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From Connectivity to Competitiveness: How Digitalization Shapes Firm Integration into Global Value Chains in the MENA Region

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Abstract

This article analyzes the role of digitalization in the integration of companies from six countries in the MENA region into global value chains (GVCs). Three dimensions are examined: the probability of initial participation, progression in the segment hierarchy, and the combined effect of digitalization and innovation. The analysis is based on the World Bank Enterprise Surveys and uses a binary logit, an ordered logit, and a sequential logit to identify the differentiated effects at each stage of integration.

The results show that digitalization is a major determinant of access to GVCs, although its components do not have the same weight. Only websites and electronic payments have a significant effect, while simple connectivity has no measurable impact. In the ordered and sequential models, the composite digitization index remains highly significant, confirming its key role in coordination, traceability, and the management of organizational complexity.

However, the interaction between digitization and innovation reveals a negative effect: in these six MENA countries, characterized by basic digital uses and mainly incremental innovation, the two dimensions do not generate complementarity but create substitution mechanisms that limit upgrading. The results highlight the need for integrated policies combining digitalization, organizational capabilities, and support for innovation to promote sustainable participation in GVCs.

Keywords: Digitalization, Innovation, Global Value Chains, MENA Region, Firm-Level Analysis, Sequential Logit.

JEL Classification : C25, F14, F23, L25, O32, O33.

Introduction

Over the past few decades, the international fragmentation of production has profoundly reshaped the global economy. Trade now relies less on finished goods and more on specialized tasks and segments distributed across several countries (Baldwin & Lopez-Gonzalez, 2015; Feenstra, 1998). In this new paradigm, global value chains (GVCs) have become a major vehicle for learning, modernization, and trade integration for emerging economies (Fernandez-Stark & Gereffi, 2019; Taglioni & Winkler, 2016). They enable companies to access technologies, expanded markets, and opportunities for upgrading (Humphrey & Schmitz, 2002; Kowalski et al., 2015). However, access to GVCs remains highly uneven: some firms are able to integrate themselves into global networks on a lasting basis, while others remain on the sidelines, held back by persistent gaps in productivity, size, organizational capabilities, and innovation (Antràs & Chor, 2021; Melitz, 2003).

In this uneven landscape, digitalization represents an additional transformation, as suggested by the now indispensable Resource-Based View (RBV) (Barney, 1991; Wernerfelt, 1984). Digital technologies improve the flow of information, reduce transaction costs, and facilitate cross-border coordination (Foster & Graham, 2017; Gopalan et al., 2022). They also support the growth of data-driven activities and automation (Acemoglu & Restrepo, 2019). However, as has been documented, the extent of these gains depends heavily on the quality of infrastructure, available skills, and institutional mechanisms that frame their adoption. While advanced economies take advantage of strong complementarities between innovation, digital tools, and organizational restructuring (Bharadwaj et al., 2013; Endres et al., 2022), emerging economies, and the MENA region in particular, operate in a limited absorption framework where digital tools can complement innovation or, conversely, substitute for it when they replace rather than augment existing capabilities (Aghion et al., 2012).

Despite the growth of this research, the literature still lacks a detailed understanding of the mechanisms linking digitalization, innovation, and gradual progress in GVCs, particularly in intermediate institutional environments such as the MENA region. These elements raise a central question: to what extent does digitalization contribute to the access and progress of MENA region companies in GVCs, and how does it interact with their innovation capabilities in an environment specific to the region?

Empirically, we draw on the five-level typology of GVCs proposed by Ayadi et al. (2024), which offers a more nuanced interpretation than the binary distinction that still dominates the literature (notably Gopalan et al., 2022). Three complementary econometric models (binary logit, ordered logit, and sequential logit) are used to examine, in succession: (i) minimum access to GVCs; (ii) progression within their hierarchy; (iii) sequential transitions between levels in order to assess the effect of digitalization on these GVCs. To date, no study has simultaneously used a gradual typology, a sequential approach, and a joint analysis of the interactions between digitalization and innovation in the MENA context.

This work also makes several contributions. It adopts a microeconomic perspective that is still rare in a region largely described using macro or sectoral indicators (Del Prete et al., 2018; Elmassah & Hassanein, 2023; Moussir, 2025; Nasser & Ouerghi, 2022; Özçelik, 2018). It also sheds light on the configurations in which digitalization and innovation can be complementary or, conversely, substitutable. An additional contribution lies in the construction of a digitalization indicator that integrates not only connectivity and online presence, but also the use of electronic payments. This transactional dimension, rarely taken into account in previous work (notably Gopalan et al., 2022), captures an essential operational component of digital transformation in emerging economies, where digital uses are often geared toward the formalization of transactions rather than advanced automation.

The rest of the article is organized as follows: the next section develops the literature review and hypotheses; section 3 presents the data and variable construction; section 4 describes the empirical strategy; section 5 discusses the results; and section 6 concludes.

2. Literature review and development of hypotheses

The integration of companies into GVCs is a gradual process that involves increasingly complex technological, organizational, and institutional requirements. Pioneering research shows that while minimal participation may be based on exchanges of inputs or intermediate goods, access to higher segments requires advanced forms of organization, such as compliance with international standards, the establishment of sustainable partnerships, or the opening of capital to foreign investors (Dovis and Zaki, 2020; Taglioni and Winkler, 2016). In emerging economies, where institutional environments are highly heterogeneous, this progression often deviates from a linear trajectory and depends on both the quality of internal capabilities and the external opportunities to which companies are exposed.

2.1. Integration into GVCs: contrasting potential gains and determinants

Microeconomic research shows that integration into GVCs offers considerable advantages. Companies gain broader access to higher-quality inputs, more diverse markets, and cutting-edge technologies. Interactions with international clients become an essential vehicle for organizational learning, the dissemination of standards, and skills development (Golo, 2023; Lee et al., 2018; Verny et al., 2023). On a more aggregate scale, these dynamics translate into differentiated growth trajectories. According to the World Bank (2019), a marginal increase in participation in GVCs results in a higher per capita income gain than that achieved through traditional trade strategies.

However, these benefits are not distributed evenly. The literature highlights a set of determinants whose effect remains mixed. Productivity, size, and technological capabilities are recognized drivers of integration, but their impact largely depends on the institutional framework in which companies operate (Urata & Baeck, 2020). In the MENA region, administrative complexity, logistical shortcomings, and regulatory rigidities can neutralize some of the identified productivity gains (Dovis & Zaki, 2020). Other contributions also highlight the importance of financial constraints, institutional uncertainty, and the ambivalent role of corruption (Lo, 2021). Innovation appears to be an essential lever for international openness (Reddy et al., 2021), but its effects remain highly dependent on the availability of financing, which is one of the main limiting factors in emerging economies (Reddy & Sasidharan, 2021).

