



FINANCIAL DEVELOPMENT AND GLOBAL VALUE CHAINS PARTICIPATION IN DEVELOPING COUNTRIES: DOES DIGITAL TRANSFORMATION MATTER?

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Abstract: This study analyses the effects of financial development on global value chains (GVCs) participation in developing countries from 1990-2019, while assessing the role of digital transformation. The generalized method of moments (GMM) was employed to overcome endogeneity problems. Driscoll and Kraay's estimation approach is further employed for the robustness check. The findings indicate that financial development increases GVC participation (general, upstream and downstream) in developing countries. These positive effects are more intensive when financial development is modulated by digital transformation. Furthermore, the results show that the U-inverted hypothesis between financial development and GVC participation is not verified in this study. Moreover, the findings show that digital transformation can be used as an effective channel to enhance the effect of financial development on GVC participation. However, these results indicate that developing countries must prioritize ICT access and use to better enhance the effects of financial development on GVC participation.

Keywords: Developing countries, cross-sectional dependence, digital transformation, financial development, global value chains.

JEL Codes: C21, O33, O16

I. INTRODUCTION

Extant literature suggests that the GVC is vital for economic development (Gereffi and Lee 2016), as it not only accelerates structural transformation

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(Lectard 2017; Stöllinger 2016) but also fosters job creation (Gereffi and Lee 2012; Norbu *et al.* 2021). International trade has undergone a new phase, in which goods and services produced in one country are now carried out in a coordinated chain involving several countries across the world (Bataka and Wonyra 2023). For example, in recent decades worldwide, goods and services exchange (70%) has taken place in organized networks known as global value chains (GVCs) or global supply chains (Bataka 2024). This growing interconnection of production and distribution processes across different countries has led to unprecedented economic interdependence, changing the GVC phenomenon (Coe and Yeung 2015; Feenstra 1998). Hence, in the present era, GVCs hold a prominent position in contemporary national development strategies (OECD 2019).

The World Trade Organization (2013) shows that high international trade costs undermine export competitiveness and nullify comparative advantage. These costs are significantly high for developing countries (Hoekman and Nicita 2011; Kowalski *et al.* 2015) and hinder firms' access to technology and intermediate inputs (OECD 2015). Recent theoretical literature suggests that reducing these costs can be associated with higher trade flows. In this context, access to financing, which is considered an important determinant of trade in developing countries (Chor 2010), can reduce export-related trade costs (Caggese and Cuñat 2013; Vaubourg 2016).

Underscoring the importance of finance, global production fell by 1.3%, and world trade volume dropped by 12.6% in 2009 during the global financial crisis (WTO 2009). Indeed, trade credit financing is vital for small and large firms in developing and advanced economies (Fisman and Love 2003; Petersen and Rajan 2002). Moreover, financially constrained companies or those with limited access to bank credit most often prefer trade credit (Atanasova 2007; Petersen and Rajan 1997), as it can be used to finance input purchases. Thang and Ha (2022) argue that one of the firms' incentives to participate in the GVC is to overcome liquidity shortages. At first glance, this implies that financial frictions might impede firms' access to the global production segment (Gopalan *et al.* 2022; OECD 2013).

Financial development (FD), defined as the process through which a financial system gains depth, accessibility, profitability, and efficiency (Svirydzenka 2016), can increase the availability of external financing options

for firms, reducing their reliance on internal funds and alleviating financial constraints (Cherchye *et al.* 2018; Love 2003). In contrast, in many sub-Saharan African (SSA) countries, the financial system is underdeveloped, and despite the implementation of several reforms, this sector remains inadequately developed, limiting its effectiveness (Sare 2021). However, the adoption of new technologies is essential for making trade-related financial institutions and markets more efficient. This will also help developing countries connect with the GVC. Digital transformation (DT), which involves the use of digital technologies to reshape business models, can improve the efficiency of financial and economic activities, facilitating GVC integration (Gopalan *et al.* 2022; Nath and Liu 2017; Sassi and Goaid 2013).

One particularly prominent and transformative digital financial service is mobile money. According to the GSMA (2024), in Africa, the number of registered mobile money accounts grew by 19% to 856 million in 2023. Similarly, transaction volumes grew by 23%, reaching approximately \$85 billion in 2023. These services have transformed labor markets in Africa and led to an increase in GDP, particularly in East African and West African countries. For example, estimates show that between 2013 and 2022, the total gross domestic product (GDP) of countries with a mobile payment service exceeded by nearly \$600 billion, which would have been without such a payment system (GSMA 2024). Furthermore, mobile money services are essential in facilitating the emergence of other financial services, such as savings, credit and equity products (Disse and Sommer 2020). In this context, the importance of the digital aspect in the relationship between finance and international trade must be recognized and taken into account. In this context, this study aims to analyze the role of digital transformation in the relationship between financial development and GVCs participation in developing countries.

