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Servicification and global value chain survival: Firm-level evidence from India

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Abstract

In this article, we study the role of servicification in sustaining global value chain participation. To empirically analyse the role of firm servicification on GVC survival, we draw information from a sample of 1,227 Indian manufacturing firms over 2001–2018. We use a complementary log–log model and find that higher servicification is associated with a lower hazard rate. Moreover, we account for the reverse causality in the model using a two-stage residual inclusion method and correct for self-selection using the propensity score matching estimator. Our finding of servicification aiding GVC survival remains robust to the endogeneity concerns. Further, our analysis also underscores the importance of servicification for sustaining GVC participation for firms with short-trading spells.

KEYWORDS

exit, global value chains, manufacturing, servicification

JEL CLASSIFICATION

F1, F14, L8

1 | INTRODUCTION

During recent years, rapid advancements in global value chains (GVCs) have not only altered the dynamics of production across nations, but also changed the production dynamics within a firm. With the rise in GVCs, there is an increasing tendency of manufacturing firms to engage in high-value added service activities referred to as 'servicification' (Chun, Hur, & Son, 2021). This tendency of manufacturing firms to increasingly engage in service activities in GVCs can be attributed to the sequential linkage of production activities in a GVC. As elucidated by the

smile curve,[1] services are extensively employed in GVCs starting from upstream services like research and development (R&D), product design to downstream services such as sales and after-sales services (Rungi & Del Prete, 2018). These segments are also characterised by high-value addition compared to manufacturing activities, which are associated with lower value addition. Therefore, greater integration of services by manufacturing firms provides a competitive advantage in the market (Cui & Liu, 2018).

In this regard, the competitive advantage from servicification materialises from multiple avenues. First, manufacturing firms bundle services solutions with their products to create differentiated products, which reduces the probability of replication and substitution in the market (Cui & Liu, 2018; Low, 2013). Second, similar effects accrue through the integration of upstream services in the form of R&D. To elucidate further, the contribution of firm innovation stems from the feasibility of innovative firms to introduce new effective products (Deng, Guo, Zhang, & Wang, 2014). Further, innovation also enables firms to improve their absorptive capacity as well as remain closer to the technological frontier, which contribute towards improving competitive advantage and longer survival in global market (Dai, Liu, & Lin, 2020; Fontana & Nesta, 2009; Zhang, Zheng, & Ning, 2018). For instance, Cui and Liu (2018) highlight that Haier, leading electronics Chinese MNC launched an innovative 'full life cycle service model', which provides complete service solutions from research, design to production, sales and even recycling services, made Haier commercial freezers a completely differentiated product in the market. Third, through servicification, firms can increase the value of their products and increase their profitability (Chun et al., 2021; Zhang et al., 2018).

In addition to making firms more competitive, servicification is also an important enabler of trade. Servicification provides the necessary logistical and business support, which are essential for firms to participate in GVCs and maintain inter-firm linkages (Gereffi & Fernandez-Stark, 2011; Heuser & Mattoo, 2017). Owing to its importance in GVCs, Low (2013) refers servicification as the *glue* which holds supply chains[2] together. Moreover, servicification is also a channel of upgrading in GVCs as firms shift from low-value added tasks towards high-value added upstream and downstream activities (Lodefalk, 2017; Thangavelu, Wang, & Oum, 2018).

Given the crucial role of servicification in the functioning of GVCs and creating a comparative advantage for manufacturing firms, servicification has implications for the duration of firms in GVCs. In this study, we aim to study whether servicification promotes GVC survival of Indian manufacturing firms. Our decision to undertake this analysis for India is driven for the following factors. First, the services sector is fundamental in India's exporting landscape. Based on the OECD-TiVA database,[3] in 2016, overall services value-addition in India's gross exports was 52.04% compared to 33.12% in China and 46.36% in ASEAN economies. A further breakdown reveals significant contribution of domestic services value-addition (46.1%) indicating prominence of domestic services in promoting Indian exports. Therefore, servicification could help resuscitate the Indian manufacturing sector whose contribution to India's GDP has remained stagnant at 15% over the past two decades. Second, Lee (2019) highlights that services can help firms tap into their comparative advantage in labour-stages of production thereby aiding firms GVCs integration. Further, servicification provides an avenue for utilising India's comparative advantage in its large labour pool. Such integration has the potential of generating employment for 40 million workers by 2025 (GOI, 2020). In order to realise these potential gains, it becomes pertinent to evaluate the factors that influence the exit and survival of firms in GVCs.

By exploring the association between servicification and GVC survival, we make certain key contributions to the literature. To begin with, our study advances the limited literature

exploring firm survival in GVCs. In this regard, our study is closely related to Cui and Liu (2018), which examines the implications of manufacturing servitization on Chinese exports. However, our study deviates from Cui and Liu (2018) in two distinct ways. First, Cui and Liu (2018) capture servicification using global input–output tables. However, the present study captures servicification at the firm level. Consequently, our study advances the scant literature on servicification at the firm level. Second, the emphasis of Cui and Liu (2018) is on manufacturing exports compared to our analysis, which focuses on the GVC integration of firms. In this regard, capturing the servicification-GVC linkage at the firm level is important as participating in GVCs and engaging in service-oriented activities in essence is a firm phenomenon. Therefore, in line with the burgeoning strand of literature on GVC at the firm level, we identify GVC firms as those that are engaged in both importing and exporting activities simultaneously at time t. Subsequently, we identify the GVC exit of the firm using a binary variable, if the firm is characterised as a GVC firm at time $t-1$ but not at time t. Further, we capture manufacturing servicification at the firm level by taking into account firm expenditure on services related to the upstream, downstream segments of value chains. Therefore, by capturing both servicification and GVC survival at the firm level, this study captures the significance of firm heterogeneity in shaping integration and survival in trade activities for Indian manufacturing firms. Moreover, by examining the role of servicification on GVC survival of Indian firms, we contribute to the strand of literature focusing on GVC dynamics in Asia (Anukoonwattaka, Scagliusi, & Mikic, 2015; Thangavelu et al., 2018).