2.2. The growing role of digitalization in integration into GVCs

The rise of digital technologies is bringing about a major transformation in the dynamics of integration, in line with the RBV analytical framework discussed in the introduction. However, this transformation is not uniform: it depends heavily on the level of technological sophistication, human capital, and the institutional climate, which accentuates the differences between advanced and emerging economies.

The very nature of digitalization varies, however, depending on the favorability of the environment. In advanced economies, it is based on the adoption of sophisticated technologies such as robotics, artificial intelligence, and integrated management systems (Giunta et al., 2025). In the MENA region, it more often corresponds to a set of intermediate uses, centered on broadband connectivity, website presence, and the adoption of electronic payments. This configuration reflects characteristic structural realities: limited infrastructure, uneven digital skills, difficulties in accessing finance, and still fragmented adoption strategies.

These basic forms of digitalization are nonetheless fundamental. Gopalan et al. (2022) empirically show that the adoption of broadband internet at the firm level significantly strengthens the participation of companies in emerging economies in GVCs. Their argument is based on a clear economic intuition: digital technologies reduce the fixed costs of accessing global production networks by facilitating communication, improving coordination along supply chains, and mitigating information asymmetries between local suppliers and international buyers. A web presence is a credible signal of reliability and visibility to international partners (Spence, 1978; Julian & Holtedahl, 2004; Rialp et al., 2024). Electronic payments reduce transactional risks, enhance traceability, and increase trust in cross-border trade (Beck et al., 2018; Demirgüç-Kunt et al., 2022). For small and medium-sized enterprises (SMEs), which are often exposed to significant information asymmetries, these tools represent a preferred route to gradual integration into global networks.

2.3. Digitalization and innovation: theoretical complementarity, empirical ambiguities

RBV theory also provides a relevant conceptual framework for understanding the strategic role of digital technologies: in well-endowed institutional environments, they function as natural complements to innovation by strengthening absorptive capacity and skills development.

However, in emerging economies where organizational and institutional capacities are more limited, this complementarity is far from systematic and can shift towards substitutability effects. Several studies show that even when companies have both digital tools and innovation capabilities, the combined effect of these dimensions on integration into GVCs remains closely dependent on the type of technologies implemented, the nature of the innovations introduced, and the level of internal organizational capabilities (Bell & Pavitt, 1995; Cirera & Maloney, 2017; Lall, 2000). In the MENA region, digitization is often limited to basic uses such as connectivity, online presence, or electronic transactions, which enhance visibility and administrative efficiency but do not necessarily lead to a structural transformation of production processes. At the same time, innovation often remains incremental or adaptive, geared more toward adjusting to local constraints than toward converging with the technological and organizational standards imposed by lead firms (Gereffi et al., 2005). This asymmetry between limited digital sophistication and essentially adaptive innovation tends to generate organizational incompatibilities, weakening the potential gains from their combination. In an environment characterized by limited managerial and institutional capacities, the coexistence of digital practices and insufficiently coordinated innovations thus tends to generate organizational friction, imperfect coordination between digital tools and new processes, and ultimately an ambiguous, even marginal, effect on participation in the most sophisticated segments of GVCs.

2.4. Formulation of hypotheses

These elements lead to the formulation of three structural hypotheses:

H1 — An increase in the composite digitalization index significantly increases the probability of accessing GVCs.

H2 — Digitalization promotes progress toward more advanced levels of integration by strengthening the ability of companies to meet the technical, informational, and organizational requirements of global networks.

H3 — In MENA economies, the interaction between digitalization and innovation has a negative effect on participation in and depth of integration into GVCs, due to financial, organizational, and institutional substitutability mechanisms that limit their potential complementarity.

The following section presents the data used, the variables constructed, and the econometric strategy adopted to test these hypotheses.

3. Data, model specification, and econometric approaches

3.1. Data source

To analyze the relationship between digitalization and participation in GVCs in the MENA region, we use company data from the World Bank Enterprise Survey (WBES). These surveys provide detailed microeconomic information collected from random samples of firms in six economies in the region: Bahrain, Jordan, Malta, Morocco, Tunisia, and Palestine. In total, our sample includes 2,586 firm observations, with the distribution by country presented in Table A1.

A key issue concerns the timing of the data: questions relating to the use and adoption of broadband Internet, one of the key indicators of digitalization, only appear in the WBES for the region from 2023 onwards, following the post-COVID revision of the digital module. Our time horizon is therefore limited to the years 2023–2024, with variable coverage depending on the country, some of which were surveyed in 2023 and others in 2024. The result is a sample observed only in cross-section, allowing for an instantaneous data estimate but without a longitudinal dimension.

Furthermore, companies with missing values on key digitization variables or control variables are automatically excluded from the estimates, as Stata eliminates these observations during statistical processing. Like any self-reporting survey, however, WBES may be subject to biases in self-reporting, measurement, or comparability between countries. While these limitations cannot be completely eliminated, the inclusion of sectoral and size controls partially mitigates their effects.

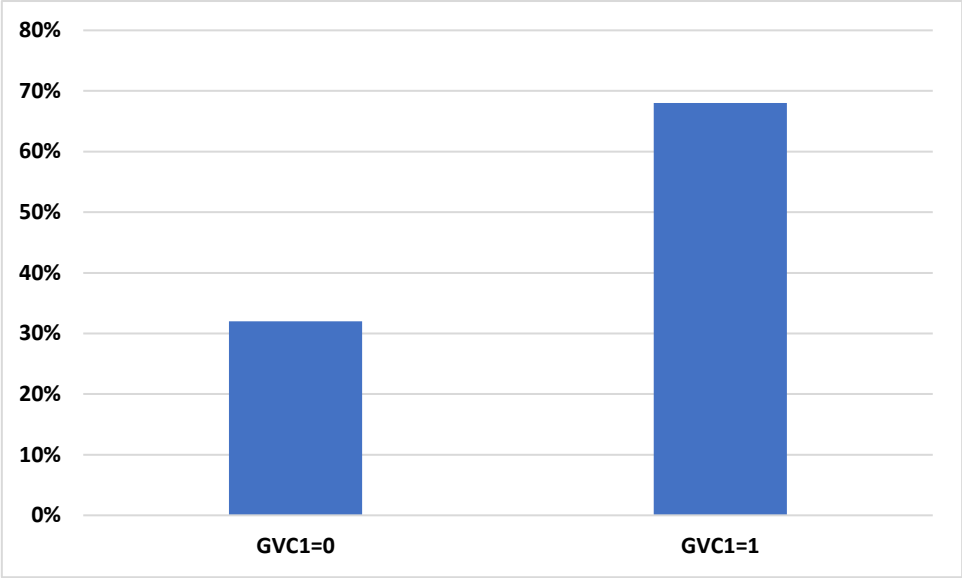
The following subsection describes the construction of key variables, in particular the levels of participation in GVCs and the digitization index used in our analysis.

