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-RESEARCH ARTICLE-

ROLE OF DIGITAL ECONOMY IN THE RECONFIGURATION OF GLOBAL VALUE CHAINS: THEORETICAL FRAMEWORK AND EMPIRICAL VERIFICATION

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─Abstract─

The expansion of the digital economy, characterised by the widespread use of information and communication technologies, large-scale data analytics, and online platforms, has reshaped the configuration and functioning of global value chains. This review examines how digitalisation is altering the structure, coordination mechanisms, and overall performance of value chains across different sectors and regions by drawing on conceptual discussions and empirical evidence. The analysis highlights that digital technologies enhance operational adaptability, reduce coordination and transaction expenses, and enable geographically dispersed firms to collaborate instantaneously. In addition, platform-based systems and data-centred innovations have emerged as key drivers of value chain reorganisation, allowing firms to access new markets, optimise production arrangements, and strengthen their competitive positioning. The paper also outlines implications for managerial and policy decision-making, emphasising the importance of expanding digital infrastructure, establishing regulatory arrangements that facilitate international data mobility, and adopting forward-looking strategies in response to evolving digital environments. Collectively, these insights contribute to a comprehensive understanding of how digital transformation is reshaping global production and trade patterns.

Keywords: Digital Economy, Global Value Chains, Digitalisation, GVC Reconfiguration, ICT, Platform Economy, Empirical Evidence.

INTRODUCTION

Global value chains (GVC) have become a core feature of modern international trade because production is now fragmented across borders and organised through networks

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of firms that contribute value at different stages, ranging from sourcing and manufacturing to distribution and retail. This form of cross-border production has supported greater specialisation and operational efficiency over recent decades, allowing firms to draw on comparative advantages, manage costs more effectively, and enter a wider range of markets (Bárcia de Mattos et al., 2021). GVCs are therefore central to stimulating growth, promoting technological progress, and generating employment, particularly for emerging economies seeking stronger participation in global production systems. Their significance encompasses not only trade flows but also patterns of foreign investment, knowledge transfer, and industrial upgrading. For scholars and policymakers, understanding GVC dynamics has become increasingly important as it supports the development of strategies that enhance firm competitiveness, national productivity, and economic resilience in a global context (Boes & Ziegler, 2021).

The rapid expansion of the digital economy has altered business operations worldwide. This domain involves extensive use of technologies such as artificial intelligence, big data analytics, blockchain solutions, the Internet of Things, and a wide array of digital platforms that allow organisations to gather, process, and transmit information with unprecedented speed and scale. Machine learning and artificial intelligence enable predictive analysis and automated decision-making, which contribute to operational improvements and supply chain optimisation. Big data tools offer the capacity to monitor global activities in real time, anticipate changes in demand, and adjust products for diverse markets. Blockchain technology supports secure and transparent transactional records, which reinforces trust, enhances traceability, and strengthens coordination throughout complex chains of production (Coe & Yang, 2022). IoT devices and sensors allow continual oversight of manufacturing systems, inventory flows, and logistics schedules, supporting just-in-time processes and preventive maintenance. Meanwhile, cloud-based systems, e-commerce structures, and online collaboration tools facilitate seamless communication among global partners, reduce transaction costs, and create new avenues for value creation. Collectively, these digital instruments underpin the digital economy and exert substantial influence on how GVCs are structured, governed, and performed (Brun et al., 2019).

The interaction between digital technologies and GVCs has opened new possibilities for redesigning global production networks. Digitalisation supports more flexible, responsive, and resilient organisational arrangements that move beyond traditional linear models of supply chain management. For example, data-enabled insights can refine sourcing decisions, guide the proactive allocation of resources, and support modular production designs that help firms respond quickly to disruptions and shifts in consumer demand. Digital platforms further enhance coordination among internationally dispersed actors, reducing reliance on physical proximity and lowering barriers to entry for smaller firms seeking to participate in global networks. Moreover, digital tools support the advancement of sustainable and responsible practices, such as

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monitoring environmental impacts and ensuring compliance with labour standards, which strengthens the overall value proposition of GVC participation (Lee & Gereffi, 2015).