Against this backdrop, using rich firm-level data from the CMIE (Centre for Monitoring Indian Economy)-PROWESS database for the period 2001–2018, the empirical analysis discerns the significance of servicification in reducing the probability of exit for Indian GVC firms. Further, correcting for endogeneity bias in the model using a two-stage residual inclusion estimator and employing propensity score matching procedure to correct for selection bias, this study finds a significant role of firm servicification in sustaining GVC participation of Indian manufacturing firms. The rest of the article is organised as follows. Section 2 documents the existing literature. Section 3 introduces the data source and variables used in the empirical analysis. Section 4 sheds light on the empirical methodology. Section 5 presents the results of the analysis followed by the conclusion.

2 | REVIEW OF LITERATURE

In this section, we present a brief overview of studies connected to the themes of servicification and GVC survival. However, given the burgeoning strand of literature on both servicification and GVCs, we connect three different strands of literature. First, we document the importance of servicification in the GVC framework. Second, we review the nascent literature on survival in GVCs. Third, we navigate through these related strands to highlight some existing evidence on servicification and GVC survival.

Over the past decade, the rising importance of servicification has received growing attention in the trade literature. For instance, using national input–output tables of Sweden, Lodefalk (2013) highlights the doubling of services input usage during 1975–2005. Similarly, using input–output tables from the OECD-TiVA database, Miroudot and Cadestin (2017) report that services contribute to 37% of manufacturing exports. Thangavelu et al. (2018) document the value-added share of services at 68% for RCEP[4] economies. In addition to the use of regional and global input–output tables, studies have also documented the rising phenomenon of

manufacturing firms undertaking service-oriented activities. For example, Neely (2008) highlights that 30% of manufacturing firms provided services. National Board of Trade (2010) in a case study of a Sandvik Tooling manufacturing firm in Sweden reported that the firm provides 40 services to sustain its GVCs. Crozet and Milet (2017) note that over three fourth of French manufacturing firm offers services. Kelle (2013) underscores that German manufacturing firms contribute 25% of service exports.[5] In the context of India, earlier studies have emphasised the importance of services inputs in production and value-added exports of Indian manufacturing. For example, Banga and Goldar (2007) highlight the contribution of services inputs to the output and productivity growth of 148 three-digit manufacturing industries. Similarly, Goldar (2020) using plant-level data over 1998–2013 underscore that services and information and communications technology (ICT) inputs play a positive and significant role on the TFP of Indian manufacturing plants. Mukherjee (2018) reports similar findings in the context of Indian manufacturing. More recently, Chakrabarty and Chanda (2019) using the TiVA database show that in terms of value-added, services exports contribute significantly to manufacturing exports. Similarly, Goldar, Banga, and Banga (2018) document a positive association between service input usage and export performance of Indian manufacturing. However, even though studies acknowledge the importance of services inputs in the Indian context, literature is still scanty concerning the implications of servicification on GVC participation and the survival using firm-level information.

Having documented the existing landscape of servicification literature, we proceed towards the nascent body of literature concerning the survival of firms in GVCs. Although there is a rich strand of literature examining firm survival in the domestic market (Cefis & Marsili, 2005; Esteve-Pérez & Mañez-Castillejo, 2008; Musso & Schiavo, 2008; Pérez, Llopis, & Llopis, 2004) and export market (Dai et al., 2020; Fu & Wu, 2014; Inui, Ito, & Miyakawa, 2017; Obashi, 2010; Zhang et al., 2018), prior studies examining this nexus from a GVC perspective is rather thin. In this context, Obashi (2010) highlights that within the fragmented production structure, trade in parts and components has a longer trade duration compared to finished machinery products in East Asian economies. Türkcan and Saygili (2019) find participation in global production chains a key factor in higher survival probability of Turkish machinery exports. Further, in a case study of the solar photovoltaics industry, Hipp and Binz (2020) report that firm survival in value chains is conditional upon the spatial stickiness of the global innovation system. Córcoles, Díaz-Mora, and Gandoy (2015) focus on the Spanish machinery and transportation equipment sector reveal that at bilateral trade level, market size, product differentiation and distance to a common trade integration area affects the survival of trade relationships in GVCs. Therefore, the brief review of prior studies on survival in GVCs clearly shows the scanty nature of the literature. Further, we observe that existing studies are either based on the experience of a specific industry or export experience through GVCs. However, studies examining the survival dynamics of GVC firms remain sparse.

The two different strands of the literature surveyed highlight that servicification has become a critical aspect of manufacturing trade and its implication on GVC survival has not been explored. A notable exception in this context is the study by Cui and Liu (2018) which examines the impact of servicification[6] on the survival of Chinese exports. The study captures servicification at the industry level and highlights the positive impact of manufacturing servitization on Chinese export duration. However, as mentioned earlier, our study differs from Cui and Liu (2018) since we examine servicification from a firm-level perspective and we focus on the GVC participation as opposed to the standard practice of export duration analysis.

Therefore, we advance this fledgling strand of literature by examining the role of servicification on the GVC survival of Indian manufacturing firms.