3.2. Measuring business participation in GVCs

In order to examine the determinants of participation in GVCs with a focus on the digital dimension, we use four variables available in the WBES to construct different participation indices at the microeconomic level, in line with the approach proposed by Ayadi et al. (2024). The first definition, GVC1, includes firms that export, directly or indirectly, or import intermediate inputs. A second, more restrictive definition, GVC2, includes only firms that export and import intermediate goods. Two even more restrictive levels, GVC3 and GVC4, add to GVC2 the possession of international certification or the presence of a foreign investor in the capital, respectively. Finally, the most demanding level, GVC5, combines all of these attributes.

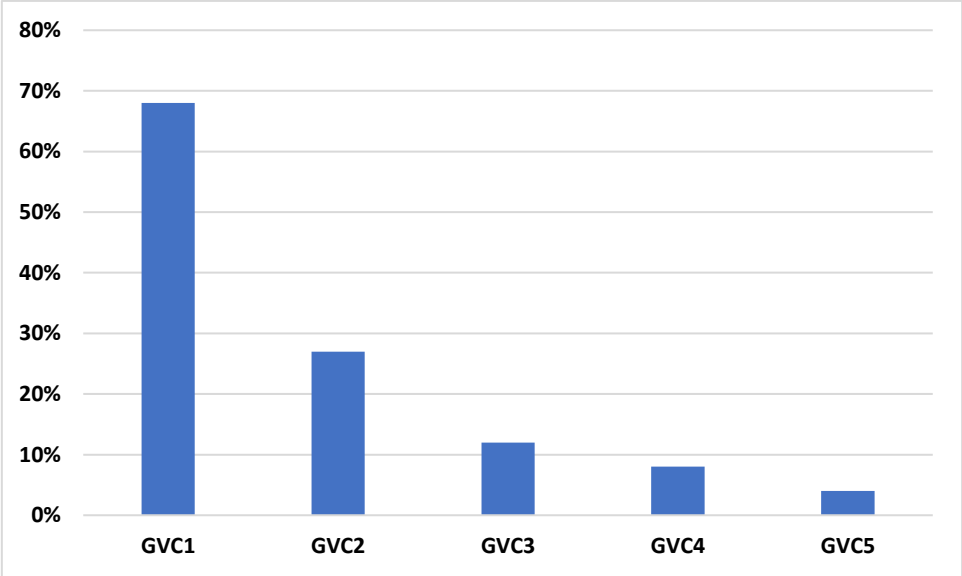
Figures 1 and 2 below illustrate only the descriptive structure of the sample. They are used for exploratory purposes only; the analytical interest lies less in the raw proportions than in the dynamics of scarcity observed as we move toward more advanced forms of integration.

Figure 1. Distribution of firms by their minimal level of participation in global value chains (GVC1)



Source: Authors' calculations based on WBES data (2023–2024).

Figure 2. Distribution of firms by their levels of integration into global value chains (GVC1–GVC5)



Source: Authors' calculations based on WBES data (2023–2024).

Figure 2 confirms that, when looking at more demanding forms of integration, the structure observed becomes distinctly pyramidal. Two-way trade, as measured by GVC2, now accounts for only 26.8% of companies, revealing a marked decline from initial access and illustrating the increased requirements associated with the joint management of imports and exports. Additional criteria related to quality or internationalization further reduce the number of companies capable of reaching these levels. Only 11.99% have international certification, 7.54% have foreign capital participation, and 3.94% have all of these attributes. This concentration at the higher levels reflects the difficulty for most firms in the MENA region to access the most valuable segments of the GVC, due to the structural constraints already mentioned, but also to the differentiated role that digitalization can play, the effects of which will be analyzed further below. Before that, the following subsection specifies the method used to construct the digitalization index used in our analysis.

3.3. Measuring the digitalization of businesses

Digitalization at the company level is not limited to the occasional use of digital tools. Like participation in value chains, it is part of a broader dynamic that reflects a company's ability to integrate information technology into its processes, organization, interactions with markets, and transactions. From this broader perspective, digitization encompasses access to adequate digital infrastructure, online visibility, and the effective use of technological solutions in day-to-day operations. In order to capture this multidimensionality using the information available in the WBES, we have constructed a composite index based on three complementary items.

The first component measures the company's access to high-speed Internet over the past two years; this is a binary variable denoted HSI_i. This access is the technical basis for any digital strategy, as it determines a firm's ability to mobilize advanced tools, exchange data in real time, and interact with digital platforms (Goldfarb & Tucker, 2019).

The second component provides information on the existence of a website, also measured by a binary variable denoted WS_i. It captures the company's external digital presence, which is essential for commercial visibility, communication with customers and suppliers, and openness to broader markets (Lo, 2021).

The third component indicates whether the company uses electronic payments in its transactions, represented by a binary variable denoted EP_i. This dimension refers to the integration of digital solutions into internal payment, billing, and commercial management processes, generally associated with reduced transaction costs and increased formalization (Aker & Mbiti, 2010).

The digitization index (DIG_i) is constructed as an unweighted average of the three components[1].

