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DOMESTIC AND FOREIGN VALUE ADDED IN GLOBAL VALUE CHAINS: EVIDENCE FROM FIVE KEY INDUSTRIES IN VIETNAM'S SOUTHEAST REGION BY MACHINE LEARNING APPROACH

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Abstract: *This study examines the impact of global value chain (GVC) participation and firm characteristics on firm performance (ROA) in the Southeast region of Vietnam. Using panel data of listed firms from 2020-2024, the study applies machine learning models, including Ridge Regression, Random Forest, and Gradient Boosting. The results show that Ridge Regression provides the best predictive performance, indicating that the relationship between GVC indicators and firm performance is predominantly linear. Firm performance also exhibits strong persistence over time. Among GVC variables, domestic value added (DVA) has a stronger impact than foreign value added (FVA), suggesting that internal value creation is more important than reliance on imported inputs. In addition, financial leverage, firm size, and supply chain efficiency significantly affect performance, while technological capability shows a moderate effect. Overall, the findings highlight that firm performance depends not only on GVC participation but also on the quality of participation and internal capabilities, particularly in the context of a developing regional economy.*

Keywords: *Global value chains (GVC); Firm performance; Southeast region of Vietnam; Domestic value added (DVA); Foreign value added (FVA); Machine learning.*

1. Introduction

In the context of globalization and the restructuring of international production, global supply chains (GSCs) and global value chains (GVCs) have become fundamental determinants of firms' competitiveness and performance. The fragmentation of production processes across geographical locations, driven by comparative advantages, has led to the formation of complex transnational production networks in which firms participate in different stages with varying levels of value creation (Gereffi et al., 2005; Baldwin, 2013). Consequently, firm performance increasingly depends not only on internal resources but also on the degree of participation and the position of industries within global supply chains. At the micro level, numerous studies have confirmed the positive role of supply chain management in enhancing firm performance. Johnson and Templar (2011) argue that supply chain efficiency measured through cash flow generation and asset utilization is closely associated with firm value. More recent studies further reinforce this argument by showing that optimizing supply chain structures, enhancing integration, and adopting digital technologies can significantly improve both financial and operational performance (Fu et al., 2022; Asante-Darko & Osei, 2024). In particular, emerging empirical evidence from developing economies highlights the critical role of supply chain

management in improving firm performance through cost reduction, improved cash flow, and market expansion.

However, in the context of deeper integration into global value chains (GVCs), an approach focusing solely on internal firm management is insufficient. Recent studies emphasize that industry-level GVC indicators such as GVC participation, foreign value added (FVA), domestic value added (DVA), and GVC position play a crucial role in explaining firm performance. According to Koopman, Wang, and Wei (2014), these indicators capture the value-added structure embedded in international trade and allow for an assessment of industries' dependence on foreign inputs. Subsequent studies further demonstrate that a high level of GVC participation does not necessarily imply a strong position within the value chain, as industries with high FVA are often "locked" into low value-added activities such as processing and assembly (Wang et al., 2017). Recent studies in the 2024-2025 period have extended this line of research along three main directions. First, research on sustainable supply chains and resilience suggests that firms deeply integrated into GVCs but lacking internal capabilities are more vulnerable to global shocks, whereas firms with higher levels of domestic value creation (high DVA) tend to maintain better long-term performance. Second, studies on digital transformation in supply chains indicate that the adoption of digital technologies such as artificial intelligence, blockchain, and big data enhances transparency, coordination, and operational efficiency, thereby improving firms' financial performance (Vial, 2019). Third, recent research in logistics and supply chain management highlights the importance of multi-tier supply chain integration and global coordination in improving firm performance, particularly in key manufacturing industries. In addition, the literature on supply chain integration consistently confirms that stronger linkages among supply chain actors improve both operational and financial performance by reducing transaction costs and enhancing information sharing (Flynn et al., 2010). In the context of industries deeply embedded in GVCs, such integration becomes even more critical, as firms must coordinate with multiple international partners within complex production networks. Nevertheless, most existing studies focus either on firm-level analysis or examine supply chain factors in isolation, while relatively few studies integrate macro level GVC indicators with firm-level performance outcomes. This research gap is particularly evident in developing economies such as Vietnam, where industries exhibit substantial heterogeneity in both GVC participation and position, leading to significant differences in value creation capacity and firm performance.