This paper contributes to the literature that explores the link between digital transformation, financial development, and GVC participation. Lastly, the previous studies have investigated the direct effect of financial development on GVCs participation (Okah Efogo 2020; Xu *et al.* 2024; Zeng *et al.* 2021) as well as the effect of digital transformation on GVCs participation (Butollo *et al.* 2022; Gniniguè *et al.* 2023; Gopalan *et al.* 2022), but the role of digitalization in moderating the GVC-financial development nexus has not been examined. To the authors' knowledge, no study has yet modeled the interaction between

digital transformation and financial development to understand the effect of their interaction on GVC participation. This empirical evidence can yield new policy implications for the economic development of the region.

The remainder of this paper is structured as follows. Section 2 provides a brief literature review. The data description and sources are discussed in Section 3. Section 4 presents the empirical model and estimation strategy variables. The main results of the study are presented and discussed in Section 5. Section 6 concludes the paper.

II. THEMATIC REVIEW

1. Financial development and global value chains participation

Assertions that financial development affects GVC participation can first be traced back to the links between finance and traditional trade, since finance acts as a driving force behind financial development, whereas GVC participation represents one aspect of international trade. The theoretical literature focuses on the findings of Foley and Manova (2015) and Beck (2002). These authors argue that financial frictions constrain the ability of firms (countries) to enter export markets and secure their positions in the GVC. Indeed, financial frictions in the form of high credit costs, delayed payments, or restricted access to finance hinder companies' ability to enter the export market and maintain their positions in trade.

The described trade costs may affect the extent to which various countries participate in domestic, regional or global value chains (Antràs and de Gortari 2020). According to Levine (2005), financial development, which is one facet of finance, arises when financial institutions reduce prevailing frictions, improve information processing and facilitate resource allocation. In this way, it is obvious that financial development can reduce the costs associated with international trade by improving countries' ability to integrate GVCs. The importance of financial development has been highlighted by several studies (Xu *et al.* 2024; Leibovici 2021; Okah Efogo 2020; Caggese and Cuñat 2013).

On the empirical side, few papers have examined the positive relationship between financial development and GVCs participation (Dollar *et al.* 2016; Okah Efogo 2020; Xu *et al.* 2024; Zeng *et al.* 2021). For example, using the GMM method and panel data from 36 African countries between 2000 and 2018, Okah Efogo (2020) reported that financial development positively

affects GVC participation. Xu *et al.* (2024), who focused on 32 countries between 1995 and 2018, reported that financial development affects position in the global value chain. Kersan-Škabić (2019), using a dynamic panel data (GMM) methodology, revealed that the development of the financial sector is an important factor that positively affects GVCs' participation in EU member states. Dollar *et al.* (2016) use the World Bank's 2005 Enterprise Survey in 30 manufacturing industries and 120 cities in China to investigate the determinants of GVC participation. They found that the quality of local institutions and access to bank loans positively influence firms' GVC participation.

2. Digital transformation and global value chains participation

Digital transformation has several positive effects on firms' GVC participation. On the one hand, through a more indirect effect, digitalization fosters access to financial services (Schumann *et al.* 2012) and thus enables firms to overcome financial obstacles to GVC participation (Gopalan *et al.* 2022; Reddy and Sasidharan 2023). On the other hand, it also directly facilitates GVC participation by reducing trade-related costs (OECD 2022). The latter is particularly relevant since the costs of international trade are high, undoubtedly reducing export competitiveness by also undermining comparative advantage (World Bank 2021b). Recent theoretical studies suggest that reducing these costs could be linked to higher trade flows (Anderson and Van Wincoop 2003; Fink *et al.* 2005). In the context of international trade, information and communication technologies (ICTs) play a key role as catalysts, significantly reducing trade-related costs (Freund and Weinhold 2004; Rodriguez-Crespo *et al.* 2021; Venables 2001).

From an empirical point of view, in most instances, studies focus on the correlation between digital technologies and trade participation. Gniniguè *et al.* (2023), over the period 1990–2019, reported that increased use of ICT has a positive effect on GVCs participation in developing countries. Similarly, Rodriguez-Crespo *et al.* (2021), using data from 55 countries over the period 1980–2016, find that each type of ICT (broadband, internet use, mobile phone subscriptions) exerts a significant and positive effect on bilateral exports. Reddy and Sasidharan (2023) considered empirical data at the rich, firm level and reported a positive and significant relationship between digitalization and firms' GVC participation. Similarly, Feng *et al.* (2024), using data on Chinese

listed manufacturing firms from 2007-2016, show that digital transformation enhances manufacturing firms' positions within the GVC.

III. VARIABLE DESCRIPTION AND DATA SOURCES

1. Dependent variable

The dependent variable is the GVC participation index, which is considered at the global, upstream and downstream levels. The upstream GVC participation index measures the share of a country's production of final goods and services that is accounted for by imported value added. The downstream GVC participation index measures the share of a country's domestic value added that is exported worldwide and embodied in intermediate goods that are consumed by both foreign and domestic firms downstream (Antràs and de Gortari 2017; Casella *et al.* 2019; de Backer and Miroudot 2014). The data are drawn from the UNCTAD-Eora database.