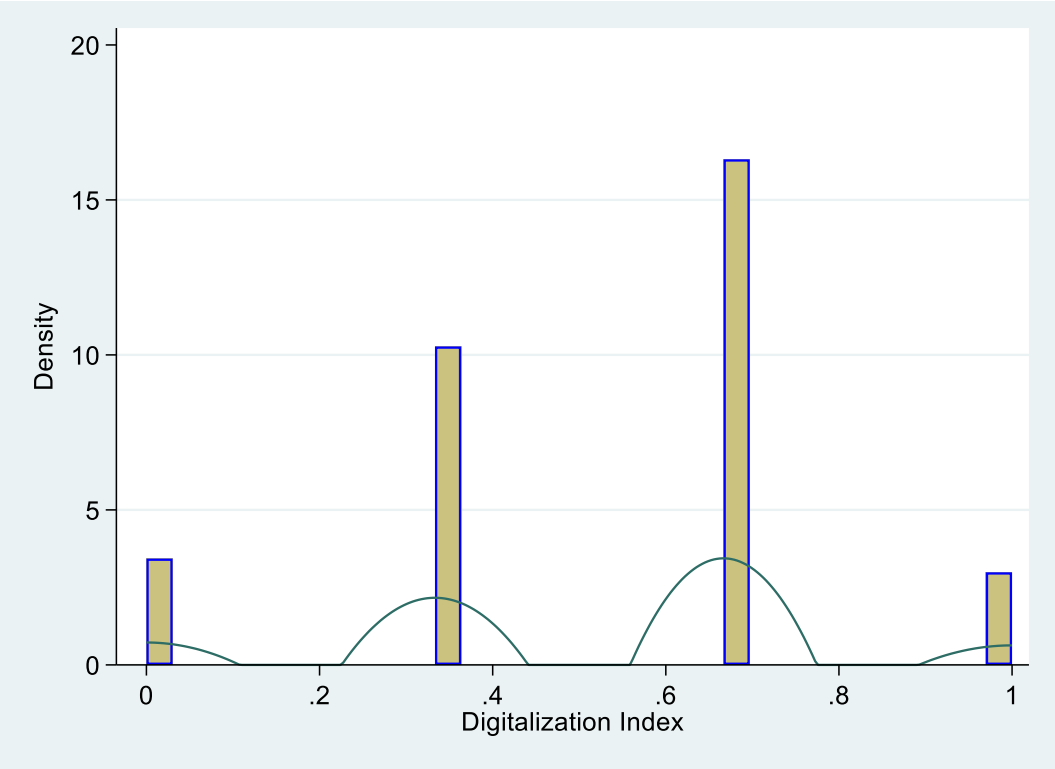
$$DIG_i = (HSI_i + WS_i + EP_i)3^{-1} \quad (1)$$

The decision to weight these three dimensions equally is based on two complementary arguments. From a conceptual point of view, each represents a necessary but non-substitutable facet of basic digitalization in emerging economies, which justifies their equivalent theoretical importance. From an empirical point of view, the correlations between the three items are weak to moderate, making it impossible to identify a structural dominance that would justify a differentiated weighting.

By design, the index varies between 0 and 1. A low value reflects virtually non-existent digitization or digitization limited to a single use, while a high value indicates that the company simultaneously combines broadband access, online presence, and electronic payments. The distribution of the index is highly polarized (Figure 3), with concentrations around 0, 0.33, 0.66, and 1. This pattern reveals uneven digital adoption: only a few companies use all of the tools, while the majority remain confined to partial or minimal configurations. This digital divide suggests that the economic effects of digital technology are likely to be non-linear and based more on adoption thresholds than on gradual progress.

Figure 3. Distribution of the Firms' Digitalization Index

[1] For robustness purposes, we also tested an alternative approach based on Multiple Component Analysis, which allows the three items to be aggregated in a statistically derived manner. The results obtained with this factorial index show the same effects as the simple index, both in terms of initial access to global value chains and gradual progression from one level of integration to another. In order to maintain the readability of the empirical section, these estimates are not presented here, but they can be made available to readers upon request.



Source: Authors' calculations based on WBES data (2023–2024).

Finally, this index is the main variable in our empirical analysis. It allows us to assess the extent to which digitization determines not only initial access to GVCs, but also progress toward more advanced levels of integration. The following section describes the econometric methodology used to study these relationships.

3.4. Econometric strategies

The econometric strategy is based on a transitional approach designed to analyze, in a consistent manner, the different stages of the process of integration into global value chains. Three complementary models are used. The binary logit model is used to examine minimum access to GVCs, a threshold decision based on fixed entry costs. The ordered logit then deals with the hierarchy of levels achieved, with each level reflecting a progressive accumulation of technological and organizational capabilities. Finally, the sequential logit captures the truly cumulative dimension of the upgrading process: companies move through the levels successively, and the effect of digitalization can vary from one level to another, which the model fully allows for. This sequence ensures a close match between the statistical tool and the economic structure of the phenomenon under study.

Initial access to GVCs is estimated using a standard binary logit:

$$P(GVC_i = 1|DIG_i, X_i) = \Lambda(\beta_0 + \beta_1 DIG_i + X_i\beta) \quad (2)$$

where the logistic function $\Lambda(z) = \frac{1}{1+e^{-z}}$ ensures a consistent probabilistic interpretation. The control variables grouped in X_i mitigate the potential endogeneity associated with the omission of characteristics correlated with both digitization and integration into GVCs. They include productivity (approximated by value added per worker), the age of the firm and its square in order to capture any non-linear effects related to organizational experience, size measured by the number of employees, financial constraints and exposure to corruption assessed on ordinal scales, as well as two binary

indicators providing information on internal training and recently introduced innovations. The inclusion of these dimensions, widely used in microeconomic literature on international openness, helps to isolate the specific effect of digitalization. In order to control for structural differences between countries and differences in productive composition, all estimates incorporate fixed country effects and detailed fixed sector effects (at the two-digit ISIC code level). The latter make it possible to correct for biases related to variations in technological intensity or differences in productive sophistication between sectors, which are often decisive in the process of participating in GVCs. Standard errors are systematically adjusted in "clusters" at the WBES sampling strata level (country × sector), which is essential for taking into account the intra-group dependence inherent in the sampling plan.

The degree of integration is then analyzed using an ordered logit model that estimates the probability of reaching or exceeding a given level of GVCs:

$$P(GVC\ level_i = 1 \leq j | DIG_i, X_i) = \Lambda(\tau_j - (\alpha_0 + \alpha_1 DIG_i + X_i\beta)) \quad (3)$$

The thresholds τ_j are estimated endogenously, and the proportional odds hypothesis imposes a constant effect of digitization on all cumulative transitions, which provides a synthetic but potentially restrictive reading in a context of heterogeneous capacities.

To overcome this constraint, the sequential logit explicitly models the probability of crossing each threshold conditionally on the previous one:

$$P(GVC\ level_i > j | GVC\ level_i \geq j, DIG_i, X_i) = \Lambda(\gamma_{0j} + \gamma_{1j} DIG_i + X_i\gamma_j) \quad (4)$$

This approach reveals whether digital technology has a different impact on entry (where information and coordination gains dominate), on intermediate levels (where standards and administrative requirements are reinforced), or on higher levels (where certification, compliance, and transparency requirements are concentrated).

Collinearity diagnostics confirm the stability of the estimates (VIF < 5), and Tables A2–A3 attest to the structural consistency of the variables.

As with any cross-sectional estimation, several sources of bias remain possible. The omission of unobserved characteristics simultaneously linked to digitalization and integration is a first risk, which is common in business surveys where certain managerial capacities remain difficult to measure (Amin & Islam, 2015; Freund & Pierola, 2015). The simultaneity of digital adoption and international integration poses a second challenge: firms may digitize to enter GVCs, but integration may also stimulate adoption, in line with export learning dynamics (Loecker, 2013; Wagner, 2012). Finally, selection bias cannot be ruled out if higher-performing or more formal firms are overrepresented in WBES, as suggested by Hallward-Driemeier & Pritchett (2015). While these limitations cannot be eliminated in a cross-sectional framework, the combined use of extensive controls, fixed effects, and transition models helps to strengthen the empirical robustness of the results.

