year FE	No	Yes	No	Yes
Industry FE	No	Yes	No	Yes
Observations	21,619	21,619	22,950	22,950

All columns report marginal effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5.4 Technology Classification

The technology defining the production process is not homogeneous across industries. Moreover, as highlighted in panels (a) and (b) in Figure 4, the servicification phenomenon is relatively more prominent for technology-intensive industries, where technology intensive industries have a higher service expenditure compared to low technology industries. We examine the impact of servicification on GVC participation of firms on sub-sample of firms belonging to technology-intensive and low technology industries.

Results are reported in Table 6, which again highlights the positive and significant impact of servicification on GVC participation for both high-tech and low-tech industries. However, despite higher services expenditure of high-tech industries, the magnitude of the servicification coefficient is larger for low-tech industries. This highlights that participation in GVCs by using services inputs is not restricted to high-tech firms as it increases the participation of low-technology firms. Further, the results of the controls are consistent with the baseline results.

**Table 6: Probit Estimates: Technology Classification**

VARIABLES	High-Tech		Low-Tech	
	(1) GVC	(2) GVC	(3) GVC	(4) GVC
L.Servicification	0.221*** (0.0630)	0.173*** (0.0668)	0.315*** (0.0459)	0.293*** (0.0560)
L.LogTFP	0.0217*** (0.00482)	0.0189*** (0.00581)	0.00932*** (0.00304)	0.00245 (0.00405)
L.LogSize	0.0150*** (0.00288)	0.0239*** (0.00345)	0.0124*** (0.00201)	0.0320*** (0.00276)
L.LogAge	-0.0406*** (0.00769)	-0.00773 (0.00898)	-0.0433*** (0.00483)	-0.00141 (0.00603)
L.Leverage	-0.00572 (0.0114)	-0.0204* (0.0123)	-0.0300*** (0.00690)	-0.0454*** (0.00798)
Foreign	0.0156 (0.0109)	0.0136 (0.0114)	0.0116 (0.00800)	0.00180 (0.00902)
Year FE	No	Yes	No	Yes
Industry FE	No	Yes	No	Yes
Observations	19,529	19,529	25,007	25,007

Notes: (i) All columns report marginal effects. (ii) High Technological industries: NIC – 20, 21, 26, 27, 28, 29, 30 & 32. Low Technological industries are: NIC- 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25 & 31. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Having established the importance of servicification for both high-tech and low-tech industries, we further examine the channels through which servicification operates for the high-tech and low-tech industries. To understand these dynamics, we estimate Equation (1) for the two industry sub-groups with each servicification component as the key explanatory variable. Table 7 presents the results of this empirical analysis. In Table 7, we observe that firm's

investment in R&D is the significant factor driving the servicification on GVC participation of high-tech firms. On the other hand, we find that investment in downstream aspects of supply chains through selling and distribution expenses and service-linkage variable such as the communication services drives GVC participation of firms from low-tech industries. The empirical analysis highlights that the impacts of servicification tends to be different across the industries, which is based on the technological intensity of firms.

**Table 7: Probit estimates: channels of servicification**

VARIABLES	HIGH-TECH				LOW-TECH			
	(1) GVC	(2) GVC	(3) GVC	(4) GVC	(5) GVC	(6) GVC	(7) GVC	(8) GVC
L.S&D	0.0650 (0.0882)				0.316*** (0.0620)			
L.Outsourced		0.209 (0.331)				0.513 (0.350)		
L.Communication			2.373 (1.450)				3.890*** (1.274)	
L.R&D				0.358** (0.178)				-0.621 (0.582)
L.LogTFP	0.0150** (0.00583)	0.0182*** (0.00600)	0.0180*** (0.00692)	0.0364*** (0.0120)	0.00194 (0.00413)	0.00238 (0.00425)	0.00475 (0.00492)	-0.000376 (0.0142)
L.LogSize	0.0252*** (0.00347)	0.0247*** (0.00349)	0.0301*** (0.00403)	0.0134** (0.00642)	0.0324*** (0.00280)	0.0330*** (0.00284)	0.0369*** (0.00330)	0.0327*** (0.00875)
L.LogAge	-0.00914 (0.00908)	-0.00627 (0.00913)	-0.00897 (0.0104)	-0.0198 (0.0165)	-0.00157 (0.00615)	-0.00206 (0.00621)	-0.00115 (0.00731)	-0.0292* (0.0173)
L.Leverage	-0.0259** (0.0125)	-0.0211* (0.0124)	-0.0167 (0.0146)	-0.0146 (0.0225)	-0.0477*** (0.00817)	-0.0501*** (0.00821)	-0.0583*** (0.00935)	-0.0576*** (0.0215)
Foreign	0.0129 (0.0116)	0.0144 (0.0116)	0.0145 (0.0134)	0.00939 (0.0195)	0.00249 (0.00915)	0.00112 (0.00925)	0.0103 (0.0119)	0.00304 (0.0229)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	19,179	19,196	14,210	8,041	24,444	23,978	17,949	4,758

