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Global value chain participation and economic upgrading in Indian textile and apparel sector: Evidence from firm-level productivity and profitability

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Abstract

This study examines the economic upgrading process among the Indian textile and apparel (T&A) firms by investigating the impact of Global Value Chain (GVC) integration on the productivity and profitability of these firms. To mitigate the selection bias and endogeneity issues, this study employs a two-stage empirical strategy, combining Propensity Score Matching and two-step system Generalized Methods of Moments. The empirical analysis is based on firm level data drawn from PROWESS database, encompassing 5,545 firms over the time period 2000-2019. This empirical analysis yields three major findings. First, GVC participation is concentrated among the firms that already exhibit higher productivity and profitability. Second, GVC participation enhances both productivity and profitability, confirming the occurrence of economic upgrading among T&A firms in India. Third, both forward and backward linkages contribute to productivity and profitability gains. Forward linkages generate immediate effects, while backward linkages exhibit a lagged impact.

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1. Introduction

Globally, the textile and apparel (T&A) industry is one of the most export-oriented manufacturing sectors, with USD 881.6 billion in global exports in 2023. Over the decades, developing countries have become the dominant exporters in this sector as firms are more integrated with the global market through a fragmented production process and global value chain (GVC). Within this, Vietnam and Bangladesh, in particular, have strengthened their positions in the global market and have overtaken India since 2017 (World Trade Organization 2018). Bangladesh's share of global exports has increased from 2.2 percent to 9.6 percent, whereas Vietnam's share has increased from 1 percent to 5.8 percent over the time period 2000 to 2023 (Gulati et al. 2025). In recent years, India has been the sixth largest exporter in T&A sector with a 3.9 percent share of global exports (Ministry of Textiles 2024).

Despite India's end to end value chain capacity spanning from raw cotton to final apparel production, paradoxically, firms remain locked in the specialization of the low value added segment, as Indian cotton yarn is exported to Bangladesh, Vietnam, and China, while simultaneously importing fabrics for apparel manufacturing (Gupta 2020; Ministry of Textiles 2023). And it indicates firms' reliance on backward linkages in this sector. Additionally, low productivity in cotton cultivation, continued dependence on cotton based textiles despite rising global demand for Man-Made Fibre (MMF) products, outdated spinning and processing technologies, and limited adaptation of updated technologies are reasons behind the weakening competitiveness of India's T&A sector (Gulati et al. 2025; Kar 2015; Tewari 2006; Kathuria 2018). These patterns indicate the limited capacity of the T&A firms to engage with higher value-added stages of production, as well as persistent challenges in producing high ended, sophisticated products and maintaining quality, undermining India's competitiveness and strategic position in the global market.

Recognizing the decreasing competitiveness, achieving the Government of India's target of raising T&A exports to USD 100 billion by 2030, strengthening the sectoral competitiveness are imperative. Within GVC, firms can enhance competitiveness in two ways – either by competing on price through lowering the production cost or by improving their capabilities through Economic Upgrading (EU). However, competing on price is not advantageous for India as countries with relatively low labor costs will capture greater market share, placing India at a structural disadvantage. Thus, the EU, through deeper GVC integration, is essential for Indian T&A firms. EU enables firms to enhance product sophistication, adopt efficient production processes, introduce advanced technologies, and specialise in high skill and higher value-added stages of the value chain. And these will contribute to enhance the firm's performance in terms of productivity and profitability and strengthen the gains from GVC participation (Gereffi 2005).

Deeper GVC participation enable firms to achieve a finer division of labor, allowing specialization in tasks, in which they are enjoying comparative advantage, thereby enhancing the productivity (Grossman and Rossi-Hansberg 2008). Through backward linkages, firms get access to cost efficient and higher quality intermediate inputs often embedded with advanced foreign technologies, facilitating knowledge diffusion and technology transfer that improve the efficiency and hence the firm performance (Baldwin and Robert-Nicoud 2014). Forward linkages of firms, require to adhere global buyers' stringent high quality, product and technical standards while facing fierce competition from foreign market compel the firms to adopt new technology, organization practices, investment in research and development and incentivize

consistent technological innovation contributing to improved firm performance (Cui, Song, and Li 2024; Stemberger and Zajc Kejžar 2025). Additionally, it provides access to diverse international markets, thus opportunities for scale expansion. Thus, the present study examines whether deeper GVC integration fosters the EU process by improving the firms' productivity and profitability.