4. Results & discussion

4.1. Effects of digitization on the probability of participating in GVCs

The results of the logit model robustly show that digitization is a major determinant of access to GVCs. The average marginal effect of the composite index reaches 0.359 (z = 11.00), indicating a substantial influence of digitization on the probability of integration. Once structural controls, sectoral effects, and

fixed country effects are introduced, the impact of the index remains highly significant and converges around 0.22, confirming that it is an autonomous effect, stable across specifications and robust to additional weightings and interactions.

Analysis of the individual components of digital capital qualifies this diagnosis. In column (6), websites and electronic payments have marginal effects of 0.096 and 0.087, respectively, reflecting effective organizational transformation and better integration of digital routines into transactions and external communication (Demirgüç-Kunt et al., 2022; Rialp et al., 2024). Conversely, simply having an internet connection has no significant impact, confirming that raw connectivity is not enough: international integration relies less on technical access than on the active use of structuring digital tools.

Structural variables show several expected patterns. Productivity significantly increases participation, consistent with the idea that a more efficient organization has an advantage in accessing global networks (Urata & Baeck, 2020). Size has a marked effect, reflecting the need to bear fixed entry costs, while age follows a non-linear profile: experience favors initial openness, but rigidities appear beyond a certain threshold. Financial constraints, which are negative and very significant, are one of the main obstacles to integration (Reddy & Sasidharan, 2021), while perceived corruption reduces the likelihood of entry due to the uncertainty it creates in contractual relationships (Lo, 2021).

Finally, innovation has a positive and stable effect across models, suggesting that increased technological adaptability facilitates compliance with standards imposed by international networks (Reddy et al., 2021). However, its interaction with digitalization will be reevaluated in the context of hypothesis H3, given the organizational limitations specific to emerging economies.

Table 1. Average marginal effects from Logit models linking digitalization to GVC participation

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Digital Index	0.359***	0.219***	0.225***	0.224***	0.229***	
	(11.00)	(6.49)	(6.61)	(6.60)	(6.69)	
Website						0.096***
						(4.87)
Internet						0.022
						(0.83)
Electronic						0.087***
payments						(4.23)
Ln(Productivity)		0.037***	0.039***	0.017**	0.019**	0.019**
		(5.48)	(5.63)	(2.21)	(2.37)	(2.37)
Ln(Age)		0.159**	0.151**	0.160**	0.153**	0.139*
		(2.19)	(2.08)	(2.24)	(2.13)	(1.94)
Ln(Age)²		-0.026**	-0.025*	-0.028**	-0.027**	-0.024*
		(-2.00)	(-1.91)	(-2.15)	(-2.06)	(-1.91)
Ln(Size)		0.072***	0.068***	0.081***	0.078***	0.076***
		(8.38)	(7.73)	(9.16)	(8.53)	(8.30)
Financial		-0.027***	-0.028***	-0.030***	-0.030***	-0.031***
constraints		(-4.02)	(-4.13)	(-4.08)	(-4.14)	(-4.27)
Training		0.055**	0.056**	0.034	0.034	0.032
		(2.53)	(2.56)	(1.46)	(1.49)	(1.39)
Corruption		-0.015**	-0.014**	-0.013*	-0.013*	-0.013*
		(-2.06)	(-2.02)	(-1.85)	(-1.82)	(-1.76)
Innovation		0.082***	0.080***	0.079***	0.078***	0.079***
		(3.74)	(3.64)	(3.54)	(3.45)	(3.52)

Observations	2088	1891	1891	1891	1891	1891
Fixed sector effects	No	No	Yes	No	Yes	Yes
Fixed country effects	No	No	No	Yes	Yes	Yes
R^2 Mac Fadden	0.0452	0.1423	0.1431	0.1611	0.1616	0.1639
P-Value of Likelihood Ratio Test	0.00	0.00	0.00	0.00	0.00	0.00

Source: Authors' calculations based on WBES.
Note: Coefficients are average marginal effects. z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights.

Overall, specification (5) appears to be the most effective (pseudo-R^2 = 0.162), identifying digitalization, productivity, size, and innovation as the main drivers of access to GVCs, while financial and institutional constraints remain the major obstacles. These results fully validate hypothesis H1 and already suggest that digital technology not only promotes entry into GVCs, but could also determine progress toward more advanced levels, a dynamic examined in the following subsection devoted to H2.

4.2. Effects of digitalization on progress in the GVC hierarchy

The ordered logit estimate presented in Table 2 extends the analysis of minimum access and allows us to assess companies' ability to progress in the GVC hierarchy. The coefficient associated with the composite digitalization index remains high and highly significant. The marginal effects reported in Appendix A4 show a consistent profile, with the digital impact being particularly marked around GVC2 and GVC3 before stabilizing at higher levels. This result confirms that digitalization plays a decisive role as coordination, compliance, and traceability requirements become more complex.

Table 2. Ordered Logit Estimates Linking Digitalization to GVC Upgrading

Variables	(1)	(2)
Digital Index	1.462***	
	(6.42)	
Website		0.615***
		(4.76)
Internet		0.141
		(0.83)
Electronic payments		0.556***
		(4.16)
Ln(Productivity)	0.118**	0.119**
	(2.35)	(2.35)
Ln(Age)	0.977**	0.890*
	(2.12)	(1.93)
$Ln(Age)^2$	-0.169**	-0.157*
	(–2.06)	(–1.90)
Ln(Size)	0.497***	0.487***
	(8.07)	(7.88)
Financial constraints	-0.194***	-0.201***
	(–4.09)	(–4.21)
Training	0.219	0.207
	(1.49)	(1.39)

Corruption	-0.085*	-0.082*
	(–1.82)	(–1.76)
Innovation	0.496***	0.507***
	(3.42)	(3.49)
Observations	1891	1891
Fixed sector effects	Yes	Yes
Fixed country effects	Yes	Yes
R^2 Mac Fadden	0.1616	0.1639
P-Value of Likelihood Ratio Test	0.00	0.00

Source: Authors' calculations based on World Bank Enterprise Surveys WBES.
Note: Reported values are ordered logit coefficients. z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights.