Building on this context, this study aims to examine the impact of global value chain (GVC) indicators of key industries on firm performance in Vietnam. Specifically, the study focuses on the role of GVC participation, the value-added structure (foreign value added-FVA and domestic value added-DVA), and GVC position in shaping firms' financial performance. By integrating both industry level and firm level perspectives, this research not only contributes to enriching the theoretical framework of global supply chains and value chains but also provides important policy implications for enhancing the position of industries within GVCs

and improving firm performance in the context of digital transformation and sustainable development.

2. Literature Review

The development of global value chains (GVCs) has fundamentally transformed the structure of international trade, as production processes are increasingly fragmented into multiple stages and geographically dispersed across countries according to comparative advantage (Gereffi et al., 2005; Baldwin, 2013). In this context, gross exports no longer fully reflect the actual value created by a country or industry due to the existence of cross-border flows of intermediate inputs. To address this limitation, Hummels, Ishii, and Yi (2001), followed by Koopman, Wang, and Wei (2014), developed a value-added trade decomposition approach. Within this framework, two key indicators widely used are foreign value added (FVA) and domestic value added (DVA). Specifically, FVA captures the portion of value created abroad that is embodied in a country's exports, while DVA measures the value generated domestically and contributed to exports. These indicators enable a more accurate assessment of the extent to which industries depend on foreign inputs and their capacity to generate domestic value. Subsequent studies have extended this approach to construct composite indicators such as GVC participation and GVC position, thereby distinguishing the roles of industries along the value chain (upstream, midstream, and downstream) (Wang et al., 2017). Accordingly, industries with a high share of FVA are typically positioned in downstream activities such as processing and assembly, whereas those with higher DVA tend to occupy stages associated with greater value creation.

From a microeconomic perspective, participation in global value chains (GVCs) through the use of foreign inputs (FVA) may generate both benefits and risks for firm performance. On the one hand, FVA enables firms to access advanced technologies, high-quality intermediate inputs, and lower production costs, thereby improving productivity and financial performance (Amiti & Konings, 2007). On the other hand, excessive reliance on foreign inputs may reduce firms' control over their supply chains, increase vulnerability to disruptions, and limit the accumulation of internal capabilities, ultimately constraining long-term performance (Baldwin, 2013). In contrast, domestic value added (DVA) reflects the internal capability of firms and the broader economy to generate value. Existing studies suggest that a higher share of DVA is often associated with stronger innovation capacity, technological accumulation, and productivity improvements, thereby enhancing firm performance and competitiveness (Koopman et al., 2014). Moreover, DVA helps firms reduce dependence on external shocks and strengthens supply chain resilience, particularly in the context of global trade disruptions (Wang et al., 2017). However, the relationship between FVA, DVA, and firm performance is not necessarily linear. Several studies indicate that a high level of GVC participation often proxied by FVA does not automatically lead to superior performance if firms remain concentrated in low value-added segments of the chain (Koopman et al., 2014; Wang et al., 2017). This phenomenon is particularly evident in developing economies, where firms are frequently "locked into" processing and assembly stages characterized by low margins and limited opportunities for upgrading.

In addition to the value-added structure, firm performance also depends on supply chain management capabilities and the degree of supply chain integration. The literature on supply chain management shows that stronger integration with suppliers and customers improves information flows, reduces transaction costs, and enhances operational efficiency (Flynn et al., 2010). Johnson and Templar (2011) further argue that supply chain efficiency is closely linked to financial performance through improved working capital management and cash flow optimization. Recent studies continue to confirm that effective supply chain management serves as an important mediating mechanism through which the benefits of GVC participation are translated into firm performance. Fu et al. (2022) demonstrate that optimizing the flows of materials, information, and finance within supply chains enhances firms' operational efficiency and competitiveness. Moreover, emerging research in the 2024-2025 period highlights the role of digital and sustainable supply chains, where the adoption of digital technologies and increased localization (higher DVA) contribute to improved financial performance and greater resilience in the face of global uncertainty (Nguyen et al., 2024). Beyond value-added structure indicators in global value chains such as FVA and DVA, firm performance is also influenced by a range of internal and external factors. These factors can be broadly categorized into key groups, including financial structure, firm size, technological capability and innovation, and supply chain management capability.