3 | DATA AND VARIABLES

We use data from the CMIE-PROWESS database, a widely used dataset in the literature (Banga, 2022; De Loecker, Goldberg, Khandelwal, & Pavcnik, 2016; Stiebale & Vencappa, 2018; Topalova & Khandelwal, 2011). The dataset maintained by the CMIE-PROWESS provides firm-level information on all listed and large number of unlisted firms sourced from their balance sheets and audited financial statements. The firms covered in the database account for 70% of the country's organised economic activity, 75% corporate taxes, 95% of excise duty, 50% exports and 60% of imports (Banga, 2022; Goldberg, Khandelwal, Pavcnik, & Topalova, 2010; Topalova & Khandelwal, 2011). Previously, Dzhumashev, Mishra, and Smyth (2016), Mallick and Yang (2013) and Padmaja and Sasidharan (2017) employed this database to examine the entry-exit dynamics of Indian firms.[7] We use annual data from 2001 to 2018 for manufacturing firms at 2-digit National Industrial Classification (NIC).

One of the first steps involved while undertaking survival analysis is to identify the key variables of interest and then render the data suitable for undertaking survival analysis. In order to define firm exit, we first need to identify GVC firms. In this regard, based on the recent work of Antràs (2020), Baldwin and Lopez-Gonzalez (2015), Dovis and Zaki (2020), Urata and Baek (2020), World Bank (2020) and Banga (2022), we define GVC firm as those involved in exporting and importing activities simultaneously.[8] The underlying rationale behind this definition is that it accounts for value-addition from two countries, hence identifying firms involved in a fragmented production process (Rigo, 2021). Consequently, we define firm *exit* using a binary variable that takes the value 1 if the firm exits the GVC market at time t and was part of GVC in $t-1$.

The key variable of interest in our analysis is the servicification of manufacturing firms. As mentioned earlier, from a GVC perspective, activities at the upstream and downstream end of the value chains are services activities (Lodefalk, 2014; Mudambi, 2008). In order to identify servicification, we draw information from firms audited financial statements about their expenditure on activities that can be characterised as services. In this regard, we obtained information on firms' investment in R&D and outsourced professional jobs proxying for firm's expenditure on upstream services.

Similarly, to account for the involvement of manufacturing firms at the downstream end of the value chain, we use information on selling and distribution expenditure incurred by a firm. Finally, another important component of servicification comes from its characteristic of being an enabler of trade. Hence, we use data on information and communication technology expenditure to proxy for this aspect of servicification. Consequently, we define firm servicification as firm's expenditure on the aforementioned services activities relative to total expenditure incurred by a firm. Our measure of firm servicification is similar to Nordwal (2016), which proxy firm servicification through the firm's expenditure on services relative to input expenditure.

Having defined our key measures of GVC and firm servicification, we move to discuss steps involved in the organisation of data suitable for survival analysis. The specific need for structuring the data comes from the empirical concerns of censoring, which originates due to the inability of observing the complete history of the firm (Besedeš & Prusa, 2006). Therefore, censoring

can be of two kinds, that is, (a) left-censoring and (b) right-censoring that besets the empirical analysis by inducing bias in the estimates (Cui & Liu, 2018). Given that the aim of the present study is to examine the survival of firms in GVCs, left-censoring is of concern. Left-censoring refers to firms that are GVC firms at the beginning of our study period, that is, 2001 and, therefore we do not have information to identify the start of GVC association of the sample firms. One standard strategy advocated in the survival literature to overcome the issue of left censoring is to exclude all left-censored spells (Besedeš & Prusa, 2006; Córcoles et al., 2015). In other words, we consider only those firms, which were non-GVC firms in 2001 and began GVC activities during 2002–2018.

Contrary to left-censoring, the concept of right-censoring refers to those firms, which continue to be GVC firms at the end of our study period, i.e., 2018 (Besedeš & Prusa, 2006; Fu & Wu, 2014). Therefore, we do not know their status of GVC participation after our study period ends. However, unlike left censoring, survival analysis methods can overcome the concerns raised by right-censoring spells (Cui & Liu, 2018).

For the data cleaning process, we dropped all the left-censored spells. Further, we also dropped firms with missing or negative information on sales, assets, capital, wages and age of the firm. We also drop firms with less than 3 years of data in the sample. After our data cleaning process, we are left with a sample of 1,227 firms corresponding to 10,986 firm-year observations. Table 1 presents the statistical description of the duration of firms in GVC. From the table, we observe that almost one-fourth of the firms survive for 1 year, while only 5% of the firms survive for 5 years. Further, among 1,227 firms only 3 firms remain GVC firms throughout the study period.

TABLE 1 Global value chain (GVC) duration of Indian manufacturing firms

Survival years	Number of firms	Percentage
1	298	24.29
2	234	19.07
3	174	14.19
4	118	9.61
5	73	5.95
6	74	6.03
7	44	3.59
8	48	3.92
9	31	2.52
10	25	2.03
11	30	2.44
12	22	1.80
13	18	1.47
14	18	1.47
15	10	0.81
16	7	0.57
17	3	0.24
Total	1,227	100

Though Table 1 depicts the GVC survival statistics, it does not highlight the sequence of firms' integration in GVCs. That is, firms that participate in international trade may exit the global market only to re-enter and then exit again. Therefore, a firm may have multiple spells over the study period. Table 2 highlights the GVC participation sequence of our sample firms to highlight the pattern of single and multiple spells in the data. From the table, we observe that 43% of the firms have single spells wherein a firm never exits from GVC (first row, Table 2). These observations highlight right-spells in the data. Further, another 34% of the firms experience a single spell, where a firm exits to never re-enter GVCs (second row, Table 2). The other 22% of the firms experience multiple spells as highlighted in the table. Further, we follow the empirical strategy following Besedeš and Prusa (2006) and treat multiple spells as independent observations.

Further, we perform the Kaplan–Meier (KM) estimation, a non-parametric estimation, to observe the role of servicification on the GVC duration of the sample firms. To plot the survival estimates, we first classify our sample firms into high and low servicification firms. To this end, first, a firm is grouped into high servicification category, if its servicification is above the industry median for a particular year, otherwise, the firm falls under the low servicification category. Alternatively, we use industry mean to group firms as high and low servicification firms. Figure 1a provides the KM survival estimates for high and low servicification firms based on median classification, while Figure 1b shows mean classification. Survival probabilities are on the vertical axis and the figure reveals that high-servicified firms have higher survival probability compared to low-servicified firms. The KM estimation provides preliminary evidence about the positive role of manufacturing servicification on GVC survival of Indian firms.