An examination of the individual components of digital capital refines this interpretation. Websites and electronic payments emerge as robust levers, reflecting the importance of visibility and formalization tools in moving upmarket. Broadband connectivity, which is not significant in the ordered estimation, nevertheless has a positive and robust marginal effect in Appendix A5. This difference is due to the distinct properties of cumulative coefficients and threshold effects. It indicates that technical access to the network is decisive precisely at the moment of crossing thresholds, without changing the cumulative dynamics of the logistic function. The effect of broadband therefore appears discrete but crucial when a company moves from a basic digital configuration to more dense cross-border interactions.

Structural determinants confirm several economic regularities. Productivity and size, already important for initial access, become even more central at high levels of GVCs, where fixed costs related to certifications, quality controls, and logistical requirements are higher. Age retains a nonlinear effect: experience facilitates the early stages of integration, but organizational rigidities emerge beyond a certain threshold. Innovation stands out clearly, with a higher coefficient than in the models in Table 1, confirming that progress toward more complex segments relies on increased capacity for adaptation and renewal.

The sequential logit estimate, presented in Table 3, adds an essential dimension to the analysis. This model, estimated without fixed country effects due to the absence of observations in certain upper segments, allows successive transitions to be identified explicitly rather than imposing a constant effect on all levels. The results show that digitization has a particularly strong effect during the first transitions, notably 0→1–5 and 1→2–5, reflecting its role in reducing information costs, formalizing transactions, and initial coordination with international partners. The effect becomes pronounced again during the final transition to GVC5, when quality, reporting, and transparency requirements are at their highest. Between these extremes, the digital impact is more moderate, suggesting that the required capabilities do not accumulate linearly but are reconfigured according to the nature of the successive stages.

Table 3. Sequential Logit Estimates for GVC Level Transitions

Variables	0 → 1–5	1 → 2–5	2 → 3–5	3 → 4–5	4 → 5
Digital Index	1.3498*	0.4961*	1.0019	–0.0681	1.5726*
	(6.49)	(1.87)	(2.43)	(–0.14)	(1.74)
Ln(Productivity)	0.2423*	–0.0310	0.1013	–0.1547	0.0790
	(5.91)	(–0.65)	(1.30)	(–1.42)	(0.37)

Ln(Age)	0.8790	0.5160	0.9799	–0.1125	1.1930
	(2.08)	(0.94)	(1.08)	(–0.08)	(0.47)
Ln(Age)²	–0.1528	–0.1284	–0.1705	–0.0439	0.0116
	(–2.03)	(–1.34)	(1.08)	(–0.19)	(0.03)
Ln(Size)	0.3402*	0.4542*	0.4235*	–0.0469	0.1360
	(6.61)	(8.04)	(4.61)	(–0.44)	(0.61)
Financial constraints	–0.1314*	0.0120	–0.0959	–0.1219	–0.1725
	(–3.28)	(0.25)	(–1.27)	(–1.28)	(–0.94)
Training	0.0721	0.1990	0.2338	–0.1842	1.5648*
	(0.58)	(1.44)	(1.09)	(–0.68)	(2.93)
Corruption	–0.0923	0.0186	0.0575	0.0869	0.0390
	(–2.24)	(0.38)	(0.73)	(0.91)	(0.21)
Innovation	0.3488*	0.0063	0.3639*	–0.7158*	0.7786
	(2.82)	(0.05)	(1.71)	(–2.66)	(1.31)
Constant	–4.4399***	–3.2193***	–4.9011***	3.0018	–7.0046
	(–6.02)	(–3.36)	(–3.19)	(1.32)	(–1.53)
Observations	1891	1891	1891	1891	1891
P-Value of Likelihood Ratio Test	0.00	0.00	0.00	0.00	0.00

Source: Authors' calculations based on World Bank Enterprise Surveys (WBES).

Note: Estimates come from a sequential (continuation-ratio) logit model. Coefficients correspond to each transition stage (0→1–5, 1→2–5, 2→3–5, 3→4–5, 4→5). z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights.

Appendices A3 to A6 confirm this internal consistency between the three models. The composite index shows a differentiated but systematic effect across levels. Electronic payments dominate intermediate transitions, websites have a greater influence on extreme transitions, while broadband becomes significant when examining the marginal effects specific to each stage. All of these results validate hypothesis H2 and show that digitization is not limited to facilitating entry into GVCs but is an essential driver of progression within their hierarchy.

Overall, digital technology appears to be a cross-cutting capability that enables companies to improve their visibility, streamline contractual interactions, and enhance their credibility with international partners. This dynamic, in line with Cirera & Maloney's (2017) analyses of digital transformations in production systems, robustly confirms the structuring role of digitalization in moving upmarket within global value chains and fully validates hypothesis H2.

4.3. Cross-effects of digitalization and innovation on the depth of integration into GVCs

The model estimate including the interaction between digitalization and innovation (Table 4) allows us to test hypothesis H3 regarding their joint effect on the depth of integration into GVCs. The coefficient of the Digital Index × Innovation term is negative and significant in the first column, and the marginal effects associated with GVC2–GVC5 confirm that innovation systematically reduces the positive impact of digitalization on growth.

This result is consistent with the logic of complementarity of internal capabilities highlighted by Barney (1991), Wernerfelt (1984), and Cirera & Maloney (2017). In strong organizational environments, digitalization strengthens absorption capacity and amplifies the effects of innovation. However, these mechanisms do not materialize in MENA countries. Digitalization there remains focused on basic uses,

while innovation remains mainly incremental or adaptive, in line with the diagnoses of Bell and Pavitt (1995), Lall (2000), and Gereffi et al. (2005).

The estimated negative interaction precisely reflects this asymmetry. When organizational routines are weak, internal innovations and digital tools do not reinforce each other, but instead generate substitutability mechanisms (Bell & Pavitt, 1995; Lall, 2000). The two dimensions then mobilize the same limited resources, without creating the complementarities necessary to respond to the growing constraints of GVCs, as reflected in the coefficients in Table 4.