The existing literature provides substantial evidence that participation in GVC enhances firm level productivity through both selection and learning effects across developed and developing economies (Melitz 2003; Lileeva and Trefler 2010; Prete, Giovannetti, and Marvasi 2017; Antràs 2020; Mazzi, Ndubuisi, and Avenyo 2020; World Bank 2020). These studies suggest that firms enter GVC because they are more productive, which is known as the selection effect, and it improves firm performance as a result of participation, broadly familiar as the learning effect. In the Indian context, only a handful of studies have investigated GVC participation at the firm level (Banga 2022; Reddy and Sasidharan 2023; Goldar, Banga, and Banga 2017), and even fewer focus explicitly on sectoral heterogeneity. Thus, this study focuses on the T&A sector, which carries substantial economic consequences, particularly given the sector's contribution of 2.3 percent to GDP, 13 percent to industrial output, and its provision of employment to nearly 100 million workers (Ministry of Finance 2025; Ministry of Textiles 2024).

Against this background, this study explores the EU process among T&A firms of India and assesses the impact of GVC engagement on firm performance, particularly on firm productivity and profitability. This study is guided by three major research questions: (i) Are Indian T&A firms with higher productivity and profitability more likely to engage in GVC? (ii) Does participation in GVC enhance the productivity and profitability of these firms? (iii) How do backward and forward linkages within GVC impact the firm's performance?

A two- stage empirical strategy is used where initially, Propensity Score Matching (PSM) is employed, followed by a two – step system generalized method of moments (GMM). PSM is adopted to address the selection bias by creating a counterfactual group of non GVC firms with similar characteristics to the GVC one. Whereas in the second stage two – step system GMM is used to mitigate endogeneity issues. A firm level data from the Centre for Monitoring the Indian Economy (CMIE) PROWESS database is used to conduct the empirical investigation for the time period 2000-2019.

The findings suggest that firms with higher productivity and profitability tend to engage with GVC activities, indicating the presence of the selection effect within the Indian T&A firms. Additionally, Indian T&A firms are experiencing the learning effect as deeper GVC participation enhances the productivity and profitability of the firms, and facilitates the EU process of these firms. Both forward and backward linkages of the firms contribute to the productivity and profitability gains.

This study contributes to the existing literature in two ways. First, this study provides an empirical analysis of the EU process in the Indian T&A sector by examining the impact of GVC engagement on firm performance. To the authors' best knowledge, this is the first empirical analysis to focus on a particular sector while investigating the dynamics between GVC integration and firm performance. Second, this study incorporates backward (importing inputs from foreign) and forward (exporting to foreign buyers) linkages of the firms while assessing the EU process. Thus, it deepens the understanding of how different modes of global integration are associated with firm performance.

2. Data description

The firm level data from the PROWESS database provided by CMIE is used here for the empirical analysis. As this study emphasized only the T&A sector, it considers only those firms whose primary activity is classified as National Industrial Classification (NIC) codes 13 and 14, following the 2008 NIC classification. It covers the time period 2000-2019, as it is confined in pre covid era, to avoid the economic distortions caused by the COVID-19 pandemic. This dataset includes both GVC and non GVC firms, a total of 5545 for the time span of 2000-2019. This dataset comprises 46 percent of GVC firms, while the remaining are non GVC firms.

3. Empirical Modelling and Methodology

A two-stage empirical approach is employed here to address two key issues while estimating the impact of GVC engagement and backward and forward linkages on firm performance. The first one is the self-selection bias, where the firms with higher productivity are more likely to participate in GVC. To mitigate this potential self-selection bias arising from observable differences in GVC and non-GVC firms, PSM is applied in the first stage. Following the matching process, a two-step system GMM estimation is employed in the subsequent stage to address the endogeneity issue, including reverse causality, unobserved firm-specific heterogeneity, and omitted variable bias. In the following section, these two steps are discussed.

3.1 Propensity Score Matching (PSM)

PSM is employed to generate a counterfactual of comparable firms that have not joined GVC, and it consists of two steps. First, it estimates the propensity score, i.e., the probability of GVC participation of all the firms in the sample. Then, comparing the GVC and non GVC firms with an almost equal probability of entering into GVC.

The probability that GVC engagement of the i^{th} firm at time period t can be written as follows-

$$\Pr(GVC_{it} = 1) = \phi\,(\alpha + \beta X_{it} + \gamma_t + \varepsilon_{it}) \quad \text{----- (1)}$$

Equation (1) suggests that the likelihood of a firm engaging in GVC is determined by firm specific characteristics and a time fixed effect. These characteristics include firm productivity, profitability, size, experience, and foreign ownership. Using equation (1), the conditional probability of a firm entering GVC is first estimated. Following this, kernel matching is applied to match GVC firms with non GVC one that have similar propensity scores. A balancing test is conducted to ensure the accuracy of the matching process. Here, the matching process reduces the selection bias which arises from the observable characteristics of the firms and it improves the comparability between GVC and non-GVC firms.

