

Firm Volatility in an Era of Global Value Chain: The Role of Product Quality

Gideon Ndubuisi
Solomon Owusu

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By

Gideon Ndubuisi

Delft University of Technology, the Netherlands

Solomon Owusu

*Boston University Frederick S. Pardee School of Global Studies,
United States*

Oxford Martin School, University of Oxford, United Kingdom

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Abstract

It is widely recognized that trade and volatility are intricately linked, which has led to a large literature that examines the nature of such relationship. Despite more than 50% of global trade now taking place through the global value chain (GVC), this literature has proceeded without considering the role of GVC. This paper fills this gap by examining the effect of GVC participation on firm job growth volatility and the role of product quality in shaping this relationship. We combine custom transaction-level data and data on firm characteristics that are both provided by the South African Revenue Services and National Treasury (SARS-NT) on the universe of formal manufacturing firms in South Africa for the period 2010-2017. We find robust evidence suggesting that embeddedness in GVC reduces firm volatility, especially for firms that produce and export higher-quality products in the value chain. Therefore, our results provide evidence that GVC offers firms the opportunity to build resilience in terms of reducing volatility, which is paramount to building production capacity, stable export earnings, and higher value capture in the value chain.

JEL Classifications: F00; F12; F14; J21; J23

Keywords: Firm Volatility; Job Volatility, Global Value Chains; Product Quality; Product Sophistication

1. Introduction

Firm volatility carries profound social and welfare implications for individuals and households that go beyond the bounds of the firm. For instance, firm volatility in terms of job and output volatility can cause firms to exit, lower the firm's physical and human capital investments and increase the income uncertainty levels of workers and households. Higher incidence and persistence of firm volatility can also result in greater uncertainty in the macroeconomic climate, affect long-run growth, and contribute to economic instability as firms lay off workers and reduce output during economic downturns. More specifically, firm job volatility negatively impacts the workers' morale and makes it difficult for firms to attract and retain talented workers, which impacts firm sale, productivity, and competitiveness. Firm output volatility, on the other hand, makes it difficult for firms to plan for future production levels and higher costs arising from production inefficiencies. It also impacts a firm's ability to meet customer demand, which can result in lost sales and decreased firm revenue. Ultimately, firm volatility can have a ripple effect throughout the economy and exacerbate the incidence of poverty.

The foregoing highlights the need to identify the sources of firm volatility and the firm characteristics that influence the nature of the relationship thereof. Extant studies aimed at shedding light on these sources have, among others, linked firm international trade activities to various forms of firm volatility (e.g., Buch et al., 2009; Vannoorenberghe, 2012; Kurz and Senses, 2016; Kiyota et al., 2020). However, this literature has proceeded without considering the role of the global value chain (GVC). This is surprising as recent evidence suggests that more than 50% of global trade is now organized through global value chains (GVCs), due to falling trade costs that have altered the country-centric view of production requiring a full range of domestic industries to assemble a final good (World Bank, 2020; Avenyo et al., 2022; Ndubuisi and Owusu, 2023). GVC trade, unlike conventional trade, takes place mostly at a more granular level wherein individual firms across the globe are responsible for specific stages belonging to a supply chain (Ndubuisi and Owusu, 2022). This could yield different volatility effects as firms integrated into GVC get the opportunity to specialize in their most productive task, which contributes positively to both productive and allocative efficiency.

Further, integration into GVC has also helped firms build resilience by establishing multiple buyer-supplier relations while investing to build their productivity capacity mandated by lead firms in the value chain, leading to stable export earnings and higher value capture in value chains that may lead to lesser volatility for GVC firms (Chacha et al., 2022). Moreover, conventional trade is largely characterized by arm's-length transactions, while GVCs trade most prominently involves international transactions with some level of explicit coordination of firms from different countries tied together in a vertically integrated production system. In most cases, this production system includes sharing blueprints and management practices, through which new ideas and know-how are continuously transferred across national and international borders and regions (Abreha et al., 2020). The explicit coordination, management, know-how exchange, and efficiency gain due to specialization that is associated with GVCs increase a firm's competitiveness in the global trade market, thus creating a relatively stable demand for their products and may lead to lesser volatility for GVC firms. Despite these obvious relationships between GVC and firm volatility, the trade-volatility literature is yet to consider the role of GVC trade.

Against this background, the first objective of this paper is to examine the firm volatility effect of GVC, paying particular attention to firm job growth volatility (referred to hereafter as job volatility). As a second research objective, we examine how the quality level of the product exported by GVC firms influences the GVC-volatility nexus. Producing and exporting higher-quality products can enable international trading firms to absorb foreign demand and supply shocks because the demand for such products is relatively more stable, and they provide a robust income source as they are less vulnerable to price competition from low-wage producers. While this justifies analyzing the role of exported product quality in the GVC-volatility nexus, the need to do so is also orchestrated by the fact that buyer-supplier relation in GVC entails higher relationship-specific investments. This often incentivizes global buyers to cherry-pick the most capable suppliers to avoid production line delays and quality debasements caused by problems in the supply base. In this case, exporting higher quality products ensures stable and longer buyer-supplier relations in value chains, leading to stable export earnings and higher value capture in value chains. Other things equal, this is expected to depress any possible positive effect that integration in GVC may have on firm volatility. Such volatility effects are also depressed due to the market power exporting sophisticated products exerts, as such products are less vulnerable to price competition.

To address our research objectives, we rely on two datasets that are both provided by the South African Revenue Service and National Treasury (SARS-NT) for the period 2010-2017. The first dataset is the customs transaction-level data at the 6-digit harmonized system classification (HS), enabling us to identify and track firms in South Africa that engaged in GVC trade. The second dataset is the CIT-IRP5 firm-

level panel, which is derived from each firm's balance sheet and value-added tax statements. Therefore, it contains comprehensive information about the characteristics, behaviour, and performance of firms in South Africa. We limit our analysis to only manufacturing firms. To identify GVC firms, we use an adapted Hummels et al. (2001) vertical specialization index. The new index we propose considers GVC-integrated firms, as only those firms that simultaneously import intermediate inputs and export final and/or customized industrial intermediate goods (more on this in section 2). As our primary measure of firm job volatility, we use the rolling standard deviation of job growth over a five-year window. However, we test the sensitivity of the measure to three and seven-year window periods and alternative methods of computing volatility, such as the residual approach. Concerning product quality, we employ the novel method developed by Khandelwal et al. (2013) that infers quality from an empirical demand function using bilateral export data. Finally, we use different estimation strategies, including OLS, structural modeling, and instrumental variable (IV) methods that enable us to address a battery of econometric issues such as reverse causality and omitted variable and selection bias that confronts our empirical analysis.

We find strong heterogeneity in the levels of GVC integration among manufacturing firms, with the firms in the medium and high manufacturing sector engaging more in GVC. Importantly, the GVC firms are, on average, significantly different from those of non-GVC firms. They are mostly large, older, and productive firms compared to non-GVC firms. Further, we document that firms that participate in GVC show lower levels of job growth volatility. This finding is corroborated by our empirical analysis, and it is robust to several sensitivity and robustness checks aimed at addressing potential econometrics and measurement challenges that besiege our analysis. Lastly, we also document how firm dynamics influence this relationship. Along this line, our analysis of the role of exported product quality in the GVC and job volatility relationship indicates that the job volatility-reducing effect of GVC accrues more strongly to firms that produce and export products at the higher quality spectrum. Put together, our results highlight the importance of GVC and product upgrading as pathways for absorbing foreign demand and supply shocks, which are paramount to building production capacity, stable export earnings, and higher value capture in the value chain.