Table 4. Ordered Logit Estimates Linking Digitalization to GVC Upgrading (with Interaction with Innovation)

Variables	Coeff. ologit	GVC=2	GVC=3	GVC=4	GVC=5
Digital Index	1.454***	0.0696***	0.0897***	0.0344***	0.0452***
	(6.85)	(6.43)	(6.34)	(5.19)	(5.38)
Ln(Productivity)	0.102***	0.0049***	0.0063***	0.0024**	0.0032**
	(2.69)	(2.66)	(2.66)	(2.56)	(2.57)
Ln(Age)	1.002***	0.048***	0.062***	0.024***	0.031***
	(2.80)	(2.77)	(2.76)	(2.64)	(2.67)
$Ln(Age)^2$	-0.191***	-0.009***	-0.0118***	-0.0045***	-0.0059***
	(-3.04)	(-3.00)	(-3.00)	(-2.85)	(-2.88)
Ln(Size)	0.491***	0.0235***	0.0303***	0.0116***	0.0153***
	(11.83)	(10.14)	(10.16)	(6.78)	(7.08)
Financial	-0.117***	-0.0056***	-0.0072***	-0.0028***	-0.0036***
constraints	(-3.38)	(-3.34)	(-3.34)	(-3.13)	(-3.16)
Training	0.051	0.0024	0.0031	0.0012	0.0016
	(0.49)	(0.49)	(0.49)	(0.49)	(0.49)
Corruption	-0.054	-0.0026	-0.0033	-0.0013	-0.0017
	(-1.55)	(–1.55)	(–1.55)	(–1.53)	(–1.53)
Innovation	0.667***	0.032***	0.041***	0.0158***	0.0207***
	(2.94)	(2.90)	(2.89)	(2.75)	(2.78)
Digital	-0.700*	-0.033*	-0.043*	-0.016	-0.022*
Index*Innovation	(–1.93)	(–1.92)	(–1.91)	(–1.87)	(–1.88)
Observations	1891				
Fixed sector effects	Yes				
Fixed country effects	Yes				
R^2 Mac Fadden	0.0862				
P-Value of Likelihood Ratio Test	0.00				

Source: Authors' calculations based on World Bank Enterprise Surveys WBES.
Note: Reported values are ordered logit coefficients. z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights.

The use of ordered logit is appropriate because it allows us to assess the cumulative effect of interaction across the entire hierarchy, rather than on specific transitions as in sequential logit. It thus provides a structural reading of the joint role of digitalization and innovation in progress.

Overall, the results clearly confirm H3. In MENA economies, the combination of basic digitalization and mainly adaptive innovations does not generate the expected complementarities and produces a substitution effect that slows progress toward the most advanced segments of the GVC.

5. Conclusion

This article analyzed the role of digitalization in the integration of SMEs in the MENA region into GVCs, assessing its effect on initial participation, progression in the hierarchy, and its complementarity with innovation. The results confirm the centrality of digital capabilities in the dynamics of international integration, while revealing more nuanced mechanisms than suggested by traditional frameworks (Taglioni & Winkler, 2016; Gereffi et al., 2005).

First, digitalization is a structural determinant of participation in GVCs, but its effect depends heavily on usage. Websites and electronic payments have a robust positive impact, while simple connectivity has no significant effect. These results confirm that organizational and transactional uses of digital technology, rather than technical availability, determine international integration (Gopalan et al., 2022; Demirgüç-Kunt et al., 2022; Rialp et al., 2024), particularly by enhancing visibility and contractual credibility (Spence, 1978; Julian & Holtedahl, 2004).

Second, digitalization supports progression along the GVC hierarchy. The composite index remains significant in ordered and sequential models, reflecting its role in inter-firm coordination, complexity management, and traceability (Cirera & Maloney, 2017; Kowalski et al., 2015). Its marked effect in early transitions is consistent with Baldwin & Lopez-Gonzalez (2015), while its influence on advanced levels corresponds to increased compliance and reporting requirements (Dovis & Zaki, 2020).

Third, the interaction between digitalization and innovation has a negative effect in MENA economies, indicating a lack of complementarity between these two capabilities. This configuration reflects the combination of mainly incremental innovation (Bell & Pavitt, 1995; Lall, 2000) and digitization focused on basic uses (Gereffi et al., 2005), generating organizational and financial trade-offs that reduce the ability to meet the requirements of sophisticated segments of the GVC (Aghion et al., 2012; Cirera et al., 2022).

These results suggest several implications. Targeted digitization, focused on online presence and electronic payments, is an effective lever for entering GVCs (Beck et al., 2018; Goldfarb & Tucker, 2019). Moving upmarket requires integrated policies combining digitalization, innovation, and organizational strengthening (Bharadwaj et al., 2013; Endres et al., 2022). Finally, reducing financial constraints and corruption appears essential to shift the relationship between digitalization and innovation from one of substitution to one of true complementarity (Lo, 2021).

However, this study has several limitations. It focuses on six MENA economies selected on the basis of data availability; extending it to other countries would strengthen its external validity. The analysis is based on a cross-sectional sample, which makes it impossible to track integration trajectories; panels would be a natural extension. Finally, the measurement of digitalization remains limited to basic indicators; the integration of advanced technologies (artificial intelligence, platforms, integrated systems) would provide a better understanding of the conditions under which digital technology becomes a driver of structural transformation (Acemoglu & Restrepo, 2019; Giunta et al., 2025).

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Appendix

Table A1. Country Distribution of Firms

Economy	Frequency	Percent	Cumulative (%)
Bahrain	150	5.8	5.8
Jordan	592	22.9	28.7
Malta	241	9.3	38.0
Morocco	598	23.1	61.1
Tunisia	645	24.9	86.1
West Bank and Gaza	360	13.9	100.0
Total	2,586	100.0	—

Source: Authors' calculations based on World Bank Enterprise Surveys WBES.

Table A2. Descriptive Statistics of Main Variables

Variable	Obs	Mean	Std. Dev.	Min	Max	Description
GVC level	2,586	1.216	1.291	0	5	Firm's level of participation in global value chains (0–5 scale).
Digital Index	2,088	0.524	0.265	0	1	Composite index of digital adoption (website, e-payments, internet use).
Website	2,583	0.713	0.452	0	1	=1 if firm owns an active website.
Internet	2,582	0.153	0.360	0	1	=1 if firm uses internet for business activities.
Electronic payments	2,089	0.667	0.471	0	1	=1 if firm uses electronic or mobile payments.
Ln(Productivity)	2,461	10.119	1.448	6.455	16.250	Log of value added per worker.
Ln(Age)	2,534	2.906	0.715	0.693	5.204	Log of firm age (years since establishment).
Ln(Size)	2,586	3.365	1.279	0	8.517	Log of total employment.
Financial constraints	2,538	1.758	1.400	0	4	Financial constraint index (0=none, 4=very severe).
Training	2,542	0.334	0.472	0	1	=1 if firm provides formal training to employees.
Corruption	2,478	1.774	1.395	0	4	Perceived corruption obstacle (0=none, 4=very severe).
Innovation	2,544	0.312	0.463	0	1	=1 if firm introduced new products or processes.

Source: Authors' calculations based on World Bank Enterprise Surveys WBES.

Table A3. Correlation Matrix

Variables	1	2	3	4	5	6	7	8
1. Digital Index	1.000							
2. Ln(Productivity)	0.122	1.000						
3. Ln(Age)	0.002	0.162	1.000					
4. ln(Size)	0.161	-0.016	0.218	1.000				
5. Financial Constraint	-0.115	-0.128	-0.163	-0.105	1.000			
6. Training	0.178	0.207	0.016	0.259	0.075	1.000		
7. Corruption	-0.080	-0.062	0.016	-0.039	0.263	0.015	1.000	
8. Innovation	0.215	0.155	0.075	0.134	-0.133	0.231	-0.081	1.000

Source: Authors' calculations based on World Bank Enterprise Surveys (WBES).