3.2 Generalised Methods of Moments (GMM)

In the second stage, a two-step system GMM is employed to estimate the following equations subsequent to the application of PSM. The following models are used to examine the impact of GVC engagement, forward and backward linkages of firms on its' productivity and profitability.

$$Firm\ Performance_{it} = a_0 + b_0 Firm\ Performance_{it-1} + b_1 Firm\ Performance_{it-2} + b_2\ GVC\ Status_{it} + b_3\ GVC\ Status_{it-1} + b_4\ GVC\ Status_{it-2} + b_5\ X_{it} + \mu_t + \varepsilon_{it} \quad \text{----- (2)}$$

$$Firm\ Performance_{it} = a_0 + b_0 Firm\ Performance_{it-1} + b_1 Firm\ Performance_{it-2} + b_2\ backward\ linkages_{it} + b_3\ forward\ linkages_{it} + b_4\ backward\ linkages_{it-1} + b_5\ forward\ linkages_{it-1} + b_6\ backward\ linkages_{it-2} + b_7\ forward\ linkages_{it-2} + b_8\ X_{it} + \mu_t + \varepsilon_{it} \quad \text{----- (3)}$$

The dynamic panel model is estimated using the two-step system GMM approach, which effectively tackles the issue of endogeneity. In this approach, the estimation process is conducted in level and differences simultaneously, and lagged levels are considered as instruments for first-differenced equations, while lagged first differences are employed as instruments for level equations (Roodman 2009). This control the firm specific time invariant heterogeneity and eliminate the firm specific fixed effect through differencing. Additionally, the use of lagged dependent variable accounts for the dynamic nature of firm performance and shows the persistency nature of it. X_{it} refers to the control variables that can have an impact on the firms' productivity and profitability. This study has used firm size, leverage of the firm, ownership of the firm, and firm experience in GVC activities as the control variables. The term μ_t refers to the time fixed effect. Time fixed effect is incorporated to accommodate time varying factors like macroeconomic shocks or policy changes that uniformly affect firm performance.

4. Variable Construction

4.1 Firm Productivity and Profitability

This study assesses firm productivity in two ways. First, it estimates the Total Factor Productivity (TFP) of firms using a semi-parametric approach following Levinsohn & Petrin (2003). This approach utilizes firms' energy input as the unobserved productivity shock. TFP is calculated by estimating a Cobb-Douglas production function, where capital and labor are the two inputs[1]. Second, the study employs value added per worker as an alternative measure of firm productivity following Prete et al. (2017).

The profitability of the firm is measured as the ratio of profit to total assets in this study.

4.2 GVC Participation

GVC is defined as the fragmentation of production process in several stages spanning at least in two countries, with continuous value addition in each stage and firms engaged in at least one stage of production will be GVC firms (Antràs 2020). Accordingly, consistent with the literature GVC firms are considered as two-way trades in this study, where firms are importing intermediate inputs through backward participation and exporting it through forward participation simultaneously (Prete, Giovannetti, and Marvasi 2017). To enhance the measurement precision, GVC firms are identified in this study as which are simultaneously exporting more than five percent of their sales and importing more than five percent of its inputs (Reddy and Sasidharan 2023). As the objective of this study is to understand the impact of GVC integration on the firm performances, GVC participation of firms are constructed in a binary variable. As GVC firms engaged with the internationally fragmented production process takes value of 1 and non GVC firms which are not a part of such fragmented production process possess value of 0 and it incorporates only exporter, only importer and domestic firms.

[1] Details of each variable construction are described in Appendix A.1.

4.3 Forward and Backward Linkages

A firm can engage with GVC through two primary channels: forward and backward linkages, which represent the firm's upstream and downstream activities. Firms' backward linkages in the value chain occur when a firm imports foreign inputs for the production of intermediate or final goods intended for export. Conversely, forward linkages involve exporting intermediate goods or services to other firms for use in the production of finished goods. Both forward and backward linkages are calculated following the methodology proposed by Korwatanasakul & Paweenawat (2020). Forward linkages of a firm are the revenue share derived from exports. Conversely, backward linkages of firms are measured as the share of the cost of imported inputs.

4.4 Control Variables

Different control variables are used in this study, and they are discussed below. The first one is firm size, and it is measured using the real total assets of the firm. Second is firm experience, which is calculated as the number of years a firm has been involved in GVC activities. The third one is firm ownership, and this study considered a firm as foreign owned if foreign promoters hold over 10 percent of the firm's equity. The last one is the leverage of the firm, and it is measured by the ratio of short- term debt to current assets.

The following table describes the variables used in the empirical analysis of this study.