TABLE 2 Global value chain (GVC) sequence order

Sequence-order	Frequency	Percentage
00	535	43.60
01	424	34.56
0101	112	9.13
010	103	8.39
01010	20	1.63
010101	17	1.39
01010101	7	0.57
101	4	0.33
0101010	3	0.24
0101010101	1	0.08
10	1	0.08

Note: (a) '0' refers to firm when it participates in GVC and '1' depicts its exit from GVCs. (b) For brevity, we report the grouped sequence order. The sequences are considered similar based on order similarity, that is, sequences are similar where the elements appear in the same order. The sequence A-B-B-A is treated identical to A-B-A-A, because the elements A and B appear in the same order in both sequences (first A, then B and then A again). For example, 001, 00001, 0000001, 000000001, 011111111111111 are all treated as similar because once a firm exits it does not re-enter in again.

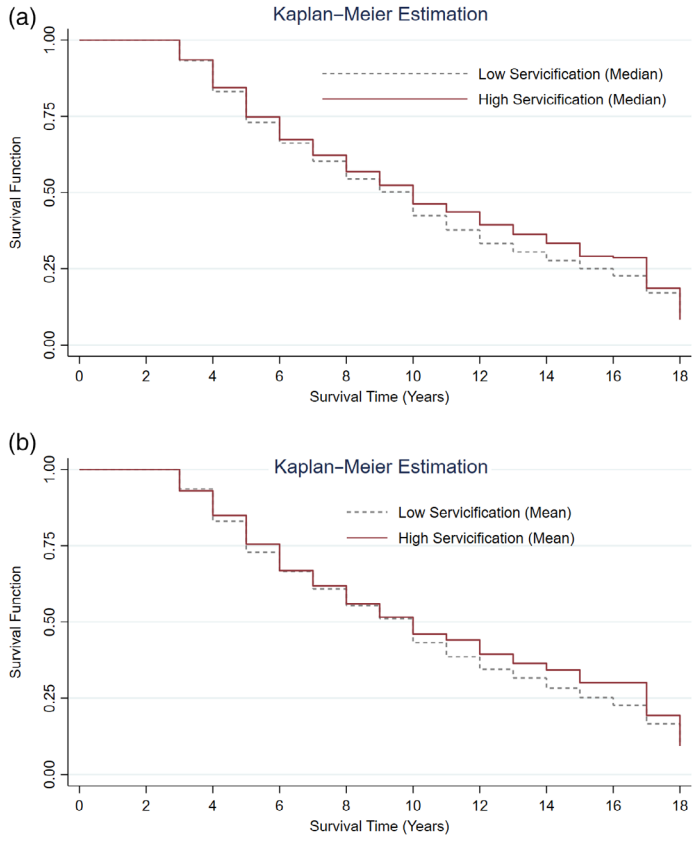

FIGURE 1 Kaplan–Meier estimation of manufacturing servicification. (a) Median Classification (b) Mean Classification [Color figure can be viewed at wileyonlinelibrary.com]

4 | EMPIRICAL STRATEGY

To empirically examine the role of servicification on firm survival, we use discrete-time complementary log–log (cloglog) model. Our modelling choice is driven by the ability of the discrete-time model to account for unobserved heterogeneity and suitability for censored data. Further, it overcomes the limitation of Cox model (Dai et al., 2020; Fu & Wu, 2014; Inui et al., 2017; Zhang et al., 2018). We estimate the following discrete-time cloglog model.

$$\text{cloglog}(1-h_{it}) = \beta_0 + \beta_1 \text{Servicification}_{i,t-1} + \mathbf{Z}_{i,t-1} + \gamma_t + \delta_j + \mu_{it}. \quad (1)$$

In Equation (1), h_{it} is the discrete-time hazard rate which measures the probability that a firm i exits GVC at time t. Our main coefficient of interest is servicification, which represents the level of servicification among the sample firms. δ_j and γ_t are industry and time fixed effects,[9] which account for the changes in exit behaviour attributable to changes in firm dynamics across industry and time. Further, we lag all explanatory variables by 1 year, since the impact of these variables on firm survival transpires with some lag. Further, lagging all explanatory variables also reduces the presence of contemporaneous effects in the model.

In Equation (1), **Z** represents a vector of firm-specific controls. First, we control for the initial export value for each GVC firm. The inclusion of this control is driven by the literature, which highlights that firms with larger initial export sales survive longer (Córcoles et al., 2015; Rauch & Watson, 2003). For instance, Impullitti, Irarrazabal, and Opromolla (2013) using a theoretical model and numerical simulations highlight that in the presence of negative efficiency shocks, firms with larger initial export sales experience a fall in exports but not to the extent that triggers their exit from the market. Further, a higher volume of initial export transactions in the presence of uncertainty also represents trust among the trading firms thereby reducing the probability of failure (Rauch & Watson, 2003). This factor becomes crucial from a GVC perspective since coordination among firms plays a pivotal role in the production process (Córcoles et al., 2015).

Second, we control for firm productivity proxied by the total factor productivity (TFP). The inclusion of TFP is in line with the new-new trade theory, which posits the importance of productivity in supporting firm's integration in global markets (Melitz, 2003). Further, from a survival perspective, productive firms are more profitable, which lowers their risk of failure in international markets (Dai et al., 2020; Roberts & Tybout, 1997). We compute TFP using the semi-parametric method following Levinsohn and Petrin (2003).[10]

Third, we control for age of the firm to account for firm experience, which improves the odds of firm entry and survival in global markets (Roberts & Tybout, 1997). We compute firm age as the number of years since its incorporation. Fourth, we control for firm size as log of total assets of the firm.[11] Inclusion of firm size receives strong support from the literature, which highlights that large firm reaps the benefits of economies of scale and, therefore, are more competitive in global markets which increases their survival (Fu & Wu, 2014). However, some studies have also documented the possible negative impact of firm size on export survival accentuating that larger firms are prone to a higher rate of failures due to rigid management modes and large size of operation (Dai et al., 2020).