2. Interest and control explanatory variables

Our explanatory interest variables include the financial development index developed by Svirydzenka (2016) and digital transformation development indicators. The financial development index is a combination of depth, access and efficiency of financial institutions and financial markets. The index is calculated based on two sub-indices; the financial institutions development index and the financial markets development index. This index incorporates a multivariate approach toward the evaluation of financial development, which is in contrast to other indices, such as the ratio of private credit to GDP or market capitalization to GDP (Svirydzenka 2016). The data are drawn from the International Monetary Fund (IMF) database.

In the economic literature, the digital transformation variable is identified as an important determinant of GVC and could impact GVC participation (Bataka and Wonyra 2023; Gnigniguè *et al.* 2023; Gopalan *et al.* 2022). Based on data availability, we measure digital transformation by computing an index that captures ICT development, which includes ICT access (number of mobile phone subscriptions per 100 people, number of fixed telephone subscriptions per 100 people), use (percentage of individuals using the internet, number of fixed broadband subscriptions per 100 people), and skills (adult literacy rate,

gross enrollment ratio in secondary and tertiary education). The data are drawn from the World Development Indicators (WDI).

Table 1: Description and source of variables

<i>Variables</i>	<i>Description</i>	<i>Sources</i>
FVA	Upstream participation	UNCTAD-Eora
DVA	Downstream participation	UNCTAD-Eora
GVC	Global value chains participation index	UNCTAD-Eora
FD	Financial development index	IMF
Mobile phone	Mobile phone subscription per 100 people	WDI
Fixed telephone	Fixed telephone subscription per 100 people	WDI
Internet	Internet users (% of the population)	WDI
Fixed broadband	Fixed broadband subscription per 100 people	WDI
Literacy rate	Literacy rate, adult total	WDI
School enrollment	School enrollment, secondary and tertiary (% gross)	WDI
DT index	Digital transformation index	Computed
OPENESS	(Exports+Imports)/GDP	WDI
GDPPC	Gross domestic product per capita	WDI
FDI_inflows	Foreign direct investment inflows (% of GDP)	WDI
TARIF	Weighed mean tariff	WDI

Notes: WDI means World Development Indicators; IMF means International Monetary Fund

Table 2: Descriptive statistics of the variables.

<i>Variable</i>	<i>Obs</i>	<i>Mean</i>	<i>Std. Dev.</i>	<i>Min</i>	<i>Max</i>
FVA	1827	0.173	0.106	0.027	0.677
DVA	1827	0.277	0.101	0.079	0.634
GVC	1827	0.52	0.108	0.228	0.803
FD	1827	0.252	0.178	0	1
Mobile Phone	1827	44.124	50.424	0	212.453
Fixed telephone	1827	9.941	11.492	0	74.518
Internet	1827	15.261	22.208	0	99.653
Fixed broadband	1827	2.355	5.579	0	46.342
Literacy rate	1827	20.357	36.406	0	99.652
School enrollment	1827	15.587	19.118	0	113.217
DT index	1827	0.013	1.516	-1.358	5.765
ICT access	1827	0.019	0.853	-1.299	2.629
ICT use	1827	0.025	1.201	-0.722	6.791
ICT skills	1827	0.018	0.791	-0.563	2.480
OPENESS	1827	35.056	25.887	0	218.663
GDPPC	1821	5884.107	11863.701	0	98041.362
FDI_inflows	1827	3.783	5.742	-26.679	50.872
TARIF	1827	6.183	8.614	0	217.78

In addition, an aggregate index is constructed using the principal component analysis (PCA) method to obtain the synthetic DT index for developing countries. This aggregate index overcomes the problem of multicollinearity that can result from internet use, mobile phone use and fixed-line telephone subscriptions. In terms of sample adequacy for the aggregate index, the Kaiser–Meyer–Olkin (KMO) index of approximately 0.52, above 0.5, indicates that we have an appropriate sample to perform the PCA method. For the reliability and validity of the aggregate index, the Cronbach's alpha coefficient, which is approximately 0.74, above 0.70, attests to the reliability and validity of the index (see Appendix). The composite index is based on the six aforementioned variables of digital transformation.

Table 3: Results of the principal component analysis.

Total variance explained and contribution of each ICT indicator in the aggregate index

<i>Component</i>	<i>Eigenvalue</i>	<i>Difference</i>	<i>Proportion</i>	<i>Cumulative</i>
Factor1	3.552	2.651	0.592	0.592
Factor2	0.900	0.258	0.150	0.742
Factor3	0.643	0.148	0.107	0.849
Factor4	0.494	0.184	0.082	0.931
Factor5	0.310	0.210	0.052	0.983
Factor6	0.101	.	0.017	1.000
Variables	Factor1	Uniqueness		
Mobile phone	0.848	0.280		
Fixed telephone	0.657	0.569		
Internet	0.926	0.142		
Fixed broadband	0.856	0.267		
Literacy rate	0.487	0.763		
School enrollment	0.756	0.428		

Kaiser–Meyer–Olkin (KMO) index for sample adequacy

Variables	Kaiser–Meyer–Olkin (KMO)					
Mobile phone	0.742					
Fixed telephone	0.857					
Internet	0.716					
Fixed broadband	0.824					
Literacy rate	0.931					
School enrollment	0.928					