Despite the growing recognition of the transformative influence of digital technologies on global production, a noticeable gap remains in the current body of literature. Existing scholarship has tended to focus on specific facets, often addressing either the effects of digitalisation on individual firms or the performance of particular value chains. Few studies bring together theoretical approaches and empirical findings in a systematic manner to provide a comprehensive understanding of how the digital economy reshapes GVCs. Much of the existing work remains divided between conceptual discussions and localised case studies, which limits insights into sector-wide and regional patterns. A systematic review that integrates theoretical foundations with empirical validation is therefore essential to identify the mechanisms, trajectories, and broader implications associated with digital transformations within GVCs. This integrative perspective offers valuable guidance for firms seeking to leverage digital tools strategically and for policymakers aiming to design supportive regulatory and infrastructural systems (Butollo, 2020).

In response to this gap, the present review pursues three objectives: first, to establish a theoretical foundation for analysing how the digital economy influences GVC restructuring; second, to consolidate existing empirical evidence on the effects of digital technologies on global production systems; and third, to discuss the strategic and policy implications that arise from these findings. The structure of the paper is organised accordingly. The second section outlines key theoretical perspectives on GVCs and digitalisation, concentrating on major conceptual models and mechanisms. The third section compiles empirical research addressing how digital technologies shape GVC configurations across industries and regions. The subsequent discussion integrates conceptual and empirical insights to draw conclusions and propose relevant managerial and policy directions. The review concludes by identifying areas for future research. Through this comprehensive synthesis, the study enriches the literature on the digital economy and provides stakeholders with a clearer understanding of ongoing transformations in global production networks, particularly in the context of digital GVC restructuring.

CONCEPTUAL AND THEORETICAL FRAMEWORK

Global Value Chains: Concepts and Dynamics

Global value chains encompass the entire sequence of activities involved in producing, distributing, and consuming goods and services, and these activities are dispersed across multiple countries. Unlike traditional trade theories that concentrate solely on the movement of finished products, GVCs highlight the extensive international division of

labour, where stages such as raw material extraction, component manufacturing, assembly, marketing, and post-sale support are allocated to different regions according to cost structures, skill availability, and operational efficiency. This dispersion enables firms to exploit comparative advantages, reduce production costs, and benefit from access to specialised expertise, which collectively enhances competitiveness and deepens participation in global markets (Downes, 2017).

The configuration of GVCs typically consists of interconnected nodes, represented by firms, intermediaries, and suppliers, and the linkages that transmit goods, services, capital, and knowledge across borders. Governance arrangements within these chains determine how value is generated, distributed, and coordinated among participants. Gereffi's (1999) typology outlines several forms of governance (Gereffi, 1999): market-based structures characterised by arm's-length exchanges; modular arrangements in which suppliers deliver standardised components; relational systems involving close, trust-dependent interactions; and captive structures where suppliers operate under strong dependence on lead firms. Lead companies often set technical and organisational standards, hold control over essential resources, and capture a disproportionate share of value, while suppliers occupy different positions along a continuum of upgrading possibilities and value appropriation (Kenney & Zysman, 2020).

Within GVCs, upgrading refers to a firm's capacity to enhance its functions and secure greater value. This can occur through several routes, including process upgrading, which aims to increase efficiency or quality; product upgrading, which involves moving towards more sophisticated outputs; functional upgrading, which expands a firm's role into higher-value tasks such as design or marketing; and inter-chain upgrading, where competencies are transferred to new chains. A firm's position within the value chain significantly shapes its potential for innovation, value capture, and long-term competitiveness. Those operating in knowledge-intensive segments such as research and development or international branding generally obtain more substantial economic and strategic advantages than firms performing labour-intensive stages such as component manufacturing or assembly (Lin et al., 2021).