Fifth, we include an indicator of firms financial health as a covariate in our cloglog model. It is well established in the literature that participation in international trade is associated with significant investments. Hence, the importance of finance is critical for firms' decision to participate as well as their ability to sustain in the global market (Cui & Liu, 2018; Minetti, Murro, Rotondi, & Zhu, 2019; Musso & Schiavo, 2008). Further, as mentioned earlier, components of servicification include R&D, ICT, outsourced professional jobs and selling and distribution expenses, which also warrant investment from firms. Therefore, financial constraint impedes firm investment in these activities, which further hamper its survival probability. To account for this concern, we proxy the financial condition of firms using liquidity (Cui & Liu, 2018; Greenaway, Gullstrand, & Kneller, 2005). We measure liquidity as the difference between firms' current assets and liabilities to the total assets. A higher value indicates better financial health of the firm and its ability to undertake investments. Finally, we control for the presence of foreign ownership since foreign-owned firms have better access to technology, networking advantages and access to information on foreign markets, which aids their survival (Padmaja & Sasidharan, 2017). We define foreign ownership following the criteria used by the Reserve Bank of India (RBI),[12] as firms with foreign promoters share greater than 10%. Consequently, we use a dummy variable that takes the value one, if the foreign promoter's share is greater than 10% and zero otherwise.

Table 3 presents a brief summary of variables used in our analysis. From the table, we observe that 47% of the firms are GVC firms, and 44% of these firms exit from GVCs. The overall exit in the sample is approximately 21%. Further, the mean value of the initial export

TABLE 3 Variable definition and descriptive statistics

Variable	Definition	Obs.	Mean	*SD*	Min	Max
GVC	=1 if firm exports and imports at time *t* and 0 otherwise	10,986	0.472	0.499	0	1
GVC exit	=1 if GVC = 0 at time *t* and GVC = 1 at *t* − 1	10,986	0.208	0.406	0	1
Initial export	First export/sales transaction of a firm	10,986	0.137	0.241	0.001	1.584
Servicification	Firms' expenditure on R&D, ICT, outsourced professional jobs and selling and distribution expenses normalised to total expenditure of a firm	10,986	0.042	0.041	0.001	0.196
Age	Number of years a firm has been in operation	10,986	24.169	13.968	1	100
Log TFP	Log of total factor productivity estimated using Levinsohn and Petrin (2003)	10,986	4.414	1.408	1.887	8.128
Foreign	=1 if foreign promoters share is ≥10% and 0 otherwise	10,986	0.033	0.179	0	1
Log size	Log of total assets	10,986	2.17	1.148	0.421	5.143
Liquidity	Ratio of current assets to liability	10,986	0.228	0.154	0.01	0.607

Note: Firm age is reported in level for descriptive understanding. However, we use log age in the econometric analysis.
Abbreviations: GVC, global value chain; R&D, research and development; TFP, total factor productivity.

transaction is 14% of firm sales. The average age of the firm in the sample is 24 years, and 3.3% of the sample firms are foreign-owned.

In terms of servicification, we note that on average, sample firms spent 4.2% of their total expenditure on services inputs. Moreover, during the study period, we observe an upward trend in the overall expenditure by firms on services inputs (Figure 2). Further, we delve deeper into the servicification aspect by examining the expenditure on service inputs at the 2-digit NIC segregation.[13] Figure 3 presents the servicification by industries over 2001–2018. From the figure, we observe that the chemical industry has the highest servicification followed by pharmaceuticals. On the other hand, tobacco, coke, leather and paper products have the lowest level of expenditure on services, pointing to the heterogeneity of services input requirements by various industries.

5 | RESULTS

5.1 | Baseline results

Table S1 reports the regression results of the cloglog model, highlighting the role of servicification on GVC survival. The first column documents the results in the absence of industry and time fixed effects, while the second column incorporates the industry fixed effects, and Column 3 includes both industry and time fixed effects. From the table, we observe a significant and negative coefficient on firm servicification across all the columns, which unambiguously show that an increase in servicification by manufacturing firms reduces their risk of failure in the GVCs. Based on the coefficient reported in Column 3, we discern that increase in firm

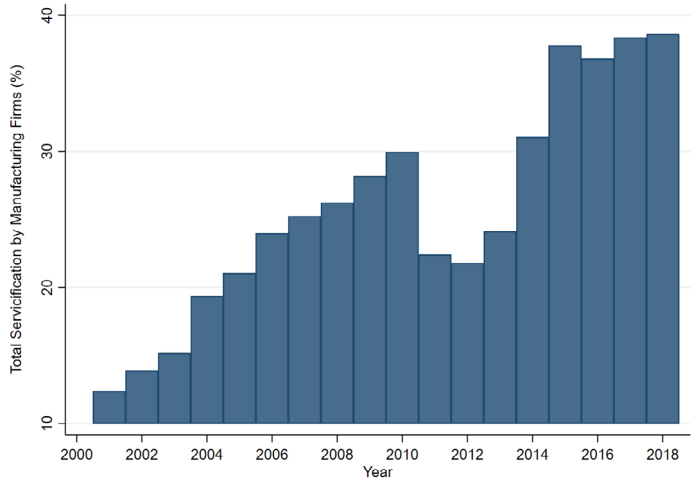

FIGURE 2 Servicification over the years. *Source*: Authors' compilation using CMIE-PROWESS database [Color figure can be viewed at wileyonlinelibrary.com]