(1) Capital structure (Leverage) and financial management: Capital structure is one of the key determinants of firm performance through its impact on the cost of capital and financial risk. According to the pecking order theory, firms prefer internal financing before resorting to debt or equity issuance (Myers & Majluf, 1984). In contrast, the trade-off theory suggests that firms optimize their capital structure by balancing the tax benefits of debt against the costs of financial distress. Empirical evidence indicates that financial leverage may have a dual effect on firm performance. On the one hand, debt allows firms to benefit from tax shields and improve capital efficiency; on the other hand, excessive leverage increases financial risk and interest expenses, thereby reducing firm performance (Zeitun & Tian, 2007). In the context of firms participating in global value chains, a high dependence on foreign value added (FVA) combined with high leverage may amplify both supply chain and financial risks.

(2) Firm size: Firm size is commonly regarded as a proxy for economies of scale. Larger firms tend to have better access to resources, lower cost of capital, and greater capacity to expand into new markets, thereby enhancing operational efficiency and overall performance. In addition, larger firms often hold stronger positions within global supply chains, which improves their bargaining power and enables better control over input costs. However, some studies suggest that larger firm size may reduce organizational flexibility and increase managerial and coordination costs, particularly in highly competitive environments or when firms operate within complex supply chain networks (Martini et al., 2023). Therefore, the relationship between firm size and performance may be nonlinear.

(3) Technology and innovation capability: Technological capability plays a crucial role in enhancing firm performance, particularly in the context of digital transformation and

participation in global value chains (GVCs). Firms with stronger absorptive capacity are better able to utilize foreign inputs (FVA), thereby improving productivity and increasing domestic value added (DVA). According to the technology spillover theory, participation in GVCs allows firms to access advanced technologies; however, the extent of the benefits depends on firms' internal absorptive capacity. Recent studies emphasize the role of digital transformation and emerging technologies such as artificial intelligence (AI), blockchain, and big data in optimizing supply chains and improving firm performance (Vial, 2019). This is particularly important as firms transition from low value-added activities, such as assembly, to higher value-added stages within GVCs. Technological and innovation capability is commonly measured using proxies such as R&D intensity (R&D expenditure relative to total assets) (Hall, Mairesse, & Mohnen, 2010) or the ratio of intangible assets to total assets (Peters & Taylor, 2017).

(4) Supply chain management and integration (SCM): Supply chain management plays a critical mediating role in the relationship between GVC participation and firm performance. Existing studies show that stronger integration with suppliers and customers enhances information flows, reduces inventory costs, and improves operational efficiency (Flynn et al., 2010). Johnson and Templar (2011) further demonstrate that supply chain efficiency is directly linked to financial performance through improved working capital management. More recent studies highlight the importance of sustainable and digital supply chains in enhancing both firm performance and resilience in the face of global uncertainty (Fu et al., 2022; Nguyen et al., 2024).

3. Model, Methodology and Data

In the context of global value chains (GVCs), recent studies emphasize that firm performance depends not only on internal factors but is also strongly influenced by the value-added structure of international trade. According to Koopman, Wang, and Wei (2014), indicators such as foreign value added (FVA) and domestic value added (DVA) reflect the degree of participation and the position of industries or firms within GVCs, thereby affecting productivity and performance. Recent empirical studies have extended this approach by integrating GVC indicators with firm-specific characteristics in panel data models. For instance, Nguyen et al. (2024) find that supply chain management has a positive impact on firms' financial performance, while studies on digital transformation highlight the role of technology in enhancing both performance and the capacity to absorb global value added (Vial, 2019). Based on this theoretical and empirical foundation, the research model is proposed as follows:

$$ROA_{it} = \beta_0 + \beta_1 ROA_{it-1} + \beta_2 GVC_{it} + \beta_3 FVA_{it} + \beta_4 DVA_{it} + \beta_5 Size_{it} + \beta_6 Lev_{it} + \beta_7 Tech_{it} + \beta_8 SCM_{it} + \beta_9 \sum_{j=1}^5 Ind_{jt} + \varepsilon_{it}$$