Our study contributes to three different research strands. First, we contribute to the literature focused on the nexus between trade and firm volatility. We contribute to this literature by providing the first empirical evidence of the nexus between GVC and firm volatility. We also contribute to this literature by providing the first empirical evidence of how the quality level of exported products shapes the nature of the relationship between trade and firm volatility. Along this line, our study also speaks to the literature that studies the importance of upgrading in the supply chain for firm resilience (Chacha et al., 2022; Lafrogne-Joussier et al., 2022). Second, our

study contributes to the literature on the effect of GVC on performance, which until now has largely focused on innovation (Avenyo et al., 2022), productivity (Mazzi et al., 2021), and efficiency level (Agostino et al., 2020). We expand this literature by focusing on firm volatility that bears ultimately on the firm's growth and performance, by lowering the firm's physical and human capital investments. Lastly, our study contributes to the nascent literature on the labor market effect of GVC. Among others, this literature has to date focused on the effect of GVC on wages (Lu et al., 2019; Ndubuisi and Owusu, 2022), employment (Pahl and Timmer, 2020), and skill premium (Lee and Yi, 2018). We expand this literature by documenting the role of job volatility.

The rest of the paper is organized as follows: The next section presents the research design, including the description of data sources, computation of variables, and descriptive statistics. Section 3 presents and discusses the results. Section 4 concludes.

2. Research Design

We combine information from two datasets that are provided by the South African Revenue Service and National Treasury (SARS-NT). The first dataset is the custom transaction-level data, containing the bilateral trade activities of formal firms in South Africa. The trade activities are reported at the 6-digit harmonized system classification (HS), enabling us to map them to different concordance tables. The second dataset is the CIT-IRP5 firm-level panel containing information about the characteristics, behaviour, and performance of firms in South Africa. Both datasets are available for the period 2009-2018. To ensure better data quality, we restrict our analysis to 2010-2017. We also restrict our analysis to only the firms in the manufacturing sector.

Beginning with the custom dataset, we restrict the observation to firms with statistical quantities in kilograms (kg) and firms with non-missing and non-zero export values or quantities. In the CIT-IRP5 panel data, we dropped firms that we observed as trading firms in the custom transaction-level data but did not consider either due to missing or zero export values and/or quantities (or because the statistical quantity is not in kg). Further, we dropped observations with missing, zero, or negative values of sales, capital, employment, or cost of sales. We restrict our final sample to only those firms that are consistently observed between 2010 and 2017. This ensures our results are not driven by new firms that enter or vulnerable firms that exit the market as their effect may be different from established firms. Our focus on job volatility and the choice of operationalization (see the next paragraph) further necessitates this as the dynamics of firm entry and exit may introduce measurement errors. Finally, we deflated all variables in monetary units, with an economy-wide deflator provided in the dataset, and merged the two datasets using the tax year and unique anonymized identifiers. Three main variables are important for our analysis: GVC participation, job volatility, and quality of exported products. We discuss how we arrive at these variables in the subsequent paragraphs.

Measuring Firm Volatility

Our indicator of firm volatility is job growth volatility. We compute it as the rolling standard deviation of job growth over a five-year window (for a similar approach see Blanchard and Simon, 2001; Buch et al., 2009). One of the weaknesses of this measure of volatility is that the window is chosen somewhat arbitrarily, and that the resulting volatility measure is autocorrelated. To this end, we test the robustness of our results to job volatility computed based on three-year and seven-year windows, respectively.¹ As an alternative measure of job volatility, we also employ the “residual” approach, which is computed as the squared residual of a job growth regression (for similar approaches see Buch et al., 2009; Fatás and Mihov, 2013; Kurz and Senses, 2016). One of the advantages of this approach is that it purges job growth rates from autocorrelation dynamics and macroeconomic developments affecting all firms alike. We test the sensitivity of the results obtained from the residual approach by employing different fixed-effects and lag values of real sales. Finally, another weakness of the rolling window approach is that it assumes that volatility is constant over time, and that there are no structural changes that would affect the volatility. We address this concern by computing job volatility using moving averages of job growth rates over a period. This helps to smooth out short-term fluctuations and provides a more stable measure of job volatility over time.

Identifying GVC Firms

Identifying GVC firms at the firm level is somewhat challenging due to data limitations. Therefore, extant studies have identified GVC participating firms in different ways. For instance, some studies identify GVC firms as those that simultaneously import intermediate inputs and export intermediate or final goods (Baldwin and Yan, 2014), two-way traders (Rigo, 2021), or traders (i.e., either imports or exports) with international quality certification (Reddy et al., 2021), or firms exporting customized industrial intermediate inputs (Mazzi et al., 2020). Others use Hummels et al. (2001) vertical specialization index adapted at the firm level (Reddy and Sasidharan, 2021). The latter accounts for both export and import intensities of the firm by incorporating the amount of imported intermediate inputs embodied in firms' exports. We follow the latter approach and compute the adapted Hummels et al. (2001) of vertical specialization index given as follows:

$$V_{it} = \frac{\text{Imported Intermediates}_{it}}{\text{Value added}_{it}} \times \frac{\text{Final goods \& Customized Intermediate exports}_{it}}{\text{Sales}_{it}} \quad (1)$$

¹ To compute this variable, we first compute job growth using log difference and then use the “rangestat” Stata routine to compute the standard deviation for the respective window periods.

Where the subscript i denotes firm and t denotes time, the resulting index from equation 1 ranges from 0 to 1, and is considered a measure of GVC embeddedness. We use cost of sales as an empirical proxy of value added as CIT-IRP5 data does not provide information on value added. While firms exporting final or customized intermediate goods can be defined as GVC firms, we restrict GVC firms to those that engage in both activities. This enables us to capture the sequential and back-and-forth aspect of global linkage and underscores the characteristic of GVC where firms use import intermediates to produce goods that are then exported (Baldwin and Yan, 2014). We also restrict the export component to final goods and/or customized intermediates to capture the prevalent view that GVC firms import intermediates to export final goods or processed intermediates. Exporters of final products are usually considered lead firms in the literature, while exporters of intermediate goods are suppliers. While identifying the former as firms that import intermediate and export final goods is somewhat straightforward and intuitive, the same cannot be said for exports of intermediate goods as we are more likely to include firms exporting standardized and generic products traded through arms-length relationships. In contrast, intermediate goods exported in GVC involve a higher degree of customization and are either part of an intra-firm exchange or are exchanged in networks with higher degrees of coordination (Gereffi et al., 2005; Sturgeon and Memedovic, 2010). Therefore, the intermediate good component of the export in equation 1 is restricted to customized intermediates.

To identify firms exporting customized intermediates, we follow a two-step approach as in Mazi et al. (2020; 2021). First, we use the United Nations Broad Economic Categories Revision 4 (BEC4) to divide the exported intermediate goods into three, namely: (i) industrial intermediates; (ii) primary intermediates (foods and beverages, fuels, and primary industrial supplies); and (iii) final products (capital and consumption goods). In a seminal paper, Rauch (1999) classified all traded products into three categories: (i) traded in organized exchanges; (ii) reference priced in trade publications; and (iii) all others. Whereas the first two categories indicate homogeneous products traded in dense markets, the residual identifies differentiated products that are more likely to be traded within networks and therefore entail both a higher degree of relationship-specific investment and coordination. The second step involves mapping the industrial intermediates identified with the BEC4 to Rauch's residual category. Customized industrial intermediates are then defined as differentiated industrial intermediates. Rauch suggested two definitions, a conservative (which minimizes the number of products that are classified as homogeneous) and a liberal one (which maximizes the number of products that are classified as homogeneous). Our empirical analysis relies on the former. However, we show the robustness of our result when we employ the latter.