Cronbach's alpha coefficient for aggregate index reliability and validity

Variables	Observations	Sign	Items-test correlation	Items-test correlation	Interitem correlation	Alpha
Mobile phone	1827	+	0.830	0.738	0.457	0.808
Fixed telephone	1827	+	0.669	0.518	0.529	0.849
Internet	1827	+	0.905	0.849	0.423	0.786
Fixed broadband	1827	+	0.837	0.748	0.454	0.806
Literacy rate	1827	+	0.549	0.367	0.453	0.876
School enrollment	1827	+	0.758	0.636	0.489	0.827
Test scale					0.523	0.737

In addition to the interest variables, we control the regressions for some variables that are supposed to affect GVC participation. As countries with different levels of economic development can be significantly different in terms of GVC participation status, we then include GDP per capita as an economic performance variable, foreign direct investment, trade openness measured by the sum of imports and exports of goods and services as a percentage of GDP, and the average applied tariff. These control variables included in our model are commonly used in studies dealing with the GVC phenomenon (Allard *et al.* 2016; Kersan-Škabić 2019; Kowalski and Gonzalez 2019; Gniniguè *et al.* 2023; Miroudot and Cadestin 2017; Okah Efogo *et al.* 2022). Tables 1 and 2 provide details of the variables, their measurements, sources, and descriptive statistics, respectively.

IV. EMPIRICAL MODEL AND ESTIMATION TECHNIQUE

The effects of financial development on GVC participation are examined through Model (1), whose specification is based on theoretical and empirical studies that investigate the effects of financial development on international trade indicators or GVCs (Beck 2002; Okah Efogo 2020; Leibovici 2021; Xu *et al.* 2024; Zeng *et al.* 2021).

$$Y_{it} = cons_{0i} + A_{1i}Y_{it-1} + A_{2i}FD_{it} + A_{3i}FD_{it}^2 + A_{4i}W_{it} + \gamma^i + \theta_i + \varepsilon_{it} \quad (1)$$

where Y_{it} is captured by GVC_{it} as the index of GVC participation, FVA_{it} for upstream (backward) participation and DVA_{it} for downstream (forward) participation.

To examine the effect of financial development on GVC participation, taking into account the role of digital transformation, we adopt this new specification:

$$Y_{it} = cons_{0i} + A_{1i}Y_{it-1} + A_{2i}FD_{it} + A_{3i}FD_{it}^2 + A_{4i}DT_{it} + A_{5i}FD_{it} \times DT_{it} + A_{6i}W_{it} + \gamma^i + \theta_t + \varepsilon_{it} \quad (2)$$

FD_{it} represents the financial development index. $FD_{it} \times DT_{it}$ represents an interaction term between financial development and digital transformation. A_5 is the coefficient to be estimated and makes it possible to appreciate how digital transformation influences the effect of financial development on GVC participation. Indeed, $A_5 > 0$ means that digital transformation amplifies the effect of financial development on GVC participation, whereas $FD_{it}^2 < 0$ means that financial development weakens more GVC participation when the digital transformation level increases. The introduction of FD_{it}^2 allows us to assess the threshold effect of the impact of FD on GVC participation. W_{it} represents country-level control variables. $cons_{it}$ is a constant; γ^i refers to the country fixed effect; θ_t captures the year fixed effect; and ε_{it} is the composite error term assumed to be spatially correlated. The indices i and t denote countries ($i = 1, 2, \dots, N$) and time periods ($t = 1, 2, \dots, T$), respectively.

To reveal how digital transformation enhances the effect of financial development on GVC participation, a series of tests are performed to provide details on appropriate estimation techniques. These tests help us select the most appropriate estimator. First, an analysis of cross-sectional dependence between the countries in the sample is carried out. Accounting for cross-sectional dependency is a sine qua non for obtaining reliable and consistent estimates. The results, following the implementation of this test, confirm the presence of cross-sectional dependence, as the probabilities (P values) for all the variables are less than 5% (see table 4).

Given that the study addresses an unbalanced panel with the issue of cross-sectional dependence, we use Pesaran's (2007) augmented Dickey–Fuller (CADF) test to analyze the unit root. The test assumes that the series are nonstationary (variables) under the null hypothesis, whereas the alternative hypothesis assumes that the series are stationary. The results, after implementing the test, reveal an absence of unit roots since the test statistics' (CADF statistics)

p values are lower than conventional thresholds, that is, 1%, 5% and 10% (see table 5).

Tables 4: Pesaran cross-sectional dependence test (CD test)

<i>Variables</i>	<i>CD-statistics</i>	<i>p-value</i>	<i>Correlation</i>
GVC	115.96	0.000	0.568
FVA	22.83	0.000	0.404
DVA	125.12	0.000	0.599
FD	103.57	0.000	0.564
Mobile phone	225.23	0.000	0.946
Fixe telephone	85.09	0.000	0.533
Internet	219.32	0.000	0.922
Fixed broadband	196.46	0.000	0.826
Literacy rate	95.57	0.000	0.555
School enrollment	47.74	0.000	0.356