Notes: (i) S&D represents selling and distribution expenditure. Outsourced represents expenditure on outsourced professional jobs. Communication is firm's expenditure on communication and R&D is expenditure on research and development. (ii) High Technological industries: NIC – 20, 21, 26, 27, 28, 29, 30 & 32. Low Technological industries are: NIC- NIC- 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25 & 31. (iii) All columns report marginal effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 6. Robustness

### 6.1. Endogeneity

Another important issue in our estimation is the possibility of endogeneity problems. Endogeneity issues in the empirical model originates from reverse causality, where extensive integration into GVC could drive greater use of service inputs in production (Thangavelu et al., 2018). The endogeneity concern induces certain biasness in the probit estimation. To address the endogeneity concerns, we use an instrumental variable approach in discrete choice estimation framework of the probit estimation (IV-Probit). We use the average industry level of service expenditure as a suitable instrumental variable. The use of industry averages as instruments is justified by the underlying rationale that firms from similar industries experience similar service needs, and may have comparable service expenditure. However, a decision to

participate in GVCs is firm-specific and is not conditional upon the servicification of other firms in the industry. Therefore, the instrument satisfies the relevance and exogeneity condition.

**Table 8: IV-Probit model: impact of servicification on GVC participation of the firm**

VARIABLES	(1) GVC	(2) GVC	(3) GVC
L.Servicification	1.458*** (0.258)	1.289*** (0.280)	1.113*** (0.292)
L.LogTFP		-0.00385 (0.00552)	-0.00596 (0.00555)
L.LogSize		0.0323*** (0.00362)	0.0370*** (0.00389)
L.LogAge		-0.0265*** (0.00739)	-0.0226*** (0.00735)
L.Leverage		-0.0437*** (0.0169)	-0.0529*** (0.0171)
Foreign		0.0207 (0.0175)	0.00895 (0.0176)
<b>First Stage</b>			
Instrument	0.962*** (0.044)	0.86*** (0.043)	0.846*** (0.044)
F-Stat	482.44	148.36	45.66
Wald Test	13.18***	13.38***	9.44***
Year Dummy	No	No	Yes
Observations	44,564	44,564	44,564

Notes: (i) All columns report marginal effects. (ii) Instrument used is average industry servicification not taking into account firm servicification for the firm in consideration. (iii) We do not include industry fixed effects since the instrument is constructed at industry level. Standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 8 presents the findings of the IV-Probit regressions. The coefficients reported in the Table supports earlier estimation of a positive and statistically significant impact of servicification on the GVC participation of the firm. Further, the first stage results show the significance of the instrumental variable adopted in the estimation, highlighting that the instrument satisfies the relevance condition. Moreover, the instruments used do not suffer from weak instruments evident from the F-statistics, which is statistically significant (Staiger and Stock, 1997). We also observed that the coefficients of productivity and foreign ownership are not statistically significant. However, results of other controls are similar to earlier findings, as younger and less leveraged firms are more like to participate in GVCs.

## 6.2. Alternate GVC measure

To further examine the validity of our findings, we employ two alternate measures of GVCs. First, we impose an additional restriction to our baseline metric of GVC, where we consider a sample firm as GVC firm, if it exports and imports 10% of its sales simultaneously for at least

three years continuously (GVC-A). As a result, the percentage of GVC firms in the sample reduces from 14.7% to 12.7%.