Further, the recent UN BEC5 divides traded products into four categories, according to their end-use (intermediates versus finals) and 'specification' type ('generic' versus 'specific'): 'specific' intermediates, 'generic' intermediates, final goods, and a residual group containing other exporters, especially exporters of unprocessed (primary) goods. By definition, specific intermediates isolate trade in primary commodities and generic intermediates, identifying those products that prominently involve international transactions with some level of explicit coordination, which as noted earlier, is a fundamental characteristic that distinguishes GVC from the arm's-length transactions underpinning more "traditional" trade. In the robustness check, therefore, we shall define customized intermediates as "specific" intermediates as captured in BEC5. Considering the foregoing, we follow Hummels et al. (2001), Lu et al. (2019), and Reddy and Sasidharan (2021) in differentiating between GVC embedded (GVC_{it}) and non-embedded GVC ($Non\ GVC_{it}$) firms as follows:

$$V_{it} = \begin{cases} GVC_{it} & \text{if } V_{it} > 0 \\ Non\ GVC_{it} & \text{Otherwise} \end{cases} \quad (2)$$

Measuring Product Quality

Product quality is an unobserved attribute of a product that incentivizes buyers to purchase higher quantities of a vertical variety irrespective of possibly higher prices charged by producers (Mazzi and Foster-McGregor, 2021). The unobserved attribute of a product quality implies it needs to be inferred. One of the approaches often used in the literature, in this case, is unit prices, with the underlying assumption being that higher prices signal higher quality. However, this approach has been criticized (Hallak and Schott, 2011; Amiti and Khandelwal, 2013). Khandelwal et al. (2013) developed a novel approach to inferring quality based on estimating a constant elasticity of substitution (CES) demand function using bilateral export data. The approach has been extensively explored elsewhere in the literature (Fan et al., 2015; Manova and Yu, 2017; Ndubuisi and Owusu, 2021; Mazzi and Foster-McGregor, 2021) and is based on the intuition that conditional on price, a product with a higher quantity is assigned higher quality. We use this approach to infer product quality. Following Khandelwal et al. (2013), we derive quality estimates of product j country i shipped to destination country c through the following empirical demand function:

$$\ln(x_{ija}) + \sigma \ln(p_{ija}) = \tau_a + \tau_j + \psi_{ija} \quad (3)$$

where x_{ija} denotes the demand for the firm's i export of product j in destination country d , p_{ija} and q_{ija} are the price and the quality of the exported product. σ is the elasticity of substitution, which we set at the commonly used value of five

following the extant literature (Fan et al., 2015; Manova and Yu, 2017; Ndubuisi and Owusu, 2021). τ_d is the destination country's fixed effect in the period, controlling for differences in income and price level across destination countries. τ_j is the product fixed effect, controlling for the differences in prices and quantities across product categories due to the inherent characteristics of the product. ψ_{ijd} is the error term. To arrive at the product quality, equation (3) is estimated with Ordinary Least Squares (OLS), and the inferred quality is then given by the predicted residual from the regression. After retrieving the inferred quality, we compute a firm-product-specific measure of quality by averaging across the importing destination countries.

Descriptive Statistics

In addition to the variables, we described above, we compute a battery of variables we use as controls in the empirical analysis. This includes a host of firm characteristics vis-a-vis capital intensity, wage per capita, royalties' payment, R&D intensity, labor productivity, age and foreign ownership, and three industry characteristics, including industry demand, competition, and the level of trade openness. We describe these variables in Appendix Table A1. In addition, the table provides the basic summary statistics of the variables used in our analysis. Our final sample comprises 6,543 firms with 52,344 total observations across 23 manufacturing sectors for the period 2010-2017.

Appendix Table A2 shows the trade classification of our sample observation. Panel A in the table is based on our main GVC indicator as formulated in equation 2. The table indicates that, on average, about 46.6% of firms in our sample do not engage in any form of international trade. While the rest in the sample are engaged in international trade, there is substantial variation in their mode of engagement. Particularly, 9.2% engage in trade only through exporting, while 8.7% engage in trade only through importing. The remaining 35.3% engage in trade both through exporting and importing. For the latter, about 90.8% of the firms (which is about 32.1% of the full sample) are GVC firms. We observe almost identical patterns of trade classification in Panel B and C, which use alternative GVC indicators as described in section 2.1, implying that our GVC indicator is not vulnerable to the choice of how we operationalize customized intermediates (which is the source of the difference across the GVC indicators).

The trade description we presented, thus, suggests that South African firms are highly engaged in international trade, albeit only a handful of them do so through GVC, on average. In the most part, this pattern is in line with those of Van Biesebroeck and Mensah (2019) and Avenyo et al. (2022) that document lower levels of firm GVC engagement across most countries in Sub-Saharan Africa, especially for

their manufacturing sectors.² However, we observe a great deal of heterogeneity across the sectors in Appendix Table A3, which characterizes the sector dimension of our final dataset. The table reveals that some sectors are far well integrated in GVC than others. For instance, about 57.6% of firms in the tobacco sectors are integrated in GVC, while only about 12.6% of the firms in the wood and related products sector are GVC firms. Moreover, the table also reveals a high GVC participation rate of South Africa's medium and high sectors (such as pharmaceuticals, chemicals and chemical products, computer and electronic and machinery and equipment) as their respective sub-sectors have GVC firms' share that is above 40.0%, which is greater than the sample average GVC share of 32.1%.

Appendix Table A3 also shows the sector dimension of the job volatility indicator and the average exported product quality. Beginning with the former, wearing apparel is the sector with the highest job volatility rate (33.2%). This is followed by the textiles sector with a job volatility rate of 31.9% and food products sector with a job volatility rate of 30.4%. Interestingly, the tobacco product sector, which is the sector with the highest GVC firm share, also has the lowest job volatility rate (16.5%). The other two sectors with the least job volatility rate are the "computer, electronic and optical products" and the "electrical equipment", with each of these sectors having a respective average job volatility rate of 20.3%. As per the average exported product quality, the three sectors with the highest quality include "computer, electronic and optical products" (2.5), "leather and related products" (2.2), and "wearing apparel" (1.9). Conversely, the sectors with the least exported product quality include "motor vehicles, trailers and semi-trailers" (-0.4124), "beverages" (-0.16), and "other non-metallic mineral products" (-0.04).

Finally, Appendix Table A4 shows the mean difference test between the characteristics of GVC and non-GVC firms. Overall, the results from the mean difference test shows that the characteristics of GVC firms in our sample are, on average, significantly different from those of non-GVC firms. Interestingly, we find that job volatility of GVC firms is lower than that of non-GVC firms. This result is robust to the different job volatility indicator we computed. This first piece of evidence suggests that GVC firms, on average, are less volatile compared to non-GVC firms. Further, we find that GVC firms are productive, capital intensive and invest more in innovation related activities (as shown by the R&D investment and royalty payments). They are also largely foreign firms, older and larger firms relative to non-GVC firms.

² Other patterns we document such as few exporting firms and a greater share of two-way traders compared to only exporting or only importing firms are also consistent with the extant literature (Bernard and Jensen, 1995; Muûls and Pisu, 2009; and Konte and Ndubuisi, 2021).

Model Specification and Estimation

The first objective of our research is to examine how GVC affects firm volatility, while the second objective examines how the quality level of the exported product influences the nature of the GVC and firm volatility nexus. The starting point of the empirical model that informs our first research objective takes the following form:

$$\rho_{it} = \delta + GVC_{it}\beta + X'_{it}\gamma + I'_{st}\theta + \tau_s + \tau_t + \varepsilon_{it} \quad (4)$$

Where the subscripts are as defined earlier, δ is the intercept and ρ_{it} is job volatility, our empirical measure of firm volatility. GVC is our firm-level measure of GVC embeddedness. X'_{it} and I'_{st} are vectors of time-varying firm and industry characteristics, respectively. Importantly, we include three sector characteristics (including industry demand, competition, and the level of trade openness) and a host of firm characteristics such as age, foreign status, size, and R&D intensity. τ_s is industry dummies to account for unobserved differences across industries, while τ_t is time dummies accounting for time-specific technological shocks that are common across firms. Finally, ε_{it} is the error term.