Table A4: Average marginal effects by GVC Level (Ordered Logit Model)

Variables	GVC=2	GVC=3	GVC=4	GVC=5
Digital Index	0.0513***	0.0661***	0.0255***	0.0334***
	(5.74)	(5.66)	(4.80)	(4.93)
Ln(Productivity)	0.00644***	0.00830***	0.00320***	0.00419***
	(4.05)	(4.03)	(3.67)	(3.71)
Ln(Age)	0.0587***	0.0756***	0.0292***	0.0382***
	(3.33)	(3.32)	(3.12)	(3.15)
$Ln(Age)^2$	-0.0107***	-0.0138***	-	-
	(–3.46)	(–3.45)	0.00531***	0.00696***
			(–3.23)	(–3.26)
Ln(Size)	0.0261***	0.0337***	0.0130***	0.0170***
	(11.11)	(11.10)	(7.03)	(7.35)
Financial constraints	-0.00299*	-0.00386*	-0.00149*	-0.00195*
	(–1.87)	(–1.87)	(–1.83)	(–1.83)
Training	0.00430	0.00554	0.00214	0.00280
	(0.89)	(0.89)	(0.89)	(0.89)
Corruption	-0.00298*	-0.00384*	-0.00148*	-0.00194*
	(–1.81)	(–1.81)	(–1.77)	(–1.78)
Innovation	0.0123***	0.0159***	0.00612***	0.00802***
	(2.60)	(2.60)	(2.51)	(2.52)

Source: Authors' calculations based on World Bank Enterprise Surveys (WBES).

Note: Coefficients are average marginal effects. z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights. Outcome GVC = 1 is obtained from a binary probit model already reported in Table 1.

Table A5: Average Marginal Effects by GVC Level (Ordered Logit Model, Disaggregated Digitalization)

Variables	GVC=2	GVC=3	GVC=4	GVC=5
Website	0.01795***	0.02306***	0.00884***	0.01165***
	(3.37)	(3.36)	(3.14)	(3.18)
Internet	0.01331**	0.01710**	0.00655**	0.00864**
	(2.27)	(2.27)	(2.20)	(2.22)
Electronic payments	0.02599***	0.03339***	0.01280***	0.01687***
	(4.93)	(4.91)	(4.31)	(4.41)
Ln(Productivity)	0.00490***	0.00630***	0.00241**	0.00318**
	(2.66)	(2.66)	(2.55)	(2.57)
Ln(Age)	0.04541***	0.05835***	0.02236**	0.02947**
	(2.61)	(2.61)	(2.51)	(2.53)
$Ln(Age)^2$	-0.00871***	-0.01119***	-0.00429***	-0.00565***
	(–2.86)	(–2.85)	(–2.72)	(–2.75)
Ln(Size)	0.02331***	0.02995***	0.01148***	0.01513***
	(10.04)	(10.04)	(6.75)	(7.05)
Financial constraints	-0.00585***	-0.00752***	-0.00288***	-0.00380***
	(–3.48)	(–3.47)	(–3.24)	(–3.28)
Training	0.00267	0.00342	0.00131	0.00173
	(0.53)	(0.53)	(0.53)	(0.53)
Corruption	-0.00257	-0.00331	-0.00127	-0.00167
	(–1.54)	(–1.54)	(–1.52)	(–1.52)
Innovation	0.01343***	0.01725***	0.00661***	0.00871***
	(2.76)	(2.77)	(2.66)	(2.67)

Source: Authors' calculations based on World Bank Enterprise Surveys (WBES).

Note: Coefficients are average marginal effects. z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights. Outcome GVC = 1 is obtained from a binary probit model already reported in Table 1.

Table A6: Sequential Logit Estimates for GVC Level Transitions (Disaggregated Digitalization)

Variables	0 → 1–5	1 → 2–5	2 → 3–5	3 → 4–5	4 → 5
Website	0.667***	-0.223	0.386	-1.327***	1.414**
	(5.54)	(–1.33)	(1.48)	(–3.51)	(2.44)
Internet	0.282*	0.184	0.366	-0.128	-0.310
	(1.83)	(1.10)	(1.37)	(–0.39)	(–0.51)
Electronic	0.338***	0.486***	0.261	1.277***	0.026
payments	(2.97)	(3.30)	(1.08)	(3.54)	(0.03)
Ln(Productivity)	0.239***	-0.018	0.095	-0.015	0.026
	(5.81)	(–0.38)	(1.18)	(–0.12)	(0.12)
Ln(Age)	0.831**	0.581	0.985	-0.220	1.124
	(1.97)	(1.06)	(1.08)	(–0.15)	(0.44)
Ln(Age)²	-0.146*	-0.138	-0.171	-0.036	0.028
	(–1.94)	(–1.44)	(–1.08)	(–0.15)	(0.06)
Ln(Size)	0.342***	0.438***	0.427***	-0.100	0.128
	(6.57)	(7.63)	(4.62)	(–0.89)	(0.56)
Financial	-0.132***	0.009	-0.096	-0.142	-0.143
constraints	(–3.27)	(0.18)	(–1.27)	(–1.44)	(–0.76)
Training	0.038	0.231*	0.225	0.014	1.445***
	(0.30)	(1.66)	(1.04)	(0.05)	(2.62)
Corruption	-0.087**	0.018	0.060	0.089	0.043
	(–2.11)	(0.36)	(0.76)	(0.88)	(0.22)
Innovation	0.346***	0.015	0.357*	-0.719**	0.807
	(2.79)	(0.11)	(1.66)	(–2.55)	(1.35)
Constant	0.212*	1.214***	0.692***	-0.210	0.903
	(1.82)	(8.80)	(2.79)	(–0.61)	(1.30)
Ln(Productivity)	-4.390***	-3.349***	-4.840***	1.862	-6.477
	(–5.94)	(–3.49)	(–3.13)	(0.78)	(–1.37)
Observations	1 891	1 891	1 891	1 891	1 891
P-Value of Likelihood Ratio Test	0.00	0.00	0.00	0.00	0.00

Source: Authors' calculations based on World Bank Enterprise Surveys (WBES).

Note: Estimates come from a sequential (continuation-ratio) logit model. Coefficients correspond to each transition stage (0→1–5, 1→2–5, 2→3–5, 3→4–5, 4→5). z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All models include the WBES sampling weights.