Table I. Description of the variables

Variable	**Description of the variable**
TFP	Levinsohn and Petrin (2003) is used to estimate TFP. Real Value Added is considered as the output. The average industrial wage rate for the textile and apparel industries is obtained by dividing the total emoluments of the sector by the total workers from ASI database. Then the average industrial wage rate is divided by the wages and salaries reported by each firm in PROWESS to calculate the labor employed in the firm. Each firm's net fixed assets are deflated using the capital deflator, which is the WPI of Manufacture of Textile and Apparel Machinery.
Productivity	Value added per worker
Profitability	The ratio of net profit to total assets
GVC Status	It is a dummy variable. Firms exporting and importing simultaneously are identified as GVC firms. Firms exporting (more than 5% of their sales) and importing (more than 5% of its inputs) simultaneously =1; Otherwise, 0
Backward Linkages	Share of imported input = (cost of imported input/ total cost)
Forward Linkages	Share of revenues from exports = (export revenue/ total revenue)
Firm size	Total asset
Firm Experience	No. of years engaged in GVC activities
Firm Leverage	Short Term Debt / Current Asset
Firm Ownership	It is captured through a dummy variable. Foreign promoters holding more than 10% of equity =1 Otherwise, 0

Source: Authors' creation

The data includes both GVC and non GVC firms in the sample. The summary statistics of the variables used in the empirical analysis are described in the following table.

Table II. Descriptive Statistics (All Firms)

Variable	Obs	Mean	Std. Dev.	Min	Max
TFP	5549	0.009	0.020	0.000	1.002
Labor	5549	1846.485	3025.182	10.334	32399.883
Capital	5549	0.488	1.225	0.000	23.658
Firm Size	5549	0.750	2.234	0.005	50.138
Firm Experience	5549	6.557	5.852	0.000	20.000
Total Assets	5549	69.696	228.022	0.550	5731.330
Power And Fuel	5549	3.738	8.491	0.010	177.280
Leverage	2670	0.470	0.451	0.000	10.7330

Source: Authors' Calculation
Notes: Continuous Variables are in USD Million

5. Results and Discussions

The study employs a probit model to estimate propensity scores, with the results presented in the following table (Table III).

Table III. Probit Results

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln TFP	0.189*** (.069)	0.108 (.075)				
Ln TFP (lag 1)	0.199 *** (.069)	0.285*** (.077)				
Ln labour productivity			0.193*** (.04)	0.167*** (.045)		
Ln profitability (lag 1)					0.111*** (.035)	0.105*** (.038)
Ln size	0.061** (.027)	0.110*** (.031)	0.016 (.024)	0.086*** (.029)	0.014 (.024)	0.084*** (.03)
Ln experience	1.055*** (.043)	1.079*** (.049)	0.938*** (.039)	0.942*** (.045)	0.953*** (.039)	0.958*** (.046)
Foreign ownership	0.454*** (.068)	0.587 *** (.081)	0.534*** (.067)	0.672*** (.08)	0.488*** (.066)	0.630*** (.08)
Constant	0.221 (.289)	0.753 (.347)**	0.121 (.379)	0.164 (.437)	-1.390*** (.126)	-1.100*** (0.194)
Number of observations	3919	3919	4517	4517	4294	4294
Time fixed effect	No	Yes	No	Yes	No	Yes

Notes: (i) Models 1,3 and 5 are estimated without incorporating time-fixed effects, and 2,4,6 are with time effects; (ii) Balancing Scores are represented in the Appendix (A.2); (iii)Values in parentheses indicate standard errors; (iv)*p<0.1; **p<0.05; ***p<0.01
Source: Authors' calculation based on PROWESS database

Table III demonstrates that the coefficients for TFP, lagged TFP, labor productivity, and profitability are statistically significant and positive. This suggests that Indian T&A firms with

higher TFP, labor productivity, and greater profitability show a greater probability toward GVC engagement within the sector. Additionally, firm size is positively significant across models 1,2,4, and 6, suggesting that larger firms have a greater probability of engaging in T&A GVC. The coefficients of experience are positive and statistically significant in all the models and it implies that firms already engaged in GVC for an extended period are more likely to remain engaged. As the coefficient of foreign ownership is also positive and statistically significant across all the models, it implies that foreign owned firms have a higher likelihood of entering T&A GVC in India.

The following tables (Table IV, V, and VI) show the result of the two-step system GMM, which estimates the firm level TFP, value added per worker, and profitability. Across all the models in these three tables, the p-value of Hansen's test statistic is more than 0.05. It implies that the issue of endogeneity is resolved. Similarly, it is observed that the AR (2) statistics lie above 0.05 as well in all the models, which indicates that the second order autocorrelation is not present in the models at the five percent significance level.