Where:

Firm performance is commonly measured using financial indicators that reflect profitability and the efficiency of resource utilization. Among these, return on assets (ROA) is one of the most widely used measures, as it directly captures how effectively a firm utilizes its assets to generate earnings (Zeitun & Tian, 2007). Recent studies continue to confirm the relevance of ROA in the context of digital transformation and globalization. For instance, Nguyen et al. (2024) employ ROA as a proxy for financial performance when examining the impact of supply chain management in Vietnam. Similarly, prior studies on digital transformation and sustainable supply chains have also adopted ROA as a dependent variable to assess firm performance in a global context.

Foreign value added (FVA) and domestic value added (DVA) are two core indicators in global value chain (GVC) analysis, derived from global input-output databases such as OECD TiVA and WIOD.

Foreign value added embodied in the exports of industry i in the Southeast region is calculated as: $FVA_{i,t}^{SE} = \theta_{SE,t} \times FVA_{i,t}^{VN}$

In which: $FVA_{i,t}^{VN}$ the component is derived from the national ICIO table using the Leontief inverse method, reflecting the value added originating from foreign economies that is utilized in the production of exported goods.

Domestic value added is determined as: $DVA_{i,t}^{SE} = X_{i,t}^{SE} - FVA_{i,t}^{SE}$

This indicator reflects the contribution of domestic production factors (labor, capital, and local technology) to the exports of the region's industry.

The position of key export industries in the Southeast region within the global value chain is determined as: $GVC_Position_{i,t}^{SE} = Forward_{i,t}^{SE} - Backward_{i,t}^{SE}$

The degree of backward participation in the global value chain of industry i in the Southeast region is determined as:

$$Backward_{i,t}^{SE} = \frac{FVA_{i,t}^{SE}}{X_{i,t}^{SE}}$$

In the absence of regional data on re-exported domestic value added (DVA), the study uses the industry-level re-export ratio at the national level as a proxy coefficient.

$$Forward_{i,t}^{SE} = \phi_{i,t}^{VN} \times \frac{DVA_{i,t}^{SE}}{X_{i,t}^{SE}}$$

In which: $\phi_{i,t}^{VN}$ the DVA re-exported share represents the proportion of domestic value added that is used as intermediate inputs in other countries' exports at the national level. This approach ensures consistency in the industry-level GVC structure while also capturing the region's role in upstream intermediate stages of the value chain.

According to Koopman et al. (2014), these indicators provide a comprehensive framework for analyzing a country's or industry's position within GVCs. Recent studies suggest that FVA can enhance productivity through technology spillovers (Amiti & Konings, 2007), while DVA is associated with upgrading capacity and improved long-term performance (Wang et al., 2017).

Firm size is commonly measured as the natural logarithm of total assets. According to the theory of economies of scale, larger firms benefit from cost advantages and better access to markets (Beck et al., 2005). However, recent studies suggest that larger firm size may reduce efficiency in digitalized environments due to lower organizational flexibility (Martini et al., 2023).

Financial leverage (Lev) is measured as the ratio of total debt to total assets. According to capital structure theory, debt can provide tax benefits but also increases financial risk (Myers & Majluf, 1984). Empirical studies generally indicate that high leverage tends to reduce firm performance, particularly in uncertain environments (Graham & Harvey, 2001; Zeitun & Tian, 2007).

Technological capability (Tech) is measured by the ratio of intangible assets to total assets (Peters & Taylor, 2017). According to absorptive capacity theory, firms with stronger technological capabilities are better able to exploit foreign value added (FVA) and enhance domestic value added (DVA) (Cohen & Levinthal, 1990). Recent studies further highlight that digital transformation enables firms to optimize supply chain processes and improve financial performance (Vial, 2019).