To estimate equation 4, we begin by estimating a simple OLS model with sector and time-fixed effects. To ensure the robustness of our results, we show results using different indicators of the outcome variables. While this reduces endogeneity concerns emanating from measurement errors, we are still left with potential endogeneity issues arising from simultaneous (unobservable) shocks affecting both job volatility and GVC, or from selection and omitted variable bias. Our model may also be subject to reverse causality as domestic volatility may drive firms to enter the international market to hedge and diversify risks. One of the conventional ways to produce an unbiased and consistent estimate in the presence of endogeneity is to adopt a two-stage least square (IV-2SLS) method, wherein the endogenous explanatory variable is corrected with an external instrument. The external instrument must be valid, implying that it must strongly explain the endogenous explanatory variable and be uncorrelated with the error component of the model. In most cases, obtaining an instrument that satisfies this condition is a daunting task and, even where successful, the IV-2SLS may also lead to a loss of precision due to the 2SLS process (Gebreyesus and Mohnen, 2013).

Another way of addressing the endogeneity issue is through structural equation modeling, whereby, in our case, the job volatility and the GVC integration are jointly estimated by Maximum likelihood. We adopt this approach to address endogeneity concerns in our model, estimating a recursive model wherein causation runs from GVC integration to job volatility. As noted by Gebreyesus and Mohnen (2013), the Maximum likelihood estimator is the most efficient if the model is correctly specified. In the estimation, we rely on exclusion restriction to identify the parameters of the GVC embeddedness equation from those of the job volatility

equation. We use the share of other GVC-integrated firms in a sector for this purpose. We expect this variable to only affect job volatility through GVC embeddedness as the intensity of other firms within the same sector that are actively engaged in GVC reflects a multitude of factors that affect the decision of a firm to engage in GVC (Avenyo et al., 2022). Therefore, it should strongly correlate with the individual firm's decision to engage in GVC. In what follows, the expression for the latent variable in equation 5 is replaced by:

$$\begin{aligned} GVC_{it} &= \chi + X'_{it}\gamma + \mathbb{Z}_{it}\tau + \tau_s + \tau_t + v_{it} \\ \rho_{it} &= \delta + GVC_{it}\beta + X'_{it}\gamma + I'_{st}\theta + \tau_s + \tau_t + \varepsilon_{it} \end{aligned} \quad (5)$$

where all variables and subscripts are as previously defined, χ is an intercept, \mathbb{Z}_{it} is the variable we use for the exclusion restriction, and v_{it} is the error term of the latent equation. To address our second research objective, we augment the firm volatility equation by accounting for the interaction between GVC embeddedness and the level of exported product quality. Therefore, the system of equations that guide the analysis for the second research objective is as follows:

$$\begin{aligned} GVC_{it} &= \chi + X'_{it}\gamma + \mathbb{Z}_{it}\zeta + \tau_s + \tau_t + v_{it} \\ \rho_{it} &= \delta + GVC_{it}\alpha_1 + \mathbb{Q}_{it}\alpha_2 + \alpha_3(GVC_{it} \times \mathbb{Q}_{it}) + M'_{it}\gamma + I'_{st}\theta + \tau_s + \tau_t + \varepsilon_{it} \end{aligned} \quad (6)$$

where all variables and subscripts are as previously defined, \mathbb{Q}_{it} is the average quality of the exported product by firm i , $GVC_{it} \times \mathbb{Q}_{it}$ is an interaction term comprising GVC integration and the average quality of exported product, and $X'_{it} = M'_{it} + \mathbb{Q}_{it}$. The total effect of GVC integration on firm volatility is captured by $\frac{\partial(\rho_{it})}{\partial(GVC_{it})} = \alpha_1 + \alpha_3\mathbb{Q}_{it}$, while the differential firm volatility effect of GVC participation given the level of the quality of exported products is given by the parameter α_3 . In line with our conjecture that producing and exporting higher quality products reduces firm volatility, we expect α_3 to be negative and statistically significant.

Further, we complement the results of the structural equation with those of Lewbel's (2012) IV approach. The approach identifies the endogenous variables in the absence of good external instruments by using heteroskedasticity present in the model to generate sets of instruments (Baum et al., 2013). Compared to the conventional IV approach requiring an external instrument for appropriate identification of the endogenous variable, identification using the Lewbel (2012) IV

approach is achieved by having regressors that are uncorrelated with the product of heteroskedasticity errors, which is a feature of many models where error correlations are due to an unobserved common factor (Baum et al., 2013). Application of the estimation strategy to address the first research question entails estimating equation 4, where we consider GVC to be endogenous. In the case of addressing the second research question, it entails estimating an augmented equation 1, where an interaction comprising GVC and export quality is incorporated into the model.

3. Results and Discussion

GVC and Job Volatility

Table 1 presents the results on the linear relationship between GVC integration and job volatility. Columns 1 and 2 show the results using our main primary outcome variable; that is job volatility computed using the rolling standard deviation of job growth over a five-year window. Column 1 is based on estimation conditional on only firm characteristics, while in column 2 we introduce three industry variables: industry demand, competition, and the level of trade openness. The estimated coefficient of GVC in column 1 is negative and statistically significant at all conventional significance levels, implying that GVC integration reduces job volatility. In column 2, the estimated coefficient of GVC remains unchanged in terms of the statistical significance, and the sign and size of the estimated coefficient, implying that the result is neither driven by confounding factors at the firm nor sector level. Columns 3 and 4 show the results for the job volatility computed using the rolling standard deviation of job growth over a 3-year and 7-year window, respectively. In both cases, the estimated coefficient of GVC remains negative and statistically significant at all conventional significance level, implying that our findings and conclusion are not susceptible to the chosen window period used in the computation of the job volatility variable.

Table 1: GVC and job volatility: Baseline regression

	5-year window		3-year window	7-year window
	(1)	(2)	(3)	(4)
<i>Firm characteristics</i>				
GVC Status	-0.0490*** (0.004)	-0.0490*** (0.004)	-0.0441*** (0.004)	-0.0505*** (0.004)
Capital Intensity	0.0014*** (0.001)	0.0014*** (0.001)	0.0016*** (0.001)	0.0014*** (0.001)
R&D Intensity	0.0969 (0.059)	0.0975 (0.060)	0.1022 (0.064)	0.0947 (0.058)
Royalty	-0.1705 (0.185)	-0.1719 (0.186)	-0.3024* (0.180)	-0.1772 (0.177)
Labor Productivity	-0.0053*** (0.001)	-0.0053*** (0.001)	-0.0050*** (0.002)	-0.0054*** (0.001)
Foreign Firm	-0.0504***	-0.0504***	-0.0412***	-0.0511***

	(0.006)	(0.006)	(0.006)	(0.006)
Age	-0.0699***	-0.0699***	-0.0692***	-0.0689***
	(0.025)	(0.025)	(0.025)	(0.025)
Age Squared	0.0016	0.0016	0.0023	0.0013
	(0.004)	(0.004)	(0.004)	(0.004)
Size	-0.0121***	-0.0121***	-0.0156***	-0.0115***
	(0.003)	(0.003)	(0.003)	(0.003)
Export Quality	-0.0018***	-0.0018***	-0.0017***	-0.0018***
	(0.000)	(0.000)	(0.000)	(0.000)
Sector characteristics				
Demand		-0.0126**	-0.0109**	-0.0123**
		(0.005)	(0.005)	(0.005)
Competition		0.0008	-0.0020	0.0009
		(0.006)	(0.006)	(0.006)
Trade Openness		0.0010	-0.0004	0.0009
		(0.011)	(0.011)	(0.011)
Constant	0.5612***	0.5720***	0.5363***	0.5738***
	(0.042)	(0.083)	(0.084)	(0.083)
No. Observations	39,258	39,258	39,258	39,258
R-squared	0.039	0.039	0.036	0.040

Note: Robust standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies. The outcome variable in all the columns is computed as rolling standard deviation of job growth using 5-year, 3-year, and 7-year window period in columns 1 and 2, columns 3, and columns 4, respectively.