The Digital Economy: Key Components

The digital economy refers to a set of economic activities enabled by digital technologies, platforms, and supporting infrastructures that reshape how goods and services are produced, distributed, and consumed. Core components of this environment include digital platforms, artificial intelligence, the Internet of Things, blockchain systems, and cloud-based computing, each of which enhances global connectivity, operational efficiency, and opportunities for innovation across production networks. Digital platforms operate as intermediaries that connect producers, consumers, and service providers, enabling transactions, collaborative exchanges, and knowledge

flows. Major platforms such as Alibaba, Amazon, and Uber demonstrate how digital ecosystems can integrate a broad range of participants and expand market reach.

Artificial intelligence and machine learning strengthen predictive capabilities, automate decision-making, and support process optimisation, which improves responsiveness to evolving market conditions. Internet of Things devices gather continuous streams of data from manufacturing systems, logistics processes, and supply chain activities, allowing real-time monitoring, system control, and preventive maintenance. Blockchain systems provide decentralised and tamper-resistant transaction records, which enhance transparency, accountability, and trust among firms operating across dispersed stages of global value chains. Cloud computing offers flexible and scalable storage and computational resources, allowing international collaboration without requiring locally situated infrastructure (Li et al., 2023). These technologies depend on robust digital infrastructure such as high-speed broadband networks, data centres, and 5G systems. Enhanced connectivity enables seamless information exchange and integration across geographically dispersed firms, facilitating real-time oversight of complex production arrangements. The rise of digital technologies has also encouraged new business models that allow firms to improve value creation, reduce operating costs, and generate alternative revenue streams. Examples include servitisation strategies, mass customisation, and platform-supported forms of commerce, all of which reflect the transformative nature of the digital shift in contemporary production systems (Kinkel, 2020).

Theoretical Linkages between Digital Economy and GVCs

Digitalisation has a substantial influence on how firms participate in, integrate into, and upgrade within global value chains, and it reshapes both governance arrangements and the broader functioning of global production networks. At the organisational level, digital tools provide deeper visibility into supply chain operations and allow firms to refine production activities, inventory control, and logistics management. These technologies support real-time coordination among suppliers, manufacturers, and customers, which lowers transaction-related expenses and encourages more relational forms of governance. Moreover, digital systems enable firms to collect extensive data sets, analyse patterns, anticipate fluctuations in demand, and design new products and services based on informed strategic decisions (Friederici & Lehdonvirta, 2021).

The Global Production Network perspective offers a useful lens through which the effects of the digital economy on GVCs can be examined. Unlike traditional GVC approaches that emphasise linear chains of activities, GPN theory foregrounds the spatial, organisational, and relational complexity that characterises modern production networks. Digitalisation intensifies these dynamics by improving connectivity and facilitating modular, multi-scalar structures in which production tasks are distributed across global and regional networks. Firms can participate in several networks

simultaneously and can reconfigure their network relationships and strategic positions to secure greater value creation and competitive advantage (Johns, 2021).

Several theoretical frameworks contribute to understanding firm-level competitiveness within digitalised GVCs. Within the Resource-Based View, digital capabilities such as proprietary platforms, advanced data analytics, and AI-driven processes are regarded as strategic assets that are valuable, rare, difficult to imitate, and likely to support sustained competitive advantage. Transaction Cost Economics proposes that digital technologies lower coordination costs, mitigate uncertainties, and improve efficiency within complex multi-actor production systems. Innovation diffusion theories suggest that digital tools accelerate learning and knowledge transfer across nodes in the chain, enhancing opportunities for functional or inter-chain upgrading. When integrated, these perspectives demonstrate that digital adoption has become a strategic necessity and a critical determinant of value capture in contemporary global production systems (Lee & Gereffi, 2021).

Drawing these ideas together allows for the construction of a conceptual framework that links elements of the digital economy with the restructuring of global value chains as shown in figure 1. Core digital technologies, including artificial intelligence, Internet of Things systems, blockchain solutions, and digital platforms, work together with digital infrastructure to expand connectivity, transparency, and coordination across production networks. These enhanced capabilities affect governance structures, firm positions, and upgrading options, ultimately leading to the reconfiguration of GVCs.