In empirical studies, supply chain management (SCM) is often measured indirectly through financial and operational indicators due to the limited availability of firm-level data on supply chain practices. Among these, inventory turnover is widely used as a proxy for supply chain efficiency, as it directly reflects the speed of inventory movement within production and distribution systems (Gaur et al., 2005; Koliass et al., 2011).

The study also considers heterogeneity across key industries (Ind). Specifically, five major industry groups are included: food processing, textiles and garments, rubber and plastics, pharmaceuticals and chemicals, and electronics and software. In this study, the food processing industry is selected as the reference (baseline) category. Accordingly, the analysis examines the differences in firm performance across the remaining four industries relative to the food processing sector.

In the context of increasingly complex firm-level financial data, machine learning methods have been widely adopted to overcome the limitations of traditional linear regression models, particularly issues related to multicollinearity, nonlinearity, and predictive performance. Among these, Ridge Regression, Random Forest, and Gradient Boosting represent three prominent approaches, corresponding to regularization-based methods, tree-based models, and boosting techniques, respectively. These methods have been shown to be highly effective in predicting and explaining firm performance, asset returns, and financial behavior in recent

studies. In particular, machine learning-based regression techniques have been extensively applied to analyze the impact of both financial and non-financial factors. Gu, Kelly, and Xiu (2020) employ various machine learning techniques, including regularized regressions, to forecast stock returns and demonstrate superior predictive performance compared to traditional linear models. Therefore, this study adopts machine learning-based regression methods instead of conventional linear regression to improve estimation efficiency and predictive accuracy. Given the characteristics of the dataset, the analysis focuses on three widely used techniques: Ridge Regression, Random Forest, and Gradient Boosting.

Table 1. Variable definitions

Variable	Definition	Measurement	Expected sign
ROA	Firm performance	Net income / Total assets (%)	-
GVC	Global value chain	Position of key export industries	+/-
FVA	Foreign value added	Share of foreign value added in exports (%)	+/-
DVA	Domestic value added	Share of domestic value added in exports (%)	+
Size	Firm size	Natural logarithm of total assets	+
Lev	Financial leverage	Total debt / Total assets (%)	-
Tech	Technological capability	Intangible assets / Total assets (%)	+
SCM	Supply chain management	Inventory turnover ratio	+
Textile	Industry dummy (textiles & garments)	1 if firm belongs to textile industry, 0 otherwise	+/-
Rubber	Industry dummy (rubber & plastics)	1 if firm belongs to rubber-plastic industry, 0 otherwise	+/-
Pharma	Industry dummy (pharmaceuticals & chemicals)	1 if firm belongs to pharma-chemical industry, 0 otherwise	+/-
Electronics	Industry dummy (electronics & software)	1 if firm belongs to electronics-software industry, 0 otherwise	+/-

Note: The food processing industry is used as the reference category

This study employs a panel dataset of listed firms in the Southeast region of Vietnam over the period 2020-2024 a timeframe marked by significant changes in international trade, the restructuring of global supply chains in the post-pandemic context, and the increasingly deep integration of both the region and Vietnam into global value chains (GVCs). The sample is selected using a purposive sampling approach, focusing on firms operating in the key export-oriented industries of the Southeast region industries that make substantial contributions to the

region’s export turnover and exhibit a high degree of participation in global supply chains and value chains. These industries include food processing, textiles and garments, rubber and plastics, pharmaceuticals and chemicals, and electronics and software. In addition to firm level (micro) data, the study integrates industry level data on GVC indicators, including foreign value added (FVA), domestic value added (DVA), GVC participation, and GVC position. These indicators are computed or obtained from international input-output tables (ICIO) and trade in value added databases, and are subsequently matched with firm-level data based on corresponding industry classifications. This integrated approach enables the study to simultaneously consider both firm level and industry level dimensions, thereby providing a comprehensive assessment of how global value chain structures influence the performance of listed firms.