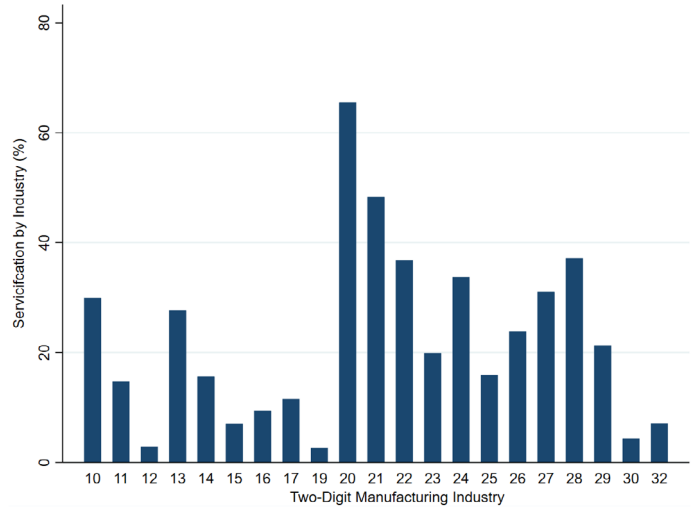

FIGURE 3 Servicification by industries. *Source*: Authors' compilation using CMIE-PROWESS database [Color figure can be viewed at wileyonlinelibrary.com]

servicification reduces the hazard rate of exit by 37%.[14] The positive impact of servicification on GVC survival is similar to the findings of Cui and Liu (2018), which documents a positive association between GVC and servitization of Chinese manufacturing enterprises. Further, in terms of controls, we observe that our findings are in line with the existing literature with firms with higher initial value of exports, higher productivity and firms with better financial health surviving longer in global markets (Córcoles et al., 2015; Dai et al., 2020; Inui et al., 2017; Zhang et al., 2018). Moreover, as mentioned earlier, there is no consensus on the impact of firm size on global market survival because recent studies highlight that large firms face the risk of rigid management practices and high risk due to the large scale of its operations (Dai et al., 2020). In this regard, we observe that larger firms face higher level of hazard rate in GVCs.

5.2 | Endogeneity correction

The preceding analysis highlights the importance of servicification in increasing the likelihood of GVC survival. However, while examining this nexus, our estimated effects could be subjected to endogeneity bias originating from reverse causality. To elucidate this phenomenon, we conceptualise this from a GVC participation perspective (because GVC participation and exit are opposite and jointly determined). In this regard, manufacturing servicification is a factor that aids the GVC participation of the firms. However, at the same time, increased GVC participation could guide firms to intensify their level of servicification. Hence, the possibility of reverse causality may create endogeneity concerns in our baseline model. From a GVC survival perspective, this implies the possibility of increased servicification due to lower GVC exits (i.e., higher survival in GVCs). Therefore, to overcome this source of bias, we estimate two-stage residual inclusion (2SRI) regression.

2SRI approach is a control function approach of correcting endogeneity in non-linear context (Grilli & Murtinu, 2018; Terza, Basu, & Rathouz, 2008). Further, the 2SRI approach is more consistent than two-stage least square (2SLS) approach in cases where the dependent variable is binary in nature (Chen, Heng, Tan, & Lin, 2018; Hong, Park, Lee, & Park, 2019). Further, Tchetgen, Walter, Vansteelandt, Martinussen, and Glymour (2015) highlight the suitability of 2SRI models in the context of censored survival outcomes. Therefore, we use the 2SRI approach to determine the likelihood of GVC exit of the firm while accounting for the endogenous servicification variable. Terza et al. (2008) highlight that 2SRI is a simple estimation procedure and similar to the 2SLS approach because the first stage involves regressing the endogenous variable on the instrument variable and other controls. However, unlike the standard IV approach where the predicted value from the first stage replaces the endogenous variable in the second stage, the 2SRI approach includes the residual from the first stage regression as an additional variable in the second stage regression[15] (Chaturvedi & Prescott, 2020; Ma & Zhu, 2020; Terza et al., 2008).

The implementation of 2SRI is similar to the standard IV approach. In this regard, we instrument the endogenous servicification variable with the industry average servicification, excluding the servicification level of the firm in consideration. The logic behind using industry averages of servicification comes from the understanding that there is heterogeneity among industries in terms of their service requirements. For instance, the computer and electronics industry may require more services compared to the construction industry. Hence, industries with high services requirements would have firms investing more in servicification, which may affect the GVC prospects of the firm. However, at the same time, the investment decision of a firm pertaining to servicification is not conditional upon the servicification expenditure incurred by other firms within the industry. Table S2 presents the results of the 2SRI estimation procedure. From the table, we observe that similar to the baseline results, manufacturing servicification lowers the hazard rate of exit for GVC firms. Moreover, the coefficient reported highlights that after accounting for endogeneity, servicification reduces the likelihood of firm exit from GVC by 53%. Further, the table also shows the significance of higher value of initial export, TFP and liquidity. The coefficient of residual is significant across all specifications, which confirms the presence of endogeneity bias in the model. Therefore, the application of 2SRI reveals the significance of servicification in reducing the likelihood of firm exit from GVCs.