The results presented in Table 1 are based on the GVC indicator computed using Rauch's conservative classification. In Appendix Table A5, we report the results based on GVC indicators computed using Rauch's liberal classification and the UN BEC5. The results for the former are shown in columns 1 to 3, while the results for the latter are shown in columns 4 to 6. Across the six columns, the estimated coefficient of GVC is negative and statistically significant at all conventional significance level, implying that our findings as reported in Table 1 are not driven by our preferred choice of GVC indicator. Next, Appendix Table A6 reports additional results using the alternative job volatility indicators as discussed in section 2. Columns 1 and 2 show the results when we use the moving averages to compute job volatility, with column 1 showing the results based on a 3-year moving average and column 2 showing the results based on a 5-year moving average. In both cases, the estimated coefficient of GVC is negative and statistically significant at all conventional significance levels, although the sizes of the estimated coefficient are somewhat smaller compared to those reported in Table 1.

Further, columns 3 to 5 of Appendix Table A6 show the results when we use the job volatility measure computed using the residual approach. Column 3 shows the results using the job volatility computed as the squared residual of a job growth regression conditional on firm, sector, and year-fixed effects. Column 4 shows the results using the job volatility computed as the squared residual of a job growth regression conditional on industry-firm pair and year-fixed effects. Column 5 shows the results using the job volatility computed as the squared residual of a job growth regression conditional on period-lagged real sales, and firm and year-fixed effects. Across the three columns, the estimated coefficient of GVC remains negative and statistically significant at all conventional significance levels. Put together, the results presented in Appendix Table 6A corroborate those presented in Table 1, suggesting that integration into GVC is associated with a reduction in job volatility, and that this result is not susceptible to the choice of job volatility and GVC measure.

Table 2: GVC and job volatility: Addressing endogeneity issues

	Structural Model (MLE)			Lewbel IV Method		
	(1)	(2)	(3)	(4)	(5)	(6)
	5-year window	3-year window	7-year window	5-year window	3-year window	7-year window
<i>Firm characteristics</i>						
GVC Status	-	-	-	-	-	-
	0.0835*** (0.008)	0.0581*** (0.012)	0.0887*** (0.008)	0.0685*** (0.015)	0.0797*** (0.015)	0.0696*** (0.015)
Capital Intensity	0.0017*** (0.000)	0.0017*** (0.001)	0.0016*** (0.001)	0.0016*** (0.001)	0.0018*** (0.001)	0.0015*** (0.001)
R&D Intensity	0.1012* (0.061)	0.1037 (0.064)	0.0988* (0.059)	0.1025 (0.063)	0.1114 (0.070)	0.0996 (0.061)
Royalty	-0.1457 (0.179)	-0.2918 (0.178)	-0.1483 (0.170)	-0.1621 (0.183)	-0.2845 (0.177)	-0.1676 (0.175)
Labor Productivity	-	-	-	-	-0.0032*	-
	0.0035*** (0.001)	0.0043*** (0.002)	0.0034*** (0.001)	0.0043*** (0.002)	-	0.0044*** (0.002)
Foreign Firm	-	-	-	-	-	-
	0.0421*** (0.006)	0.0378*** (0.007)	0.0419*** (0.006)	0.0459*** (0.007)	0.0329*** (0.007)	0.0467*** (0.007)
Age	-	-	-	-	-	-
	0.0737*** (0.025)	0.0708*** (0.025)	0.0732*** (0.025)	0.0723*** (0.025)	0.0736*** (0.024)	0.0712*** (0.025)
Age Squared	0.0028 (0.004)	0.0028 (0.004)	0.0027 (0.004)	0.0023 (0.004)	0.0035 (0.004)	0.0020 (0.004)
Size	-0.0053* (0.003)	- (0.004)	-0.0040 (0.003)	-0.0083** (0.004)	-0.0086** (0.004)	-0.0077** (0.004)
Export quality	-	-	-	-0.0013**	-0.0007	-0.0012**
	0.0019*** (0.000)	0.0017*** (0.000)	0.0018*** (0.000)	(0.001)	(0.001)	(0.001)

Sector characteristics						
Demand	-0.0127** (0.005)	-0.0109** (0.005)	-0.0123** (0.005)	-0.0127** (0.005)	-0.0110** (0.005)	-0.0124** (0.005)
Competition	0.0011 (0.006)	-0.0019 (0.006)	0.0011 (0.006)	0.0010 (0.006)	-0.0017 (0.006)	0.0010 (0.006)
Trade Openness	0.0005 (0.011)	-0.0006 (0.011)	0.0003 (0.011)	0.0010 (0.011)	-0.0005 (0.011)	0.0009 (0.011)
Constant	0.5473*** (0.079)	0.5076*** (0.080)	0.5662*** (0.079)	0.5604*** (0.080)	0.4940*** (0.081)	0.5823*** (0.081)
Lnsig_2	- 1.1707*** (0.014)	- 1.1775*** (0.015)	- 1.1674*** (0.014)			
atanhrho_12	0.0672*** (0.015)	0.0275 (0.023)	0.0743*** (0.014)			
No. of Observations	52,344	52,344	52,344	39,258	39,258	39,258
Uncentred R-Squared				0.43	0.40	0.039
Kleibergen-Paap F statistic				30.7	30.7	30.7

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies. The outcome variable in all the columns is computed as rolling standard deviation of job growth using 5-year, 3-year, and 7-year window period in columns 1 and 4, columns 2 and 5, and columns 3 and 6, respectively.

Thus far, our estimations are based on OLS. As discussed in section 2, the results obtained from such estimation may be vulnerable to endogeneity issues arising particularly from simultaneity and selection bias. To address this concern, we re-estimate the baseline result as reported with alternative estimation methods as discussed in section 2. The results of this exercise are reported in Table 2. Columns 1 to 3 show the results of the job volatility effect of GVC resulting from the structural model. Appendix Table A7 shows the aspect of the structural model result for the drivers of GVC integration. The results show that foreign firms and larger firms are more likely to participate in GVC. It also shows that higher levels of capital intensity, labor productivity and R&D intensity increase the likelihood of GVC integration. These results are consistent with those of the extant literature on the drivers of GVC (Lu et al., 2019; Reddy and Sasidharan, 2021; Reddy et al., 2021). Further, consistent with our expectation the estimated coefficient of the variable “*Other GVC share*” for the exclusion restriction is positive and statistically significant. Returning to Table 2, the estimated coefficient of GVC in columns 1 to 3 is negative and statistically significant at all conventional significance levels across the columns. Columns 4 to 6 report the result when we implement the Lewbel IV approach. The results are consistent with those of the structural model and the baseline results, suggesting that our earlier conclusion is not influenced by endogeneity issues. Put together, the

results presented thus far provide the first empirical evidence of a potential effect of GVC on job volatility, with our finding indicating that integration into GVC is associated with a reduction in job volatility.