**Table 9: Probit estimates: robustness – GVC\***

VARIABLES	(1) GVC-A	(2) GVC-A	(3) GVC-A	(4) GVC-A
L.Servicification	0.182*** (0.0303)	0.177*** (0.0286)	0.133*** (0.0280)	0.119*** (0.0260)
L.LogTFP		0.0102*** (0.00202)	0.00114 (0.00192)	0.00673*** (0.00213)
L.LogSize		0.00681*** (0.00126)	0.0147*** (0.00123)	0.0129*** (0.00128)
L.LogAge		-0.0303*** (0.00314)	-0.00314 (0.00347)	0.00104 (0.00328)
L.Leverage		-0.0140*** (0.00511)	-0.0227*** (0.00496)	-0.0178*** (0.00441)
Foreign		0.00793 (0.00487)	0.00352 (0.00465)	0.00261 (0.00405)
Year FE	No	No	Yes	Yes
Industry FE	No	No	No	Yes
Observations	44,569	44,569	44,569	44,569

Note: \*GVC firm is defined as a dummy variable if a firm simultaneously imports and exports 10% of its sales for three years continuously. All columns report marginal effects. Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 9 presents the results using the alternate measures of GVCs. From Table 9, we observe a statistically significant and positive impact of servicification on GVC participation. The Table also shows that productive, younger, larger, and less financially constrained firms are more involved in GVCs, supporting our baseline estimates.

## 7. Conclusion

In this paper, we examine the role of servicification on GVC participation of Indian manufacturing firms. We use detailed firm-level data of an unbalanced panel of 4608 firms from 2001-2018. We adopted the discrete-choice modelling framework of the probit model. The empirical analysis reveals that manufacturing firms using service inputs in production are more likely to participate in GVCs. We also find that servicification promotes GVC participation of SMEs. Further, the gains from adopting services inputs in production has positive impact on less technology intensive firms to participate in the GVC. The results of the study is very robust alternate specifications and measures of GVCs.

The findings of the study highlights that the servicification as a key factor promoting GVC participation of the firms. Policies promoting complementarity between services and the manufacturing sector could enable greater integration of services by manufacturing firms. Hence, providing an avenue for Indian manufacturing firms to increase their global presence in GVCs.

Further, the study also highlights different channels through which servicification affects firms from high-tech and low-tech industries. This finding can enable policymakers to draft different policies focusing on high-tech and low-tech industries separately.

However, despite a robust empirical analysis, the present study is not free from limitations. Identifying the origin of services, i.e., distinguishing between domestic and foreign services, could help identify the key source of service advantage for Indian firms. However, data limitation at the firm level restricts us from undertaking such an empirical exercise. In addition, the lack of granular data on trade dynamics also restricts us from using refiner metrics of GVC participation of (Koopman, Wang, & Wei, 2014).

The results of the study clearly indicates the importance for services and service activities in the manufacturing activities to increase the GVC participation of the Indian firms. Further, there should be policies to address the GVC participation of SMEs in India and the complementarity of policies in promoting manufacturing and services industries are very apparent from the results of the study. In particular, the greater services activities in the economy, especially in the manufacturing activities, open up opportunity for SMEs and also less technology intensive firms to participate in the GVC activities. The participation of GVC activities increase the competitiveness and productivity of the Indian firms and hence the positive impact on economic growth in the long-run.

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## Annexure

**Table 1: Summary Statistics [Move to Annex]**

Variable	Description	Obs	$\bar{X}$	Std. Dev.	Min	Max	GVC Firms			Non-GVC Firms			T-Test
							Obs	$\bar{X}$	Std. Dev.	Obs	$\bar{X}$	Std. Dev.	
GVC	=1 if firm exports and imports at least 10% of its sales	50098	0.147	0.354	0	1							
Servicification	Firm expenditure on selling & distribution, outsourced professional jobs, communications expenses, and R&D normalized to total expenditure	50098	0.047	0.047	0.001	0.271	7374	0.056	0.043	42724	0.046	0.047	0.010***
Log TFP-LP	Log of TFP measuring following Levinsohn and Petrin (2003)	50098	4.038	1.093	1.457	6.881	7374	4.18	1.105	42724	4.013	1.089	0.167***
Log Size	Log of total assets	50098	7.035	1.677	3.405	12.095	7374	7.757	1.64	42724	6.911	1.652	0.846***
Log Age	Log of Number of years firm has been in operation	50098	3.217	0.571	1.386	4.511	7374	3.233	0.532	42724	3.215	0.577	0.018***
Leverage	Debt/total assets	50098	0.387	0.292	0.001	2.663	7374	0.352	0.235	42724	0.393	0.3	-0.040***
Foreign	=1 if Foreign promoters share (%) >10%	50098	0.055	0.229	0	1	7374	0.084	0.278	42724	0.05	0.219	0.033***

Note: t-test tests the null hypothesis that the mean values of a variable are equal for GVC and non-GVC firm