4. Empirical Results

Table 2. Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev	Min	Max
ROA	287	6.52	7.34	-2.67	52.21
GVC	287	0.14	1.39	-0.68	3.50
FVA	287	15.76	8.33	5.11	26.75
DVA	287	16.79	8.23	8.11	27.12
Size	287	6.99	1.79	3.12	11.90
Lev	287	34.23	24.19	0	75.57
SCM_Turnover	287	11.02	28.14	0	229.01
Tech	287	4.45	11.47	0	79.18

Source: Author’s calculations. (*Note: FVA and DVA are expressed in natural logarithmic form*)

Table 2 presents the descriptive statistics of the variables used in the study, based on a sample of 287 firm-year observations. The average return on assets (ROA) is 6.52%, with a relatively large standard deviation of 7.34, indicating substantial variation in firm performance across the sample. The minimum ROA is -2.67%, while the maximum reaches 52.21%, suggesting the presence of both underperforming and highly profitable firms. Regarding global value chain indicators, the mean GVC participation index is 0.14, with a standard deviation of 1.39, reflecting considerable heterogeneity in the level of integration into global production networks. The foreign value added (FVA) averages 15.76%, while domestic value added (DVA) is slightly higher at 16.79%, implying that domestic contributions remain an important component in export activities. Firm characteristics show that the average firm size (Size) is

6.99 (logarithmic scale), with values ranging from 3.12 to 11.90. Financial leverage (Lev) has a mean of 34.23%, but varies widely across firms (standard deviation of 24.19), indicating differences in capital structure and financial risk. Supply chain efficiency, proxied by SCM_Turnover, has a mean of 11.02 with a high dispersion (standard deviation of 28.14), suggesting uneven supply chain performance among firms. Meanwhile, the technology variable (Tech) has an average value of 4.45, with a wide range from 0 to 79.18, indicating significant disparities in technological capability across firms. Overall, the descriptive statistics reveal substantial variability across firms in terms of performance, GVC participation, and firm-specific characteristics, providing a suitable basis for further econometric analysis.

Table 3. Regression results using machine learning models

No.	Model	RMSE	MAE	R ²
1	Random Forest	5.139902	2.894693	0.544855
2	Ridge(*)	4.971037	2.780705	0.574270
3	Gradient Boosting	5.204642	2.777226	0.533317

Source: Author's calculations. (*) indicates the best-performing model.

The empirical results reveal notable differences in predictive performance across the examined models. Contrary to expectations from the machine learning literature, the Ridge Regression model demonstrates the best overall performance, achieving the highest explanatory power ($R^2 = 0.574$) and the lowest prediction error (RMSE = 4.97; MAE = 2.78). This suggests that the relationship between global value chain (GVC) indicators and firm performance in the sample is predominantly linear. In particular, variables such as foreign value-added (FVA) and domestic value-added (DVA) appear to exert relatively stable and additive effects on firm performance, rather than interacting in highly complex nonlinear ways. This finding partially contrasts with prior studies emphasizing the superiority of tree-based methods in capturing nonlinearities and high dimensional interactions (Breiman, 2001; Gu et al., 2020). Instead, it aligns more closely with the argument that regularized linear models can perform well when the underlying data-generating process is relatively smooth and when multicollinearity among predictors is present (Hastie et al., 2009). In the context of firm-level financial data, where variables such as size, leverage, and GVC participation are often correlated, Ridge Regression helps stabilize coefficient estimates and improves predictive accuracy. The Random Forest model yields slightly lower performance ($R^2 = 0.545$; RMSE=5.14), indicating that while nonlinear patterns may exist, they are not sufficiently strong or pervasive to outperform a regularized linear specification. Similarly, the Gradient Boosting model records the lowest predictive accuracy among the three models ($R^2 = 0.533$; RMSE=5.20). This relatively weaker performance may be attributed to several factors, including the limited sample size and the presence of noise and heterogeneity in firm-level data, which can reduce the effectiveness of boosting algorithms. As noted by Friedman (2001), although Gradient Boosting is powerful in modeling complex relationships, it is also sensitive to overfitting and requires careful

hyperparameter tuning, particularly in small or noisy datasets. Overall, the findings highlight the importance of model selection in empirical analyses of GVC participation and firm performance. While recent studies in finance and supply chain management increasingly emphasize the advantages of machine learning approaches (Gu et al., 2020), the present results suggest that linear models with appropriate regularization may still provide superior performance when the underlying relationships are relatively stable and additive. From an economic perspective, this implies that firm performance in the context of GVCs is driven not only by participation intensity (FVA and DVA) but also by systematic firm characteristics such as size, leverage, and technological capability, whose effects can be adequately captured within a linear framework.