GVC, Exported Quality and Job Volatility

The analysis has so far focused on the linear relationship between GVC embeddedness and job volatility. In this section, we examine the role of the quality level of the exported product. As noted earlier, producing and exporting higher-quality products can reduce firm volatility because the demand for such products is relatively more stable and they provide a robust income source as they are less vulnerable to price competition from low-wage producers. We expect this relationship to be stronger for GVC firms, since GVC entails irreversible and relationship-specific investment. In this case, GVC firms with better product quality ensure stable and longer-term trade linkages that bear ultimately on firm stability.

Table 3: GVC, product quality and firm volatility

	OLS			Structural Model (MLE)			Lewbel IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	5-year window	3-year window	7-year window	5-year window	3-year window	7-year window	5-year window	3-year window	7-year window
<i>Firm characteristics</i>									
GVC Status	-0.0491*** (0.004)	-0.0447*** (0.004)	-0.0506*** (0.004)	-0.0833*** (0.008)	-0.0581*** (0.013)	-0.0885*** (0.008)	-0.0594*** (0.012)	-0.0654*** (0.012)	-0.0616*** (0.012)
GVC Status × Export Quality	-0.0015*** (0.001)	-0.0011** (0.001)	-0.0015*** (0.001)	-0.0016*** (0.001)	-0.0012** (0.001)	-0.0016*** (0.001)	-0.0015* (0.001)	-0.0009 (0.001)	-0.0015* (0.001)
Capital Intensity	0.0015*** (0.001)	0.0016*** (0.001)	0.0014*** (0.001)	0.0017*** (0.000)	0.0017*** (0.001)	0.0017*** (0.001)	0.0014*** (0.001)	0.0016*** (0.001)	0.0013*** (0.001)
R&D Intensity	0.0971 (0.059)	0.1007 (0.063)	0.0943 (0.058)	0.1009* (0.060)	0.1022 (0.063)	0.0985* (0.059)	0.0904 (0.056)	0.0992 (0.063)	0.0879 (0.055)
Royalty	-0.1762 (0.187)	-0.3076* (0.181)	-0.1815 (0.179)	-0.1503 (0.180)	-0.2975* (0.180)	-0.1527 (0.171)	-0.0059*** (0.001)	-0.0048*** (0.002)	-0.0060*** (0.001)
Labor Productivity	-0.0053*** (0.001)	-0.0050*** (0.002)	-0.0054*** (0.001)	-0.0035*** (0.001)	-0.0043*** (0.002)	-0.0034*** (0.001)	0.0100*** (0.004)	0.0076** (0.004)	0.0115*** (0.004)
Foreign Firm	-0.0504*** (0.006)	-0.0412*** (0.006)	-0.0511*** (0.006)	-0.0422*** (0.006)	-0.0380*** (0.007)	-0.0420*** (0.006)	-0.0607*** (0.003)	-0.0549*** (0.003)	-0.0614*** (0.003)
Age	-0.0698*** (0.025)	-0.0691*** (0.025)	-0.0688*** (0.025)	-0.0736*** (0.025)	-0.0706*** (0.025)	-0.0731*** (0.025)	-0.0135*** (0.003)	-0.0141*** (0.003)	-0.0128*** (0.003)
Age Squared	0.0016 (0.004)	0.0022 (0.004)	0.0013 (0.004)	0.0028 (0.004)	0.0027 (0.004)	0.0026 (0.004)	-0.0016 (0.001)	-0.0018 (0.001)	-0.0016 (0.001)
Size	-0.0119*** (0.003)	-0.0152*** (0.003)	-0.0112*** (0.003)	-0.0052* (0.003)	-0.0126*** (0.004)	-0.0038 (0.003)	-0.0135*** (0.003)	-0.0141*** (0.003)	-0.0128*** (0.003)
<i>Sector characteristics</i>									

Demand	-0.0127** (0.005)	-0.0109** (0.005)	-0.0124** (0.005)	-0.0127** (0.005)	-0.0109** (0.005)	-0.0124** (0.005)	-0.0126** (0.005)	-0.0109** (0.005)	-0.0123** (0.005)
Competition	0.0008 (0.006)	-0.0020 (0.006)	0.0008 (0.006)	0.0010 (0.006)	-0.0020 (0.006)	0.0011 (0.006)	0.0007 (0.006)	-0.0020 (0.006)	0.0008 (0.006)
Trade Openness	0.0010 (0.011)	-0.0004 (0.011)	0.0009 (0.011)	0.0005 (0.011)	-0.0006 (0.011)	0.0004 (0.011)	0.0015 (0.011)	-0.0003 (0.011)	0.0014 (0.011)
Constant	0.5704*** (0.083)	0.5343*** (0.084)	0.5722*** (0.083)	0.5463*** (0.079)	0.5065*** (0.080)	0.5652*** (0.079)	0.5725*** (0.073)	0.4946*** (0.073)	0.5966*** (0.073)
Lnsig_2				-1.1706*** (0.014)	-1.1775*** (0.015)	-1.1674*** (0.014)			
atanhrho_12				0.0668*** (0.015)	0.0264 (0.023)	0.0739*** (0.014)			
No. of Observations	39,258	39,258	39,258	39,258	39,258	39,258	39,258	39,258	39,258
R-squared	0.039	0.035	0.040				0.43	0.40	0.039
Kleibergen-Paap F statistic							22.3	22.3	22.3

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies. The outcome variable in all the columns is computed as rolling standard deviation of job growth using 5-year window period in columns 1, 4 and 7; 3-year window period in columns 2, 5 and 8; and 7-year window period in columns 3, 6 and 10. R-squared in columns 7 to 9 is uncentred R-Square

Table 3 provides the baseline results for this exercise. The OLS regression results are presented in columns 1 to 3, while columns 4 to 9 present results obtained from two alternative estimation strategies aimed at addressing endogeneity issues as discussed in section 2.

The OLS results show that the estimated coefficient of GVC is negative and statistically significant, and the interaction term comprising GVC and exported product quality is also negative and statistically significant. While this result is based on our main primary outcome variable (i.e., job volatility computed using the rolling standard deviation of job growth over a five-year window), the results reported in columns 2 and 3, which are based on job volatility computed using 3-year and 7-year window, leads to the same conclusion. Put together, the results imply that the job volatility-reducing effect of GVC accrues more strongly to those GVC firms that produce and export products at the higher quality segment. Columns 4 to 6 show the results of the job volatility effect of GVC resulting from the structural model, while columns 7 to 9 show the results from the Lewbel IV method. In both cases, the estimated coefficient of the interaction term comprising GVC and exported product quality remains negative and statistically significant at conventional significance. Thus, they corroborate our earlier conjecture on the benefit of producing and exporting products with higher quality, especially for those firms that are integrated into GVC.

4. Conclusion

Firm volatility has far-reaching implications for firms, workers, households, and the economy at large, and it is widely recognized that trade and volatility are intricately linked. While this has spurred extensive literature examining the trade-volatility nexus, extant studies have overlooked the impact of global value chain (GVC) trade, which accounts for more than half of the current global trade. Moreover, the emergence of GVC has offered firms the opportunity to specialize in their most productive tasks and build resilience by establishing multiple buyer-supplier relations and stable export earnings that have strong implications for firm volatility. Our study sheds light on this complex relationship between GVC trade and volatility, paying particular attention to firm job growth volatility and the role that product quality plays in shaping the nature of this relationship. Two main insights emerge from our study. First, we document robust evidence suggesting that integration into GVC is associated with lower levels of firm job growth volatility. Second, we document that the level of exported product quality is an important source of heterogeneity among GVC-integrated firms as our results show that the volatility-reducing effect of integration into GVC is stronger for those firms producing and exporting products at the higher quality spectrum. As we argued in the paper, this latter effect is largely driven by inelastic demand for high quality products, which sheds producers from price competition from low-wage producers. At the same time, exporting higher quality products ensures stable and longer buyer-supplier relations in value chains, leading to stable export earnings and higher value capture in value chains. Other things equal, this is expected to depress any possible positive effect that integration in GVC may have on firm volatility.