Table IV. Impact of GVC Participation, Backward and Forward Linkages on The Firms' TFP

Variables	Model 1	Model 2	Model 3	Model 4
Ln TFP (Lag 1)	0.717 *** (.043)	0.591*** (.078)	0.629 *** (.047)	0.506*** (.096)
Ln TFP (Lag 2)			0.110 *** (.04)	0.056 (.063)
GVC	0.139*** (.053)			
GVC (Lag 1)	-0.005 (.060)	0.042 (.034)		
GVC (Lag 2)		0.082** (.04)		
Ln Backward Linkage			0.0007 (.023)	-0.046 (.053)
Ln Backward Linkage (Lag1)			0.017 (.02)	0.017 (.032)
Ln Backward Linkage (Lag2)			0.042 ** (.016)	0.007 (.03)
Ln Forward Linkage			0.097 * (.052)	0.120 ** (.057)
Ln Forward Linkage (Lag 1)			-0.028 (.06)	0.086 (.067)
Ln Size	0.015 (.044)	0.066 (.073)	-0.019 (.029)	0.044 (.074)
Ln Experience	-0.019 (.188)	-.2550*** (.082)	0.183 (.121)	0.041 (.183)
Foreign Ownership	0.010 (.242)	0.111 (.205)	0.055 (.123)	0.009 (.258)
Ln Leverage		-0.082 ** (.042)		-0.027 (.028)
Constant	-1.535 (.498)	-1.770*** (.478)	-1.870*** (.37)	-2.160 *** (.638)
Number of Observation	3899	1697	1377	574
Number of Instruments	149	139	161	151
AR 2 test statistics	0.135	0.759	0.467	0.820
Hansen Test Statistics	0.299	0.505	0.461	0.758

Notes: (i)Models 1 and 2 show the result of the step system GMM with respect to the independent variable GVC participation of the firm. And the results with respect to backward and forward participation are shown in models 3 and 4; (ii) Kernel matching process is employed here; (iii) *p<0.1; **p<0.05; ***p<0.01; (iv)Values in parentheses indicate standard errors

Source: Authors' calculation based on PROWESS database

The above table (Table IV) illustrates the effect of GVC participation on firms' TFP. Models 1 and 2 demonstrate that the coefficients for the lagged values of TFP are positive and statistically significant, which indicates the consistency and stability of firms' performance with respect to TFP over time. The current GVC participation has a positive and statistically significant effect in both models, while the second lag of GVC participation is significant only in Model 2. It indicates that GVC participation is conducive to the productivity gains in terms of TFP of the T&A firms. In some cases, the productivity gain is not instantaneous. This underscores the dynamic relationship between GVC participation and firm level productivity. These findings are consistent with the prior literature, indicating a productivity gain for the manufacturing firms arising from GVC involvement in several countries, such as India (Banga 2022), Italy (Brancati, Brancati, and Maresca 2017), Canada (Baldwin and Yan 2014), Indonesia, the Philippines, and Vietnam (Urata and Baek 2021), as well as North African countries (Prete, Giovannetti, and Marvasi 2017).

Table IV shows that the coefficient of forward participation is positive and statistically significant across the models, whereas backward participation is statistically significant in Model 3. These findings imply that GVC participation of T&A firms through backward and forward linkages leads to productivity gains in terms of TFP. However, the impact differs between these two modes of GVC engagement. The results indicate that forward participation has an instantaneous impact on the firm's productivity. As forward participation of the firms entails firms' engagement in upstream, capital, technology, and skill intensive activities, which enhances technological efficiency and innovation, thus resulting in rapid productivity growth. Backward linkages integrate India's T&A firms into the global market through importing intermediate goods, thus the associated productivity gains are realized with a lag period. As firms need time to assimilate with the imported technologies and knowledge, through developing necessary capability, reorganizing production process, and adapting new managerial practices. These findings are consistent with previous studies as well. The study by Korwatanasakul & Paweenawat (2020) demonstrated that both forward and backward linkages have a positive impact on the TFP of the manufacturing firms in Thailand. Hence, productivity gains in terms of TFP through GVC participation in the T&A sector are independent of firms' backward and forward linkages.

This study has also examined the impact of GVC participation on the labor productivity of T&A firms, and the results are summarized in Table V. In Model 1, the coefficient of the second lag of GVC participation, whereas in Model 2, the coefficient of current GVC participation is positive and statistically significant. These results indicate that the GVC participation of firms plays a significant role in productivity gains; however, in some cases, the gain is not immediate.