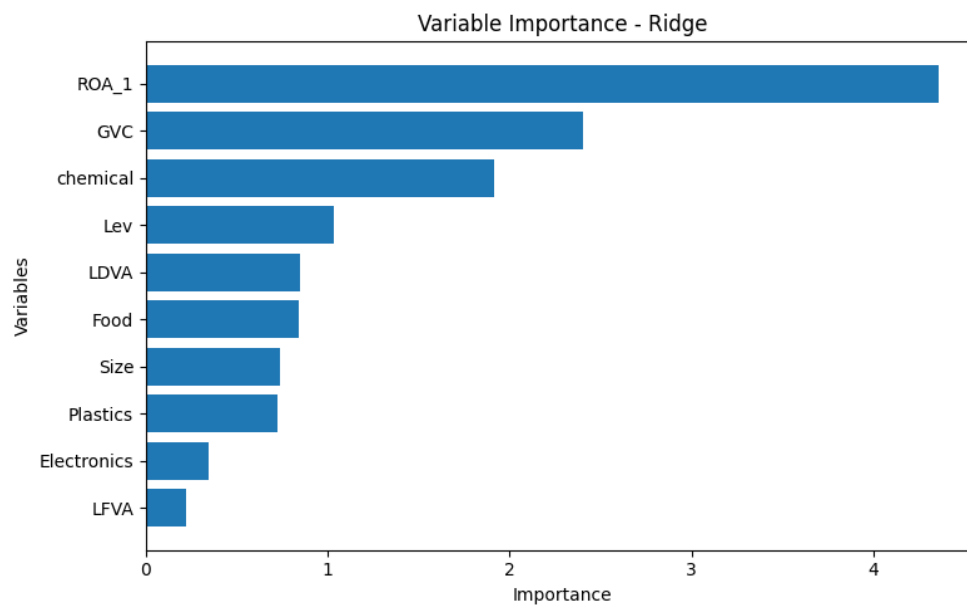


Figure 1. Importance of influencing factors

Source: Author’s calculations.

The results from the Ridge Regression model reveal substantial heterogeneity in the contribution of explanatory variables to firm performance (ROA). Notably, the lagged dependent variable (ROA_{t-1}) exhibits overwhelmingly the highest importance, indicating a strong degree of persistence in firm performance over time. This finding suggests that firm performance is inherently dynamic, where past profitability significantly influences current outcomes. Such persistence is consistent with prior studies on firm dynamics and dynamic panel models, which highlight the role of path dependence and capability accumulation in shaping firm performance (Hanif & Arshed, 2016). It also reflects the presence of operational inertia and learning by doing effects within firms. Among the explanatory variables, GVC participation (GVC) emerges as one of the most influential factors after the lagged dependent variable. This result underscores the critical role of integration into global value chains in enhancing firm performance. It implies that firms more deeply embedded in GVCs are better able to access international markets, advanced inputs, and knowledge spillovers, thereby