Tableau 5: Pesaran (2007) CIPS unit root test

<i>Variables</i>	<i>Level CIPS</i>	<i>CV at 10%</i>	<i>CV at 5%</i>	<i>CV at 1%</i>
GVC	-3.595	-2.020	-2.080	-2.190
FVA	-3.815	-2.020	-2.080	-2.190
DVA	-3.426	-2.020	-2.080	-2.190
FD	-2.299	-2.020	-2.080	-2.190
Mobile phone	-2.690	-2.020	-2.080	-2.190
Fixe telephone	-2.133	-2.020	-2.080	-2.190
Internet	-2.518	-2.020	-2.080	-2.190
Fixed broadband	-2.466	-2.020	-2.080	-2.190
Literacy rate	-3.452	-2.020	-2.080	-2.190
School enrollment	-2.178	-2.020	-2.080	-2.190
Output	-2.850	-2.020	-2.080	-2.190
OPENESS	-1.798	-2.020	-2.080	-2.190
GDPPC	-2.613	-2.020	-2.080	-2.190
FDI	-2.905	-2.020	-2.080	-2.190
TARIF	-3.100	-2.020	-2.080	-2.190

Recent econometric studies suggest that traditionally used estimation methods such as ordinary least squares (OLS), generalized least squares (GLS), feasible generalized least squares (FGLS), within (FE), and between (RE) estimators within dynamic panel frameworks are not suitable for our models. The reasons for this assertion are outlined below. First, removing the fixed effects through the "within" transformation leads to nickel bias, which

arises because of the induced correlation between the transformed error terms and the lagged dependent variables. Second, the explanatory variables in our model are macroeconomic and institutional in nature, which poses the risk of endogeneity, meaning that they themselves may be explained by the dependent variables. Hence, instrumental variables are needed to address these endogeneity concerns. However, identifying reliable instruments is a significant challenge in practice. Drawing on a combination of first differencing and the use of internal instruments, the GMM panel data estimator not only overcomes the nickel bias associated with the lagged dependent variable but also addresses the potential endogeneity of other explanatory variables (Arellano and Bover 1995; Blundell and Bond 1998; Walle 2022). As lagged levels could be weak instruments in cases where the time series variables are persistent, the system GMM estimator mitigates small sample biases by complementing the first-difference equation with the level equation, where lagged differences are taken as instruments for lagged levels (Struthmann *et al.* 2022).

Notably, two types of GMM estimators are applicable to dynamic panels. The system GMM estimator differs from the first-difference GMM estimator. Indeed, the former has proven to be both efficient and robust to heteroskedasticity, whereas the latter suffers from inefficiency and lacks robustness to heteroskedasticity (Roodman 2009). When the system GMM estimator is applied, the main issue is the potential for too many instruments, which can invalidate the instrument set and skew test results. However, its efficiency can be enhanced by employing a two-step system GMM estimation approach. Additionally, a high instrument count can lead to downward bias in two-step GMM standard errors due to poorly estimated weighting matrices. Windmeijer (2005) highlights this issue and suggests a correction that accounts for the variability in the weighting matrix. To minimize bias, Windmeijer's (2005) correction is implemented in this analysis. We assume that all explanatory variables are potentially endogenous and thus employ second and further lags as instruments. To check the validity of the internal instruments, we applied Arellano and Bond's autocorrelation test (Arellano and Bond 1991) and the Hansen test for overidentification.

In addition, we use the approach of Driscoll and Kraay (1998) as a robustness check to address potential issues related to cross-sectional dependence and issues of heteroskedasticity and autocorrelation of errors, with the option of incorporating fixed effects to obtain robust standard errors.

V. RESULTS AND INTERPRETATIONS

1. Baseline results

Table 7 analyzes the effects of financial development and digital transformation on overall GVCs participation, both upstream and downstream, by considering three proxies of digital transformation (ICT access, ICT use and ICT skills). Through the Variance Inflation Factor (VIF) test, the results in column 1 of Table 6 indicate that the VIF values for the interest variables (those related to digital transformation) exceed 5. Such results confirm the presence of multicollinearity between these variables. The VIF values for the control variables are all below 5. Hence, the hypothesis of multicollinearity among the control variables is rejected.

Tableau 6: Variance inflation factor

<i>Variables</i>	<i>VIF</i>	<i>1/VIF</i>
DT index	93.070	0.011
ICT_use	31.610	0.032
ICT_access	12.470	0.080
ICT_skills	9.580	0.104
Output	4.300	0.233
lnGDPPC	2.820	0.354
FD	1.960	0.509
lnOPENESS	1.610	0.620
FDI inflows	1.280	0.780
TARIF	1.050	0.953
Mean VIF	15.980	

In most cases (table 7), the coefficients of the FD variable are positive and significant at the 1% level. These results indicate that financial sector expansion significantly leads to greater participation of developing countries in GVCs. For instance, the results show that a one-unit improvement in FD is associated with an approximate 0.504-unit increase in overall GVC participation. Relative to backward and forward participation (the supply of inputs and the receipt of finished goods, respectively), developing countries would gain approximately 0.239 and 0.413 units, respectively, if they increase the FD by one unit. These results underscore the importance of financial development as a driver of GVC participation in developing countries. Additionally, the coefficients associated

with the FD square term are positive and significant at the 1%, 5%, or 10% levels in most cases. These results show that there is no inverse U-shaped relationship between FD and GVC participation. Okah Efogo (2020) and Xu *et al.* (2024) found similar results on data covering 36 African countries and 32 countries, respectively. However, these findings contrast with the results reported by Zeng *et al.* (2021).