Model 3 in Table V finds out that the coefficient for the current value of forward participation is positive and statistically significant, indicating that firms engaged in GVC through forward linkages experience immediate improvements in labor productivity. Conversely, Model 4 shows that the coefficient for the current value of backward linkages and the second lag of forward participation are positive and statistically significant. This suggests that while current involvement in backward linkages directly enhances labor productivity immediately, the forward linkages have a lagged effect on the labor productivity growth. These findings collectively indicate that participation in GVC, whether through forward or backward linkages, plays a crucial role in enhancing labor productivity in the Indian T&A sector.

Table V. Impact of GVC activities, Forward and Backward Linkages on Labour Productivity of the Firm

Variables	Model 1	Model 2	Model 3	Model 4
Ln Labour Productivity (Lag 1)	0.294** (.118)	0.235** (.114)	0.460*** (.109)	0.439*** (.082)
Ln Labour Productivity (Lag 2)	-0.058 (.067)	-0.084 (.066)	0.102 (.067)	0.024 (.036)
GVC	0.087 (.072)	0.114*** (.068)		
GVC (Lag 1)	-0.062 (.087)	0.006 (.048)		
GVC (Lag 2)	0.086** (.044)	0.050 (.037)		
Ln Backward Linkage			0.031 (.032)	0.046* (.027)
Ln Backward Linkage (Lag 1)			-0.005 (.032)	0.005 (.02)
Ln Backward Linkage (Lag 2)			-0.016 (.027)	0.016 (.016)
Ln Forward Linkage			0.104** (.05)	0.029 (.058)
Ln Forward Linkage (Lag 1)			-0.035 (.049)	-0.038 (.055)
Ln Forward Linkage (Lag 2)			0.033 (.056)	0.078** (.04)
Ln Size	0.081 (.109)	0.070 (.114)	0.077 (.054)	0.112*** (.032)
Ln Experience	-1.060 ** (.448)	-0.947 ** (.382)	-0.127 (.103)	-0.184** (.109)
Foreign Ownership	-0.841 (.604)	-0.797 (.530)		
Ln Leverage	-0.039 (.042)	-0.079*** (.041)	-0.015 (.024)	
Constant	-4.423*** (1.45)	-5.572*** (1.28)	-3.550*** (1.10)	-4.342 *** (.766)
Number of Observation	1697	1697	574	1372
Number of Instruments	99	135	151	158
AR 2 test statistics	0.851	0.949	0.478	0.340
Hansen Test Statistics	0.458	0.645	0.959	0.536

Notes: (i) Models 1 and 2 examine the relationship between GVC participation and labor productivity, while Models 3 and 4 focus on the impact of backward and forward linkages within GVC; (ii) Kernal matching process is employed here; (iii) *p<0.1; **p<0.05; ***p<0.01; (iv)Values in parentheses indicate standard errors
Source: Authors' calculation based on PROWESS database

The lagged impact of forward participation on labor productivity, compared to its immediate effect on TFP, arises from the different nature of these productivity measures. Labor productivity focuses on the efficiency of labor, which often requires time to improve through workforce training, adjustments in labor allocation, or scaling up production. These changes take a longer time to materialize, resulting in a delayed impact. In contrast, TFP reflects the overall efficiency of all inputs, including labor, capital, and technology, and can show immediate improvements when firms engage in forward participation.

This study also investigates the effect of GVC participation on firm profitability, and the findings are presented in Table VI. In the following table, models 1 and 2 indicate that the coefficient for the first lag of GVC engagement is positive and statistically significant, as it indicates GVC participation enhances profitability for T&A firms. However, the impact is not

instantaneous. Model 3 indicates that both backward and forward linkages have a positive and significant impact on profitability. Specifically, the first lag of forward linkages and the current value of backward linkages contribute to higher profits for T&A firms.

Table VI. Impact of GVC Participation, Forward and Backward Linkages on Profit of The Firm

Variables	Model 1	Model 2	Model 3
Ln Profitability (Lag 1)	0.378*** (.055)	0.374*** (.084)	0.371*** (.068)
Ln Profitability (Lag 2)	0.002 (.036)		0.006 (.051)
GVC	0.106 (.114)		
GVC (Lag 1)	0.200*** (.118)	0.196** (.092)	
GVC (Lag 2)		-0.061 (.06)	
Ln Backward Linkage			0.179* (.095)
Ln Backward Linkage (Lag 1)			0.003 (.043)
Ln Backward Linkage (Lag 2)			-0.036 (.037)
Ln Forward Linkage			-0.111 (.132)
Ln Forward Linkage (Lag 1)			0.226* (.135)
Ln Forward Linkage (Lag 2)			-0.010 (.081)
Ln Size	0.005 (.079)	0.161** (.082)	0.036 (.062)
Ln Experience	-0.115 (.339)	-0.029 (.211)	-0.201 (.217)
Foreign Ownership			0.056 (.239)
Ln Leverage		-0.094 (.071)	
Constant	-1.004*** (.277)	-1.317*** (.531)	-0.581 (.556)
Number of Observation	3033	1563	1296
Number of Instruments	94	112	127
AR 2 test statistics	0.051	0.738	0.453
Hansen Test Statistics	0.163	0.112	0.286