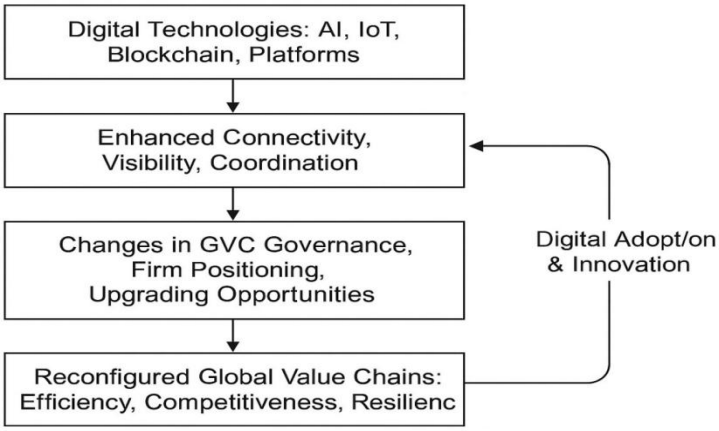

Figure 1: Conceptual Framework Linking Digital Economy to GVC Reconfiguration (Self-Computing)

The redesigned networks tend to display greater efficiency, competitiveness, and resilience, and these improvements generate feedback mechanisms that further encourage investment in digital tools and new technologies. This conceptualisation provides theoretical depth for understanding the ongoing digital transformation of

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international production and offers a foundation for empirical inquiry as well as strategic and policy-oriented decision making.

This section outlines the conceptual and theoretical discussion concerning the influence of the digital economy on the reconfiguration of GVCs. It highlights the multi-layered linkages between technological enablers, network governance, and strategic behaviour at the firm level. By combining insights from GVC and GPN perspectives with digital economy theory, the framework establishes a broad analytical basis for understanding how digitalisation reshapes global production networks in ways supported by empirical research. This integration is important for interpreting recent shifts in international trade and provides practical guidance for managers and policymakers who aim to utilise digital opportunities as a means of strengthening competitive performance and supporting long-term development.

EMPIRICAL EVIDENCE

Firm-Level Studies

The firm-level perspective provides the most granular understanding of how digital technologies shape participation in GVCs. Empirical evidence consistently shows that the adoption of digital tools, including enterprise resource planning (ERP) systems, cloud-based solutions, big data analytics, and artificial intelligence (AI) applications, strengthens firms' ability to integrate into global production networks. Organisations that invest in these technologies are able to establish seamless links with suppliers, customers, and logistics partners, exchange information instantaneously, and manage dispersed operations with greater coordination (Ding et al., 2021; Raza et al., 2021).

A substantial body of research demonstrates the transformative effects of digitalisation within the manufacturing sector. Case studies from European and East Asian industries reveal that advanced robotics and Internet of Things (IoT) technologies have reduced production lead times and improved operational accuracy, enabling firms to meet the demanding quality requirements characteristic of high-value GVC segments (Pardi et al., 2020). Digital platforms have also supported international expansion by reducing the need for firms to establish physical offices abroad. For instance, studies of Indian IT service providers and professional services firms show how cloud-based tools are being used to coordinate multinational projects (Huang & Zhang, 2023). Similarly, high-technology industries, such as biotechnology and advanced electronics, have benefited from digital design systems and simulation software that allow them to participate in upstream and downstream tasks within GVCs that were previously beyond their capabilities.

A key theme in the literature concerns the influence of digital adoption on firm competitiveness and value capture. Empirical work indicates that digitalised firms are better positioned to shift into knowledge-intensive segments of GVCs, such as design,

research and development (R&D), and branding, while relocating standardised manufacturing tasks to external partners (Hess et al., 2020). Research focusing on Chinese electronics manufacturers shows that firms using digital supply chain management systems not only integrate more rapidly into global networks but also achieve higher profit margins and gain improved negotiating strength when dealing with lead firms (Angelopoulos et al., 2023). Furthermore, digitalisation appears to lower the long-standing barriers that previously restricted small and medium-sized enterprises (SMEs) from entering GVCs dominated by large multinational corporations.