Table 7: Effects of financial development on developing countries' participation in global value chains

	(1)	(5)	(9)
Variables	GVC	FVA	DVA
FD	0.5036***	0.2391***	0.4125***
	(0.153)	(0.099)	(0.185)
FD_square	0.6317**	0.7010**	-1.3866
	(0.198)	(0.247)	(0.262)
lnGDPPC	0.0121**	0.0386***	0.0169***
	(0.006)	(0.009)	(0.004)
FDI_inflows	0.0029***	0.0006*	0.0041***
	(0.001)	(0.000)	(0.001)
lnOPENESS	0.0006***	0.0013***	0.0002**
	(0.000)	(0.000)	(0.000)
TARIF	-0.0015***	-0.0011	-0.0012*
	(0.001)	(0.000)	(0.000)
Constant	0.1160***	-0.0782*	-0.0138
	(0.028)	(0.045)	(0.023)
Observations	1746	1748	1746
Countries	64	64	64
AR (1)	0.000	0.000	0.000
AR (2)	0.952	0.661	0.337
Hansen P-value	0.779	0.188	0.122
Instruments	35	35	35

The dependent variable is GVC participation (general, upstream and downstream). The standard deviations are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

The control variables are now examined. Trade openness shows positive and significant coefficients in most regressions. In addition to this variable, the results highlight the importance of other control variables. Indeed, inward foreign direct investments (FDI_inflows), trade barrier reduction (TARIF),

and increasing country revenue (GDPPC) are critical for GVC participation in developing countries.

We now direct our analysis toward the effects of FD on GVCs participation but are moderated by the aggregate DT index and its three proxies (ICT access, ICT use and ICT skills). Table 8 reports these moderated results. Notably, the coefficients associated with the FD variable remain positive and significant at the 1% level in all columns, except in columns (3) and (11). This can be interpreted as a confirmation of the relevance of FD for GVC participation. The coefficients linked to the DT index proxies are also positive and significant at either 1% or 5% in all columns, except for the ICT skills proxy, which is insignificant in column (11). According to the interaction variables between the FD and DT proxies, the findings show that the coefficients have positive effects and are significant at the 1%, 5%, or 10% levels in all columns (Table 8). These results highlight the importance of DT in the FD-GVC relationship, which suggests that improvements in a country's digital capabilities can amplify the positive effect of financial development on GVC participation. These results, in our view, reflect empirical reality. Indeed, a well-developed DT environment enables businesses and economies to access financial resources more easily and fully integrate into the GVC.

The above results are in line with theory and corroborate several empirical studies. Indeed, some theoretical studies suggest that the adoption of new technologies can increase firms' access to trade credit (OECD 2022), which, in turn, enhances the connectivity and global competitiveness of developing countries (Chien *et al.* 2021), essential elements for quick evolution in GVCs (OECD 2022). Empirically, digitization can strengthen GVC participation for firms constrained by financing issues (Gopalan *et al.* 2022). The positive effect of financial development on GVC participation has also been documented by Okah Efogo (2020) and Zeng *et al.* (2021).

2. Robustness Check

We undertake further robustness checks to verify the consistency of our benchmark findings regarding strong and robust positive associations between digital transformation, financial development and GVC participation. As mentioned above, Driscoll and Kraay (DK) estimation is used for the robustness check. Table 9 and Table 10 present these results. The DK standard error allows

Table 8: Effects of financial development on developing countries' participation in global value chains moderated by digital transformation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	GVC	GVC	GVC	GVC	FVA	FVA	FVA	FVA	DVA	DVA	DVA	DVA
FD	0.5102*** (0.237)	0.4628*** (0.162)	0.1646 (0.150)	0.5565*** (0.161)	0.1600*** (0.051)	0.3632*** (0.164)	0.3533*** (0.115)	0.2258*** (0.167)	0.4672*** (0.157)	0.2064*** (0.234)	0.5074 (0.136)	0.1368*** (0.112)
FD_Square	-0.9950 (0.323)	-1.2401 (0.355)	-0.1159 (0.172)	-0.6988 (0.215)	1.2304* (0.460)	0.7400** (0.312)	0.8561** (0.366)	0.7817** (0.308)	-2.8553 (0.515)	-3.3301 (0.608)	-0.7655 (0.191)	-2.6276 (0.436)
ICT_access	0.0303*** (0.011)				0.0152*** (0.022)				0.0835*** (0.017)			
FD*ICT_access	0.0928** (0.059)				0.0706*** (0.058)				0.2275*** (0.050)			
ICT_use		0.0414*** (0.010)				0.0087** (0.010)				0.0692*** (0.014)		
FD*ICT_use		0.0879*** (0.025)				0.0704** (0.055)				0.1746*** (0.039)		
ICT_skills			0.0612*** (0.009)				0.0208*** (0.008)				0.0004 (0.003)	
FD*ICT_skills			0.0856*** (0.022)				0.0338* (0.018)				0.0153* (0.011)	
DIindex				0.0113*** (0.004)				0.0093* (0.008)				0.0409*** (0.007)
FD*DIindex				0.0189** (0.009)				0.0128** (0.018)				0.1074*** (0.020)
lnGDPPC	-0.0087 (0.007)	0.0105* (0.006)	0.0173*** (0.005)	0.0104** (0.005)	0.0391*** (0.010)	0.0280*** (0.006)	0.0283*** (0.007)	0.0326*** (0.007)	0.0147** (0.007)	0.0286*** (0.007)	0.0208*** (0.003)	0.0194*** (0.006)
FDL_inflows	0.0041*** (0.001)	0.0039*** (0.001)	0.0008 (0.001)	0.0029*** (0.001)	0.0008 (0.001)	0.0003 (0.000)	0.0000 (0.000)	0.0006 (0.000)	0.0084*** (0.002)	0.0078*** (0.002)	0.0018*** (0.001)	0.0070*** (0.002)