5.3 | Self-selection

In addition to the endogeneity arising from reverse causality, the possibility of further bias in our estimation emerges from the self-selection issue. The underlying rationale of self-selection in our analysis stems from the possibility that GVC firms that have a higher survival likelihood are also more productive (Melitz, 2003). Consequently, the presence of the selection bias makes it difficult to establish the servicification-GVC survival nexus. In order to overcome this concern, we resort to the widely applied propensity matching estimation (PSM) (Rosenbaum & Rubin, 1983) to create a group of non-GVC firms similar to the GVC firms. We match firms based on their age, productivity, foreign ownership, size and financial condition (liquidity ratio).[16] Table S3 presents the results of the first stage probit estimation and the balancing tests of the PSM procedure.[17] From the table, we observe the significance of coefficients reported in the left panel of Table S3. The right panel of the table report the balancing tests. After our matching procedure, we observed no statistical difference between the mean values of the covariates across the two groups as highlighted by the *p* values (last column). Further, the table also highlights the extent of bias reduction achieved after the PSM procedure. Based on the percentage bias reported, we discern that there is a large decrease in the bias between the covariates across the two groups.

The results reported in Table S3 discern that our matching procedure is successful. Following the matching, we estimate Equation (1) on the matched sample. Table S4 documents the results of the cloglog model. From the table, we observe that across all specifications the coefficient of the servicification is negative and statistically significant at 1% significance level. The results reveal that servicification is a critical factor in aiding the survival of manufacturing firms in GVCs. Further, similar to the baseline estimates, we observe that productive firms, firms with higher liquidity and larger initial value of exports reduce the probability of exit from GVCs.

5.4 | Channels of transmission

As described earlier, servicification encompasses activities from upstream and downstream ends of the production chain. Hence, to disentangle the effect of upstream and downstream servicification, we estimate Equation (1) with the upstream and downstream metrics of servicification as the main variable of interest. In this regard, we measure upstream servicification of the firm as the firm's expenditure on R&D and outsourced professional jobs with respect to the firm's overall expenditure. Similarly, downstream servicification included ICT expenditure and selling and distribution expenditure of the firms. Table S5 documents the results of this analysis. From the table, we observe that the coefficient of both upstream and downstream servicification on GVC exit is negative. However, the coefficient is significant at 1% level for downstream servicification compared to the upstream servicification variable (significant at 5%). The results reveal that manufacturing firms in GVC can survive longer through increased investment at either upstream or downstream activities.

5.5 | Trading spells

In Table 1, we highlighted the different lengths of GVC participation of the sample firms. The table showcased that nearly 80% of the firms exit from their GVC integration. This raises the

question, of whether increased servicification could aid the GVC survival of firms with shorter duration. To answer this, we group firms into three categories, i.e., short-duration firms with GVC trade spell below 6 years. Medium-duration firms where the length of GVC duration ranges from 7 to 12 years, and long-term survivor firms with GVC survival period greater than 12 years. The grouping of firms in the range of 6 years is driven by the observation that the average firm survival is 5.5 years and almost 80% of the firms exit within the first 6 years. Hence, we divide the 18-year period into three groups of 6 years each.

Table S6 presents the formal econometric results of cloglog model on the three different groups of firms. From the table, we observe a negative and significant coefficient for servicification in the case of GVC duration less than 12 years. These results documented in Table S6 highlight that increased manufacturing servicification helps firms survive longer in GVCs. Moreover, this impact of servicification is prominent for firms that are more likely to exit in the first 6 years of their first involvement in GVCs.

5.6 | Alternate GVC definition

In the present study, we identify a GVC firm as one that partakes in exporting and importing activities simultaneously. However, in this sub-section, we use two alternative definitions of a firm's GVC participation. In this first definition, a firm is recognised as a GVC firm (GVC-N1), if it simultaneously exports at least 10% of its total sales and imports at least 10% of its sales. In the second definition, we identify a firm to be involved in GVCs (GVC-N2), if a firm is involved in exporting and importing activities simultaneously, and its import of raw materials as a percent of total imports is at least 10%.[18] Imposing restrictions on the minimum level of export integration, import integration and use of intermediate inputs, enables us to identify those firms that are deeply integrated into global production linkages compared to fringe GVC firms.

As mentioned earlier, survival analysis requires the setting up of data that accounts for censoring concerns in the data. With the revised GVC (GVC-N1) definition, our sample consists of 957 firms corresponding to 11,804 firm-year observations. Similarly, with respect to the second definition (GVC-N2), our sample consists of 1,354 firms corresponding to 15,633 firm-year observations. Interestingly, the sample size with the new GVC-N1 and GVC-N2 definition is larger (11,804 for GVC-N1 and 1,354 for GVC-N2) than the baseline GVC measure (10,896). This is due to the stringency of the definition which results in more left censoring spells with the baseline GVC definition compared to the new GVC definitions. Because we remove these left-censored spells from our analysis, we have a higher sample size for the two-alternative metrics of GVC. With this revised definition of GVC, firms exit from GVC is defined using a binary variable that acquires the value 1, when the firm exits from GVC-N1 (GVC-N2) and 0 otherwise. In Table S7, we document the results with the revised definition of GVC-N1 exit, while Table S8 presents the results for GVC-N2. From the tables, we observe that the coefficient of servicification is similar to the baseline estimates, where higher manufacturing servicification results in a lower likelihood of exit from the GVCs.

5.7 | Alternate measure of servicification

Having highlighted the robustness of our findings using an alternate definition of GVC in the preceding section, in this sub-section, we proceed by accentuating the robustness of the servicification measure. In this regard, the study captures firm servicification as manufacturing

firms' expenditure on R&D, outsourced profession jobs, selling and distribution services, and information and communication-related expenditure relative to the total expenditure of the firm, in line with Nordwal (2016). As an alternate measure, we employ the principal component analysis (PCA) to compute a composite variable of firm servicification.