Industry-Level Analysis

At the industry level, digital technologies have driven significant structural transformations, altering both the composition and organisation of GVCs. One prominent trend is the shift towards segments that are intensive in digital content and capabilities. For example, in the automotive sector, the adoption of connected vehicles and AI-enabled production planning has enabled firms to generate value not only during assembly but also through software integration, predictive maintenance, and post-sales services (Chi et al., 2021). In the apparel industry, automation of cutting machinery and digital design tools have brought manufacturers in developing countries closer to high-value design and branding activities that were historically dominated by lead firms in developed economies (Mao, 2020).

Empirical evidence also highlights that digital technologies facilitate product customisation and innovation. Industries such as consumer electronics and medical devices increasingly employ digital platforms to co-develop products with customers, enabling rapid iteration and on-demand production (Yeung, 2020). This digitally enabled innovation enhances firms' ability to differentiate their offerings, strengthen their positions within GVCs, and potentially capture greater value. Furthermore, the adoption of digital tools has fostered new business models, including servitisation and platform-based ecosystems, which reshape traditional value chains by converting revenue streams from one-off product sales to recurring service income. Sectoral case studies additionally indicate that industries with higher levels of digital intensity demonstrate greater resilience to global disruptions. This was evident during the COVID-19 pandemic, where digitally advanced industries were better able to maintain operations and preserve their participation in GVCs compared with sectors that had limited digital adoption (Liu et al., 2021).

Country-Level Studies

At the national level, digital infrastructure and policy frameworks play a critical role in shaping participation in GVCs. Comparative analyses between developed and developing economies reveal significant disparities in the capacity to leverage digital technologies. In developed nations, high broadband coverage, robust cybersecurity

systems, and widespread digital literacy enable firms to operate in higher-value segments of GVCs. For instance, research within the European Union shows that countries with comprehensive national digital strategies facilitate greater integration of domestic firms into knowledge-intensive segments of global networks, including research and development (R&D), logistics, and design services (Qian & He, 2021).

Conversely, developing countries face structural and institutional obstacles that limit the benefits derived from digital adoption. While some firms in nations such as China and India are increasingly incorporating digital tools into their GVC participation, inadequate digital infrastructure, limited access to skilled labour, and regulatory constraints hinder broader integration (Verhoef et al., 2021). Comparative studies suggest that policy measures—such as investment in national broadband networks, development of digital skills, and the establishment of supportive regulatory frameworks—can significantly enhance the ability of firms in these countries to move up the value chain. For example, the implementation of national digital agendas in several Latin American countries corresponded with measurable increases in SME engagement in export-oriented GVCs, particularly within high-tech manufacturing and service sectors (Chi et al., 2021). Additional cross-country evidence indicates a strong link between digital preparedness and the resilience of GVCs. Economies with higher levels of digitalisation are better equipped to respond to disruptions, coordinate complex production systems, and adapt rapidly, allowing firms to maintain or even strengthen their positions within international markets (Liu et al., 2021).

Synthesis of Findings

Analysis of empirical evidence across firm, industry, and national levels reveals several key trends. Firstly, digitalisation consistently enhances participation in GVCs by improving connectivity, reducing transaction costs, and enabling real-time coordination. Firms that adopt digital technologies are more capable of accessing higher value-added segments, diversifying their operations, and strengthening their competitive position. Secondly, industries with high levels of digital intensity, particularly in manufacturing and services, experience structural shifts towards digital-intensive and knowledge-based operations, signalling broader reorganisation within global value chains. Digital tools facilitate product customisation, support innovation, and enable the development of new business models, thereby enhancing differentiation and organisational resilience (Farboodi & Veldkamp, 2021).