Our findings have important policy implications. Our results on the volatility-reducing effect of GVC integration highlight the importance of GVC for firm resilience among international trading firms. This calls for active trade-and-industrial-related policies to achieve stronger insertion into GVC. The policy options along this line include careful interventions that lower barriers to entry into GVC and make it easier for firms to form broader value chain networks. Among others, this includes tariff liberalization and reduction of non-tariff barriers such as increasing border efficiency. Behind the border factors, such as inefficient product market regulations, credit and labor market frictions should also be targeted and improved accordingly as extant studies indicate they affect the level to which firms participate in GVC, firms' patterns of specialization in GVC, and the competitiveness of firms in embedded value chains. Further, our results showing that firm volatility effects of

GVC integration depend on exported product quality call for additional complementary policy instruments that enhance the extent of general knowledge and the accumulation of product-specific knowledge and capability that engenders production of products at the higher-quality segment. Among others, policy options in this regard include, but are not limited to, educational policies targeted at improving the school curriculum to build productive and innovation capability, and industrial policies targeted at skill upgrading and capability accumulation, such as export platforms, R&D tax credits, and incentives, and national programs that encourage forced local linkages between foreign multinational enterprises and domestic firms.

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Appendix

Table A1: Variable definition and descriptive statistics

Variable	Description	Obs	Mean	Std. dev.	Min	Max
Job Volatility	Rolling standard deviations of job growth over a 5-year window	39,258	0.261	0.316	0	5.973
GVC (Conservative)	=1 if Hummels vertical specialization index > 1; and 0 if otherwise	52,344	0.321	0.467	0	1
GVC (Liberal)	=1 if Hummels vertical specialization index > 1; and 0 if otherwise	52,344	0.320	0.466	0	1
GVC (BEC5)	=1 if Hummels vertical specialization index > 1; and 0 if otherwise	52,344	0.311	0.463	0	1
Capital Intensity	Log ratio of capital to labor	52,344	9.665	3.310	-7.182	22.658
R&D Intensity	Log ratio of R&D expenses to sales	52,344	0.0004	0.018	0	3.281
Royalty payment	Log the ratio of royalty expenses to sales	52,344	0.001	0.010	0	1.038
Labour Productivity	Log ratio of sales to labour	52,344	13.229	1.539	-7.323	21.610
Foreign Firm	=1 if firm's ultimate holding company is resident outside South Africa; and 0 if otherwise	52,344	0.040	0.195	0	1
Age	Log Age, computed using incorporation year	52,344	2.811	0.610	0	4.787
Age Squared	Log squared Age	52,344	8.273	3.466	0	22.920
Size	=1 if employment level ≤ 50 ; 2 if $50 < \text{employment level} \leq 100$; and 3 if employment level > 100	52,344	1.502	0.786	1	3

Exported Product Quality	Average exported product quality computed following Khandelwal <i>et al.</i> (2013)	52,344	0.731	3.212	-33.924	35.459
Demand	Annual growth in sales at the two-digit industry level	45,801	0.088	0.283	-3.167	3.149
Competition	Log Herfindahl Hirschman index at the two-digit industry level	52,344	-2.850	0.704	-3.992	-0.171
Trade Openness	Log ratio of total sector trade to total industry sales	52,344	-5.776	0.636	-7.083	-3.158

Table A2: Trade classification by global value chain status

	Panel A		Panel B		Panel C	
	GVC = 0	GVC = 1	GVC = 0	GVC = 1	GVC = 0	GVC = 1
Non-Traders	24,425	0	24,425	0	24,425	0
Exporters Only	4,851	0	4,851	0	4,851	0
Importers Only	4,573	0	4,573	0	4,573	0
Two way Traders	1,691	16,804	1,769	16,726	2,194	16,301
Total	35,540	16,804	35,618	16,726	36,043	16,301

Note: The GVC is based on the adapted Hummels vertical specialization index. A firm takes the value of 1 and is considered a GVC firm if the Hummels vertical specialization index > 0. GVC status in Panel A is computed using Rauch's conservative classification, while Panel B uses Rauch's liberal classification. GVC status in Panel C is computed using UN BEC 5.

Table A3: Sector averages by GVC, job volatility and exported product quality

2-digit Manufacturing sector	GVC	Job Volatility	Product Quality
Food products	0.2881	0.3043	0.8428
Beverages	0.2383	0.2339	-0.1604
Tobacco products	0.5763	0.1658	0.3409
Textiles	0.4002	0.3196	0.7008
Wearing apparel	0.3227	0.3319	1.9311
Leather and related products	0.5446	0.2665	2.2392
Wood and related products	0.1265	0.3012	0.1702
Paper and paper products	0.3533	0.2470	0.8138
Printing and reproduction of recorded media	0.1641	0.2426	1.3711
Coke and refined petroleum products	0.3852	0.2441	0.3550
Chemicals and chemical products	0.4339	0.2302	0.2518
Pharmaceuticals, etc	0.5075	0.2392	1.7619
Rubber and plastic products	0.3327	0.2473	0.6540
Other non-metallic mineral products	0.2221	0.2786	-0.0407
Basic metals	0.2264	0.2427	0.2802
Fabricated metal except machinery and equipment	0.2500	0.2550	0.4284
Computer, electronic and optical products	0.4608	0.2035	2.5529
Electrical equipment	0.4418	0.2036	1.4813
Machinery and equipment	0.4307	0.2215	1.0817
Motor vehicles, trailers and semi-trailers	0.5121	0.2238	-0.4124
Other transport equipment	0.5390	0.2473	0.8709
Furniture	0.2056	0.2976	0.2024
Other manufacturing	0.3282	0.2810	0.9322

Note: GVC status is computed using Rauch's conservative classification. We compute it as the rolling standard deviation of job growth over a five-year window, while product quality is inferred product quality computed based on Khandelwal *et al.* (2013).

Table A4: Firm characteristics: A mean difference test

Variables	GVC=1	GVC=0	t-test ($H_0 \neq 0$)
Job Volatility (1)	0.2055 (12.934)	0.2888 (26.324)	0.0000
Log Capital Intensity	10.3636 (16.804)	9.3348 (35.540)	0.0000
Log R&D Intensity	0.0007 (16.804)	0.0003 (35.540)	0.0276
Log Royalty Payment	0.0022 (16.804)	0.0005 (35.540)	0.0000
Log Labour Productivity	13.7170 (16.804)	12.998 (35.540)	0.0000
Foreign Firm	0.1060 (16.804)	0.0081 (35.540)	0.0000
Log Age	3.0004 (16.804)	2.7215 (35.540)	0.0000
Log Age Squared	9.4267 (16.804)	7.7282 (35.540)	0.0000
Size	1.9416 (16.804)	1.2942 (35.540)	0.0000
Exported Product Quality	1.6809 (16.804)	0.2812 (35.540)	0.0000

Note: See Appendix Table A1 for a description of the job volatility variables and any other variable. The mean difference test is based on the GVC status computed using Rauch's conservative classification.