Note: (i) model 1 and 2 examine the relationship between GVC participation and firm profitability, while Models 3 and 4 focus on the impact of backward and forward linkages within GVC; (ii) Kernal matching process is employed here; (iii) *p<0.1; **p<0.05; ***p<0.01; (iv)Values in parentheses indicate standard errors.
Source: Authors' calculation based on PROWESS database

The results showed in Table VI suggest that firms engaged in upstream activities through forward linkages in the T&A value chain can absorb new knowledge and technology, and translate it into higher productivity. Subsequently, productivity gains result in greater revenue and profitability. At the same time, firms involved in GVC through backward linkages are engaged in the lower value- added downstream activities and experience productivity and profitability enhancement. The backward linkages of the firms require a greater reliance on imported inputs, which are superior in quality at a lower cost and embedded with advanced technology. Thus, it positively influences the overall performance of the T&A firms in India.

The above results (Tables IV, V and VI) for specific models show that the coefficient of firm size is positive and statistically significant, indicating that larger firms are experiencing a productivity and profitability gain due to economies of scale. The results also show a negative and statistically significant coefficient for firm experience for some models. This suggests that newer entrants into international markets through GVC activities experience greater productivity and profitability gains than firms with longer-term involvement in GVC. Furthermore, firm leverage has a negative and statistically significant coefficient. This implies that firm leverage negatively impacts T&A firms' profitability and productivity gains, as high debt levels constrain new investment opportunities of the firms (Marchica and Mura 2010). Lastly, the results indicate that foreign owned firms achieve higher productivity and profitability gains than domestic firms.

6. Conclusion

This study empirically examines whether the GVC integration of T&A firms results in EU of it, as measured by firm productivity and profitability. More precisely, it investigates whether only firms with high productivity and profitability can participate in GVC activities and whether such participation results in subsequent productivity and profitability gains. Moreover, this study goes beyond considering GVC engagement by explicitly differentiating between backward and forward linkages of the firms.

The empirical analysis is conducted using the firm level PROWESS database for the time period 2000-2019. A two-stage empirical strategy is employed to address the selection bias and endogeneity issue. A counterfactual group is constructed using kernel matching to ensure that GVC and non GVC firms are comparable in terms of their observable characteristics. Following the matching process, firm productivity and profitability are estimated using two step system GMM.

The findings reveal the presence of selection and learning effects within the Indian T&A firms. So, it signifies that firms with higher productivity as measured by TFP and value added by workers, and profitability, are more likely to participate in GVC activities. Furthermore, GVC integration boosts the firm's performance as it enhances the firm's productivity and profitability. Backward and forward linkages of the firms are found to positively influence the firm TFP, labor productivity, and profitability. Collectively, the evidence indicates that Indian T&A firms are undergoing EU through GVC integration.

However, this study is subject to several limitations. First, it uses the PROWESS database, which primarily captures the formal sector. Hence, it is excluding lower tier firms that participate in GVC through subcontracting rather than direct engagement with international activities. Second, the existing literature distinguishes between three kinds of EU: product, process, and functional. However, due to the data paucity, this study could not differentiate between these three kinds of EU and employ a more aggregated proxy, firm performance, to indicate EU. Future research could aim to disaggregate these dimensions of upgrading and adopt a more comprehensive framework to assess the specific forms of EU occurring within India’s T&A sector. Third, the present study estimates the direct benefits of GVC participation in terms of the EU process of GVC integrated firms. However, these gains may not be confined solely to GVC participating firms as it can have a positive spillover effect on the non-GVC firms, specifically to the local and domestic firms through several mechanisms like knowledge diffusion, technology transfer, and competitive pressures. Due to paucity of data, examination of this kind of spillover effect is beyond scope of this study. Future research can explore these indirect impacts on the local firms for a more comprehensive understanding of EU upgrading process in T&A sector.

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A.1 Appendix

Value Added by Firm: This study follows De & Nagaraj (2014) to calculate the value added by firms. The calculation of nominal value added is derived by subtracting inputs from outputs.

Output: Output is determined using deflated sales, adjusted for changes in inventory and purchases of finished goods. In the PROWESS database, purchases of finished goods are defined as acquiring completed products from other producers for resale purposes only. Thus, while calculating the firms' output manufactured by itself, the purchase of finished goods is subtracted from the firms' sales. Moreover, inventory changes are considered while calculating firms' output by adding it to sales when there is an increase in inventory, and decreases are deducted.