improving their productivity and profitability. This finding aligns with the GVC literature, which emphasizes the importance of global integration for upgrading and performance improvement (Koopman et al., 2014; Wang et al., 2017). Interestingly, the industry specific variable for the chemical sector (chemical) also shows relatively high importance, suggesting that certain industries may benefit more from GVC participation due to their technological intensity or position within the value chain. This indicates that while industry effects are generally limited, specific sectors with higher knowledge content or upstream positioning may exhibit stronger performance differentials. Financial leverage (Lev) continues to play a significant role, reflecting the importance of capital structure in shaping firm performance. This is consistent with capital structure theory, where leverage influences both the cost of capital and financial risk (Myers & Majluf, 1984; Zeitun & Tian, 2007). A moderate level of importance is also observed for domestic value-added (LDVA), which further supports the argument that internal value creation capacity contributes positively to firm performance. Compared to foreign value-added (LFVA), which exhibits the lowest importance, the results suggest that reliance on imported inputs does not necessarily enhance firm profitability. This finding is consistent with the view that deeper domestic embedding within GVCs is more beneficial for sustainable upgrading (Koopman et al., 2014). Other firm level characteristics, including size (Size) and supply chain related efficiency proxies, show relatively modest contributions. This implies that while these factors are relevant, they are secondary compared to core drivers such as past performance and GVC participation. Similarly, most industry dummy variables (Food, Plastics, Electronics) exhibit limited importance, indicating that variations in firm performance are primarily driven by firm specific characteristics and GVC positioning rather than industry level differences. Overall, the findings highlight that firm performance in the context of global value chains is shaped by a combination of dynamic persistence, structural integration into GVCs, and internal value creation capacity. The dominance of ROA persistence and GVC participation suggests that both historical capability accumulation and external linkages are key determinants of firm performance, reinforcing recent empirical evidence in the GVC and firm performance literature.

5. Conclusions and Implications

This study investigates the impact of global value chain (GVC) participation, value-added structure, and firm-specific characteristics on firm performance in Vietnam using machine learning approaches. By employing Ridge Regression, Random Forest, and Gradient Boosting models, the study provides a comprehensive assessment of both linear and nonlinear relationships among key variables. The empirical results indicate that the Ridge Regression model outperforms the tree-based machine learning models in terms of predictive accuracy and explanatory power. This finding suggests that the relationship between GVC indicators and firm performance is predominantly linear and relatively stable, rather than highly nonlinear or driven by complex interactions. From a methodological perspective, this result highlights the continued relevance of regularized linear models in firm-level analysis, particularly in the presence of multicollinearity and limited sample sizes (Hastie et al., 2009). It also implies that,

in the context of Vietnamese firms, the marginal effects of key explanatory variables such as GVC participation, domestic value added (DVA), and financial leverage can be effectively captured within a linear framework. Another important finding is the strong persistence of firm performance over time, as reflected by the dominant importance of the lagged ROA variable. This confirms that firm performance is inherently dynamic and path-dependent, shaped by accumulated capabilities, learning effects, and operational inertia (Hanif & Arshed, 2016). Such persistence suggests that short-term performance improvements are closely tied to long-term capability building and strategic positioning within value chains. Regarding GVC-related factors, the results demonstrate that domestic value added (DVA) plays a more significant role than foreign value added (FVA) in explaining firm performance. This finding reinforces the argument that the quality of GVC participation matters more than the extent of participation. Firms that enhance their internal value creation capacity are more likely to achieve sustainable upgrading and improve financial performance (Koopman et al., 2014; Wang et al., 2017). In contrast, a high reliance on foreign inputs does not necessarily lead to higher profitability, as it may reflect a concentration in low value-added segments such as processing and assembly. In addition, firm-specific characteristics such as financial leverage and firm size remain important determinants of performance. Financial leverage reflects the trade-off between tax benefits and financial risk (Myers & Majluf, 1984; Zeitun & Tian, 2007), while firm size captures both economies of scale and potential organizational rigidities (Beck et al., 2005). Technological capability also shows a positive but moderate effect, indicating that although digital transformation and intangible assets contribute to firm performance, their impact is not yet fully realized across firms. This reflects the uneven level of technological adoption in developing economies, where firms differ significantly in their absorptive capacity (Peters & Taylor, 2017; Vial, 2019). From a policy perspective, the findings suggest several important implications. First, policies should shift from promoting mere participation in global value chains toward enhancing the quality of participation by increasing domestic value creation. This requires targeted support for industrial upgrading, innovation, and the development of supporting industries. Second, improving firms' internal capabilities, particularly in supply chain management and technological adoption, is essential for translating GVC participation into higher performance. Third, policymakers should pay attention to financial structure and risk management, as excessive leverage may undermine firm performance, especially in a volatile global environment.

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