Table 8: Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	GVC	GVC	GVC	GVC	FVA	FVA	FVA	FVA	DVA	DVA	DVA	DVA
lnOPENESS	0.0005*** (0.000)	0.0006*** (0.000)	0.0007*** (0.000)	0.0005*** (0.000)	0.0014*** (0.000)	0.0011*** (0.000)	0.0011*** (0.000)	0.0012*** (0.000)	0.0004* (0.000)	0.0003 (0.000)	-0.0000 (0.000)	0.0003 (0.000)
TARIF	-0.0010* (0.000)	-0.0011** (0.000)	-0.0013* (0.000)	-0.0020** (0.000)	-0.0001 (0.000)	-0.0000 (0.000)	0.0000 (0.000)	-0.0000 (0.000)	-0.0002** (0.000)	-0.0003** (0.000)	-0.0001*** (0.000)	-0.0001** (0.000)
Constant	0.0471 (0.036)	0.0544* (0.028)	0.2569*** (0.034)	0.0963*** (0.023)	-0.0381 (0.060)	-0.0408 (0.028)	-0.0323 (0.026)	-0.0620* (0.035)	-0.1656*** (0.051)	-0.0896** (0.038)	0.0816*** (0.011)	-0.1092*** (0.031)
Observations	1746	1750	1750	1750	1748	1752	1752	1752	1746	1750	1750	1750
Countries	64	64	64	64	64	64	64	64	64	64	64	64
AR (1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)	0.911	0.535	0.726	0.789	0.442	0.487	0.581	0.665	0.759	0.521	0.676	0.373
Hansen P-value	0.435	0.145	0.152	0.357	0.185	0.114	0.225	0.114	0.147	0.145	0.233	0.130
Instruments	35	35	35	35	35	35	35	35	35	35	35	35

Dependent variable is GVC participation (general, upstream and downstream). Standard deviation in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

for robust estimates in the presence of heteroscedasticity, error autocorrelation and spatial dependence in the data (Baloch *et al.* 2019; Sarkodie and Strezov 2019). Indeed, this approach relies on the semiparametric estimation technique (Hoechle 2007) and is appropriate for general forms of cross-sectional dependence. While addressing various forms of dependence in handling the variance-covariance matrix, this method also takes into account the countries' fixed effects and provides robust standard errors. We observe that the findings confirm our baseline results; variables of interest, that is, the FD, DT and interaction variables, have a positive and significant association with GVC participation. These results, overall, confirm the baseline results; however, there are some slight differences related to the coefficients' significance and intensity. Based on this information, we believe that the results are robust and can be subjected to recommendations for policymakers.

Table 9: Effects of financial development on developing countries' participation in global value chains

	(1)	(5)	(9)
Variables	GVC	FVA	DVA
FD	0.0190 (0.040)	0.2122*** (0.065)	0.1931*** (0.044)
FD_square	0.0988* (0.056)	-0.0808 (0.083)	0.1795*** (0.063)
lnGDPPC	0.0180*** (0.004)	0.0204*** (0.002)	0.0024 (0.004)
FDI_infows	0.0063*** (0.001)	0.0067*** (0.001)	-0.0004 (0.001)
lnOPENESS	0.0729*** (0.007)	0.0821*** (0.006)	0.0092** (0.003)
TARIF	-0.0000 (0.001)	-0.0007*** (0.000)	0.0007 (0.001)
Constant	0.3039*** (0.060)	-0.0036 (0.030)	0.3074*** (0.037)
Observations	1761	1762	1761
F-Stat	676.93	96.92	357.70
F-Prob	0.000	0.000	0.000
Country-FE	YES	YES	YES