Table A5: GVC and job volatility: Alternative GVC indicators

	Rauch Liberal Classification			UN BEC5		
	(1)	(2)	(3)	(4)	(5)	(6)
	5-year window	3-year window	7-year window	5-year window	3-year window	7-year window
<i>Firm characteristics</i>						
GVC Status	-0.0484*** (0.004)	-0.0434*** (0.004)	-0.0498*** (0.004)	-0.0480*** (0.004)	-0.0432*** (0.004)	-0.0495*** (0.004)
Capital Intensity	0.0014*** (0.001)	0.0016*** (0.001)	0.0014*** (0.001)	0.0014*** (0.001)	0.0016*** (0.001)	0.0014*** (0.001)
R&D Intensity	0.0975 (0.060)	0.1022 (0.064)	0.0947 (0.058)	0.0987 (0.060)	0.1033 (0.064)	0.0960 (0.058)
Royalty	-0.1714 (0.186)	-0.3020* (0.180)	-0.1768 (0.177)	-0.1701 (0.185)	-0.3008* (0.180)	-0.1753 (0.177)
Labor Productivity	-0.0053*** (0.001)	-0.0051*** (0.002)	-0.0054*** (0.001)	-0.0054*** (0.001)	-0.0051*** (0.002)	-0.0055*** (0.001)
Foreign Firm	-0.0507*** (0.006)	-0.0414*** (0.006)	-0.0513*** (0.006)	-0.0504*** (0.006)	-0.0412*** (0.006)	-0.0511*** (0.006)
Age	-0.0700*** (0.025)	-0.0693*** (0.025)	-0.0690*** (0.025)	-0.0689*** (0.025)	-0.0684*** (0.025)	-0.0680*** (0.025)
Age Squared	0.0016 (0.004)	0.0023 (0.004)	0.0013 (0.004)	0.0014 (0.004)	0.0021 (0.004)	0.0011 (0.004)
Size	-0.0122*** (0.003)	-0.0157*** (0.003)	-0.0116*** (0.003)	-0.0123*** (0.003)	-0.0157*** (0.003)	-0.0116*** (0.003)
Export Quality	-0.0018*** (0.000)	-0.0017*** (0.000)	-0.0018*** (0.000)	-0.0019*** (0.000)	-0.0018*** (0.000)	-0.0019*** (0.000)
<i>Sector characteristics</i>						
Demand	-0.0126**	-0.0109**	-0.0123**	-0.0127**	-0.0109**	-0.0124**

	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Competition	0.0008	-0.0021	0.0008	0.0006	-0.0022	0.0006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Trade Openness	0.0008	-0.0006	0.0007	0.0013	-0.0002	0.0011
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Constant	0.5716***	0.5360***	0.5734***	0.5733***	0.5375***	0.5751***
	(0.083)	(0.084)	(0.083)	(0.083)	(0.083)	(0.083)
Observations	39,258	39,258	39,258	39,258	39,258	39,258
R-squared	0.039	0.036	0.040	0.039	0.035	0.040

Note: Robust standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies. Outcome variable in all the columns is computed as rolling standard deviation of job growth using 5-year window period in columns 1 and 4; 3-year window period in columns 2 and 5; and 7-year window period in columns 3 and 6.

Table A6: GVC and job volatility: Alternative volatility indicators

	Moving Average		Residual Approach		
	(1)	(2)	(3)	(4)	(5)
<i>Firm characteristics</i>					
GVC Status	-0.0170*** (0.002)	-0.0064*** (0.002)	-0.0333*** (0.009)	-0.0329*** (0.008)	-0.0331*** (0.009)
Capital Intensity	0.0010*** (0.000)	0.0006 (0.000)	0.0023* (0.001)	0.0022* (0.001)	0.0022* (0.001)
R&D Intensity	-0.1002 (0.180)	-0.2087 (0.149)	0.0656 (0.060)	0.0725 (0.060)	0.0330 (0.059)
Royalty	-0.0885 (0.076)	-0.0411 (0.079)	-0.3915* (0.225)	-0.3779* (0.214)	-0.3823* (0.229)
Labour Productivity	-0.0018 (0.001)	-0.0029* (0.002)	0.0055 (0.006)	0.0056 (0.006)	0.0055 (0.006)
Foreign Firm	-0.0125*** (0.004)	-0.0014 (0.005)	-0.0191 (0.013)	-0.0229* (0.013)	-0.0184 (0.013)

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Age	-0.0337** (0.015)	-0.0357** (0.017)	-0.0904** (0.046)	-0.0909** (0.045)	-0.0849* (0.045)
Age Squared	0.0013 (0.002)	0.0023 (0.003)	0.0083 (0.008)	0.0084 (0.007)	0.0074 (0.007)
Size	-0.0104*** (0.001)	-0.0099*** (0.001)	-0.0136** (0.006)	-0.0132** (0.005)	-0.0137** (0.006)
Export Quality	-0.0009*** (0.000)	-0.0010*** (0.000)	-0.0022** (0.001)	-0.0019* (0.001)	-0.0022** (0.001)
Sector characteristics					
Demand	-0.0081** (0.003)	-0.0017 (0.003)	-0.0186* (0.010)	-0.0112 (0.010)	-0.0188* (0.010)
Competition	0.0027 (0.004)	-0.0069 (0.014)	-0.0018 (0.011)	-0.0028 (0.010)	-0.0019 (0.011)
Trade Openness	0.0041 (0.008)	-0.0067 (0.019)	-0.0077 (0.019)	-0.0109 (0.018)	-0.0078 (0.019)
Constant	0.2998*** (0.060)	0.1731 (0.127)	0.2974* (0.160)	0.2668* (0.154)	0.2884* (0.159)
Observations	32,715	19,629	45,801	45,308	45,801
R-squared	0.024	0.020	0.007	0.007	0.007

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies. Job volatility in columns 1 and 2 are computed as rolling standard deviation of job growth using 3-year and 5-year moving averages, respectively. Job volatility in columns 3 to 5 are computed as the squared residual of a job growth residual. For column 3, this is achieved controlling for firm, sector, and year-fixed effects. For column 4, it is conditional on industry-firm pair and year-fixed effects, while for column 5 it is conditional on period-lagged real sales, and firm and year-fixed effects.

Table A7: Drivers of GVC integration (structural model)

	(1)	(2)	(3)
Capital Intensity	0.0215*** (0.002)	0.0214*** (0.002)	0.0215*** (0.002)
R&D Intensity	0.8519** (0.383)	0.8518** (0.383)	0.8520** (0.383)
Royalty	3.3974*** (0.949)	3.4058*** (0.946)	3.3991*** (0.949)
Labor Productivity	0.3486*** (0.007)	0.3485*** (0.007)	0.3487*** (0.007)
Foreign Firm	0.6923*** (0.042)	0.6919*** (0.042)	0.6923*** (0.042)
Age	-0.1596** (0.070)	-0.1626** (0.070)	-0.1591** (0.070)
Age Squared	0.0834*** (0.012)	0.0839*** (0.012)	0.0834*** (0.012)
Size	0.6306*** (0.009)	0.6304*** (0.009)	0.6306*** (0.009)
Others GVC share	2.8970*** (0.427)	2.9102*** (0.428)	2.9031*** (0.427)
Constant	-7.5526*** (0.205)	-7.5505*** (0.205)	-7.5562*** (0.205)
Ln _{sig_2}	-1.1707*** (0.014)	-1.1775*** (0.015)	-1.1674*** (0.014)
atanrho_12	0.0672*** (0.015)	0.0275 (0.023)	0.0743*** (0.014)
Observations	52,344	52,344	52,344

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All regression contains unreported sector and time dummies.



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African Economic Research Consortium
Consortium pour la Recherche Economique en Afrique
Middle East Bank Towers,
3rd Floor, Jakaya Kikwete Road
Nairobi 00200, Kenya
Tel: +254 (0) 20 273 4150
communications@aercafrica.org