PCA is a multivariate statistical procedure employed to reduce the dimensionality of the dataset into a smaller set of components (Dunteman, 1989; Vyas & Kumaranayake, 2006). These components are a linear combination of the original variables. In our case, we calculate PCA on the four components of servicification (R&D, outsourced profession jobs, selling and distribution services, and information and communication-related expenditure) to derive the new servicification index (Serv-R). In the PCA framework, the variance for each principal component is measured by the eigenvalues. In this regard, to compute Serv-R, we follow Kaiser's rule which suggests the use of components with eigenvalues greater than 1.[19] Consequently, we use component 1 which explains over 35% of variations in the variable. Using Serv-R, we re-estimate the servicification and GVC survival linkage and we find that similar to the baseline estimates, the coefficient on Serv-R is negative and significant. The results reported in Table S9 clearly indicate a robust relationship between firm servicification and GVC survival because higher servicification is associated with longer duration in GVCs.

6 | CONCLUSION

With the rapid rise of servicification phenomena globally, examining the effect of servicification on GVCs becomes an important question. In this regard, this study examines whether higher servicification enables Indian manufacturing firms to sustain longer in GVCs. To provide answers to this question, we use detailed firm-level data obtained from CMIE-PROWESS for a sample of 1,227 Indian manufacturing firms for the period 2001–2018. Employing the complementary log–log model, we find that higher servicification results in a lower hazard rate of exit for Indian GVC firms. Further, while examining the servicification-GVC survival nexus, we account for the endogeneity bias in the model using the two-stage residual inclusion (2SRI) method and correct for self-selection using PSM estimator. Our finding of servicification aiding GVC survival of manufacturing firms remains robust to the endogeneity concerns. Further, our analysis also underscores the importance of servicification for sustaining GVC participation for firms with short-trading spells. The results from this study reveal that by adopting servicification measures, firms can sustain their participation in GVCs which goes in line with India's policy perspective of fostering greater participation in GVCs.

DATA AVAILABILITY STATEMENT

The data used are obtained from a proprietary database and are available on subscription from CMIE-PROWESS (https://prowessiq.cmie.com/).

ENDNOTES

[1] Smile curve highlights that highest value-addition in a value chain happens at the beginning and end of the value chain (Marín-Odio, 2014).

[2] In this study, we use *GVCs* and *supply chains* synonymously.

[3] We use the 2018 version of the TiVA database.

[4] RCEP refers to the Regional Comprehensive Economic Partnership which is a free trade agreement between the major Asia-Pacific nations.

[5] Interestingly, the existing strand on servicification includes studies that focus either on the use of service inputs (Lodefalk, 2013) or incorporation of services in the export basket (Crozet & Milet, 2017; Kelle, 2013). Moreover, Ariu (2016) also observe that Belgian firm trading in goods also add services to their export basket. Aquilante and Vendrell-Herrero (2021) document that German SMEs that bundle goods and services experience higher export intensities, highlighting the importance of services in trade performance of firms. However, the distinction between service inputs and service exports is largely driven by the availability of data. Such a distinction is not feasible using our database (CMIE-PROWESS).

[6] Cui and Liu (2018) use the term servitization in their study and is defined synonymously to servicification.

[7] A caveat of the database is that it is not suitable for examining entry and exit of firms in the domestic markets (Topalova & Khandelwal, 2011). This happens due to the following reasons: (a) Prowess does not remove firms from the database even if the firm exits the market, (b) entry of a new firm in the database is an outcome of CMIE-PROWESS receiving information for the first time and hence new entry in the database does not necessarily represent formation of a new firm. The database provides information on exporting and importing activities of the firm making it suitable to understand the survival dynamics in the international markets. However, PROWESS does not provide information on whether these are processed or ordinary exports.

[8] PROWESS database does provide information on firms export destination.

[9] We acknowledge that destination country fixed effects may have strong implication on the survival level of the firms. However, due to unavailability of the data on destination of firm exports restricts us from incorporating destination fixed effects in the present empirical set-up.

[10] For estimating TFP, we compute firm capital using the perpetual inventory method (Srivastava, 1996), which revalues capital at historical cost to replace cost. Further, consistent information on number of workers employed by a firm is not available in the PROWESS database. To overcome this concern, we deflate wage bill of the firm obtained from PROWESS with the industry average rate obtained from Annual Survey of Industries (ASI) database.

[11] We define firm size based on total assets as in India a firm size if officially defined in terms of its total assets. However, recently in 2020, the Indian government revised the definition of firm size based on firm's turnover and investment in plant and machinery. However, given that our analysis only pertains till 2018, this change in definition remains extraneous for this study.

[12] https://www.rbi.org.in/scripts/FAQView.aspx?Id=26#Q8 – Refer to the response for question 6.

[13] NIC 2-digit classification is as follows. 10 – Food Products; 11 – Beverages; 12 – Tobacco; 13 – Textiles; 14 – Wearing Apparel; 15 – Leather; 16 – Wood; 17 – Paper and Paper Products; 18 – Printing; 19 – Coke and Refined Petroleum; 20 – Chemicals and Chemical Products; 21 – Pharmaceuticals; 22 – Rubber and Plastic Products; 23 – Other Non-Metallic Mineral Products; 24 – Basic Metals; 25 – Fabricated Metals; 26 – Computer, Electronic and Optical Products; 27 – Electrical Equipment, 28 – Machinery and Equipment; 29 – Motor Vehicles; 30 – Other Transport Equipment; 31 – Furniture; 32 – Other Manufacturing.

[14] Hazard rate if computed as $(1 - e^{\text{coefficient}}) \times 100$, which in present case is $e^{-0.473} = 0.623$, hence the hazard rate is $(1 - 0.623) \times 100 = 37.6\%$.

[15] For recent application of 2SRI approach, see Chaturvedi and Prescott (2020), Ma and Zhu (2020), Chen et al. (2018) and Hong et al. (2019).

[16] We do not include servicification as a matching variable to purely evaluate servicification impact on firm survival.

[17] We use Kernel matching procedure to create group of counterfactuals.

[18] We thank the anonymous referee for this valuable insight.

[19] According to Kaiser (1960), components have a negative reliability if the eigenvalue score is less than 1.

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