The dependent variable is GVC participation (general, upstream and downstream). Driscoll and Kraay standard deviations are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 10: Effects of financial development on developing countries' participation in global value chains moderated by digital transformation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	GVC	GVC	GVC	GVC	FVA	FVA	FVA	FVA	DVA	DVA	DVA	DVA
FD	-0.0083 (0.024)	0.1150*** (0.040)	0.0349 (0.029)	0.0879*** (0.020)	0.1749*** (0.036)	0.2221*** (0.019)	0.1580*** (0.033)	0.2240*** (0.019)	0.1832*** (0.035)	0.3369*** (0.042)	0.1928*** (0.026)	0.3118*** (0.023)
FD_square	0.0848** (0.033)	0.2782*** (0.060)	0.1356*** (0.047)	0.2376*** (0.035)	0.1030** (0.038)	0.1689*** (0.027)	0.0523 (0.048)	0.1779*** (0.022)	0.1877*** (0.044)	0.4470*** (0.072)	0.1878*** (0.050)	0.4154*** (0.042)
ICT_access	0.0109** (0.010)				0.0042*** (0.004)				0.0150* (0.011)			
FD*ICT_access	0.0324** (0.035)				0.0409** (0.019)				0.0086* (0.026)			
ICT_use		0.0101** (0.004)				0.0066 (0.006)				0.0167*** (0.006)		
FD*ICT_use		0.0171*** (0.005)				0.0160** (0.006)				0.0331*** (0.009)		
ICT_skills			0.0111* (0.006)				0.0064 (0.005)				0.0174** (0.008)	
FD*ICT_skills			0.0127 (0.013)				-0.0099 (0.016)				0.0225 (0.021)	
DT_index				0.0055* (0.003)				0.0014*** (0.003)				0.0070*** (0.005)
FD*DT_index				0.0165*** (0.011)				0.0238*** (0.006)				-0.0403*** (0.010)
lnGDPPC	0.0141*** (0.004)	0.0149*** (0.005)	0.0152*** (0.005)	0.0139*** (0.004)	0.0179*** (0.002)	0.0166*** (0.001)	0.0163*** (0.001)	0.0170*** (0.001)	0.0038 (0.004)	0.0018 (0.004)	0.0011 (0.005)	0.0031 (0.004)
FDI_inflows	0.0035** (0.001)	0.0038*** (0.001)	0.0037*** (0.001)	0.0037*** (0.001)	0.0028* (0.001)	0.0025 (0.002)	0.0026* (0.001)	0.0025 (0.002)	0.0008 (0.001)	0.0013 (0.001)	0.0011 (0.001)	0.0012 (0.001)
lnOPENESS	0.0016*** (0.000)	0.0015*** (0.000)	0.0015*** (0.000)	0.0015*** (0.000)	0.0022*** (0.000)	0.0022*** (0.000)	0.0022*** (0.000)	0.0023*** (0.000)	0.0007*** (0.000)	0.0007*** (0.000)	0.0007*** (0.000)	0.0008*** (0.000)

Table 10: Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	GVC	GVC	GVC	GVC	FVA	FVA	FVA	FVA	DVA	DVA	DVA	DVA
TARIF	-0.0000 (0.001)	-0.0000 (0.001)	0.0001 (0.001)	0.0000 (0.001)	-0.0007*** (0.000)	-0.0006** (0.000)	-0.0007*** (0.000)	-0.0006** (0.000)	0.0007 (0.001)	0.0006 (0.001)	0.0008 (0.001)	0.0007 (0.001)
Constant	0.3039*** (0.060)	0.3051*** (0.062)	0.3181*** (0.065)	0.2993*** (0.061)	-0.0036 (0.030)	-0.0121 (0.022)	-0.0266 (0.018)	-0.0086 (0.024)	0.3074*** (0.037)	0.3171*** (0.044)	0.3446*** (0.051)	0.3078*** (0.040)
Observations	1761	1765	1765	1765	1762	1766	1766	1765	1761	1765	1765	1765
F-Stat	676.93	422.78	867.35	1455.11	96.92	167.53	71.13	113.62	357.70	263.41	402.55	179.67
F-Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Country-FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

The dependent variable is GVC participation (general, upstream and downstream). Driscoll and Kraay standard deviations are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

VI. CONCLUSION AND POLICY IMPLICATIONS

This study analyzed the effect of financial development on GVC participation and assessed whether digital transformation could act as a channel to enhance the effect of financial development on GVC participation in developing countries. The empirical analysis covers a panel of 64 developing countries for the period 1990-2019. Second-generation tests are used to determine the cross-sectional dependence and unit roots of the variables. We used the generalized method of moments (GMM) to address potential endogeneity issues. To test the robustness of the results and effectively control for cross-sectional dependence, heteroscedasticity and error autocorrelation, the Driscoll and Kraay technique (1998) is employed. The results remain robust to these estimation techniques and reveal that financial development enhances GVC participation, both upstream and downstream, in developing countries. However, the inverted U-shaped hypothesis between financial development and GVC participation has not been validated. Additionally, we observe that digitization strengthens the effect of financial development on GVC participation in developing countries, even in countries with minimum digital transformation scores.

The conclusions drawn from this study emphasize that, to increase GVC participation, the governments of developing countries must prioritize policies that promote financial inclusion and expand access to financial services. These countries need to do more to reap the benefits of financial development. Digital transformation, which can improve the efficiency of economic and financial activities, must be encouraged by policymakers. Policymakers must prioritize ICT access, ICT use, and, to a certain extent, ICT skills given that with increasing digitalization, the latter has proven to be more important for deepening GVCs participation and forward and backward involvement through financial development.

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