Input: Input expenditures incorporate the variable costs of production related to materials, fuel, packaging, and distribution, all of which are available in the PROWESS database.

Real Value Added by Firm: Nominal value added is deflated using the wholesale price index (WPI) of the Textile and Apparel industry, with the base year 2011-12. The WPI data is sourced from the Office of the Economic Adviser's website.

Labour: PROWESS database captures limited data on the number of labor employed in the firms. To address this issue, this study has followed existing literature and compiled data from the Annual Survey of Industries (ASI) with the PROWESS database. The average wage rate in the T&A sector is calculated by dividing the total emoluments of the industry by the total number of workers using the ASI database. Subsequently, it is divided by wages and salaries reported by individual firms in the PROWESS database to determine the number of labor employed by each firm.

Capital: Following Sharma (2010), capital stock is constructed using a deflation method to construct capital stock. The gross fixed assets of each firm are deflated using the capital deflator, which is based on the Wholesale Price Index (WPI) for the manufacture of textile and apparel machinery. The WPI data is sourced from the Office of the Economic Adviser's website, using 2011-12 as the base year.

A.2 Appendix

Table I. Balancing Test Result corresponding to Probit Model 2

	Mean				T test		
Variable	Treated	Control	Bias (%)	Reduction in bias (%)	t	p>t	V(C)/V(T)
Ln TFP	-5.210	-5.274	9.800	3.080	0.002	0.710*	
U							
M	-5.215	-5.132	-12.700	-29.600	-4.280	0.000	0.75*
Ln Experience	2.222	1.312	122.300	38.590	0.000	0.600*	
U							
M	2.216	2.064	20.400	83.300	8.380	0.000	1.37*
Ln Size	-0.965	-1.249	22.400	6.970	0.000	0.890*	
U							
M	-0.961	-1.003	3.300	85.200	1.100	0.270	0.91*
Ln leverage	-1.205	-0.897	-30.700	-6.640	0.000	1.740*	
U							
M	-1.205	-0.964	-24.000	21.900	-4.780	0.000	1.38*
foreign	0.497	0.471	5.000	1.570	0.118	.	
U							
M	0.492	0.605	-22.400	-345.400	-7.500	0.000	.

Notes: U refers to unmatched sample and M refers to matched sample

Table II. Balancing Test Result corresponding to Probit Model 4

	Mean				T Test		
Variable	Treated	Control	Bias(%)	Reduction in bias (%)	t	p>t	V(C) /V(T)
Ln Labor productivity	-9.160	-9.228	10.300	3.440	0.001	0.860*	
U							
M	-9.164	-9.084	-11.900	-16.200	-4.280	0.000	0.91*
Ln Experience	2.166	1.290	115.000	38.810	0.000	0.680*	
U							
M	2.158	2.002	20.400	82.200	8.620	0.000	1.36*
Ln size	-1.005	-1.315	24.500	8.200	0.000	0.890*	
U							
M	-1.003	-0.992	-0.900	96.400	-0.310	0.755	0.92*
Ln leverage	-1.206	-0.894	-31.400	-7.150	0.000	1.71*	
U							
M	-1.206	-0.868	-34.000	-8.100	-7.450	0.000	1.64*
foreign	0.525	0.497	5.600	1.880	0.061	.	
U							
M	0.520	0.638	-23.500	-318.300	-8.480	0.000	.

Notes: U refers to unmatched sample and M refers to matched sample

Table III. Balancing Test Result corresponding to Probit Model 6

Unmatched	Mean				T Test		
Variable	Treated	Control	bias	Reduction in bias (%)	t	p>t	V(C) /V(T)
Ln Profit	-2.218	-2.313	13.500	4.420	0.000	0.780*	
U							
M	-2.223	-2.224	.200	98.800	0.060	0.953	1.09*
Ln Experience	2.172	1.289	117.000	38.470	0.000	0.670*	
U							
M	2.163	2.021	18.800	83.900	7.790	0.000	1.33*
Ln Size	-0.997	-1.307	24.700	8.060	0.000	0.89*	
U							
M	-0.992	-0.995	.300	99.000	0.090	0.929	0.930
Ln Leverage	-1.216	-0.948	-27.500	-6.080	0.000	1.82*	
U							
M	-1.216	-0.923	-30.100	-9.200	-6.370	0.000	1.57*
foreign	0.524	0.505	3.8	1.240	0.215	.	
U							
M	0.518	0.641	-24.600	-544.100	-8.740	0.000	.

Notes: U refers to unmatched sample and M refers to matched sample