Thirdly, the influence of digital technologies on GVC participation is highly contingent upon national context. Developed economies, characterised by advanced digital infrastructure and supportive policy environments, enable firms to adopt digital solutions extensively and move into higher-value segments. In contrast, developing countries face structural and institutional barriers, although targeted interventions, investments in digital skills, and infrastructure improvements can yield substantial

gains. Comparative studies underscore the importance of national digital readiness in shaping GVC engagement and value capture. Nevertheless, the literature presents some contradictions. While many studies suggest that digitalisation can help SMEs overcome traditional barriers to entering GVCs, other research indicates persistent inequalities, with small firms in developing countries often lacking the resources and institutional support required to leverage digital tools effectively (Na & Li, 2021). Furthermore, although digital adoption can facilitate integration into high-value segments, the benefits are not evenly distributed across sectors or regions, highlighting the need for more nuanced analysis of contextual and institutional factors.

Finally, several research gaps emerge from the empirical literature. Longitudinal studies examining digital adoption and subsequent GVC participation over time remain limited. While substantial evidence exists at firm and industry levels, cross-country studies often rely on aggregate indicators that obscure intra-national variation. Moreover, the effects of emerging technologies, such as blockchain, AI-enabled predictive analytics, and digital twins, on GVC governance and value capture are underexplored. Addressing these gaps is essential for constructing a comprehensive understanding of how the digital economy is reshaping global production networks (Liu et al., 2021). Overall, the empirical findings demonstrate that digital technologies are central to the reconfiguration of GVCs across multiple levels. Adoption of these tools enhances firm competitiveness, drives industrial transformation, and interacts with national policy frameworks to influence the depth and quality of engagement with global networks. The evidence highlights both the transformative potential of the digital economy and the persistent disparities that warrant further investigation.

RECONFIGURATION MECHANISMS

Digital technologies have profoundly reshaped the structure, governance, and operational dynamics of GVCs, creating mechanisms that support more adaptive, responsive, and efficient production networks. Traditionally, GVCs were organised in hierarchical, linear arrangements, with lead firms coordinating suppliers and subcontractors across distinct stages of production. These conventional structures relied heavily on physical proximity, standardised procedures, and fixed contractual arrangements, which often constrained flexibility and limited responsiveness to market fluctuations. The introduction of digital technologies has transformed this paradigm by decentralising coordination, enhancing real-time visibility, and converting formerly rigid supply chains into dynamic, networked configurations (Wu & Liu, 2021).

This decentralisation is largely driven by digital platforms. Platforms such as Alibaba, Amazon Business, and cloud-based supply chain management systems connect suppliers, manufacturers, and customers across multiple regions, reducing the dependence on hierarchical, firm-centric control. By providing shared digital ecosystems, these platforms facilitate knowledge and resource exchange, transforming

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linear GVCs into interconnected networks. As a consequence, smaller firms can participate in GVCs without entering direct contracts with lead firms, thereby widening access to international markets and diversifying participants. Additionally, platform-mediated networks enable modular arrangements that can be flexibly distributed among geographically distant partners across functions such as design, production, logistics, and marketing (Yang et al., 2012).

Automation, AI, and real-time data analytics are critical for reconfiguring production and logistics within these networks. Automation streamlines repetitive tasks, reduces operational errors, and lowers costs, while AI applications improve scheduling, inventory management, and demand forecasting. IoT devices provide timely information on production lines and shipments, allowing firms to anticipate disruptions and make rapid adjustments. Predictive analytics, for instance, can identify potential bottlenecks before they occur, and machine learning algorithms can automatically adjust production volumes in response to changes in demand. Collectively, these technologies reduce transaction and coordination costs, enhance responsiveness, and enable more effective resource allocation across the network (Li et al., 2022).

Digitalisation also has broader implications for labour, trade, and value distribution within GVCs. Automation and AI reduce the need for routine labour, shifting demand towards high-skill roles such as programming, data analysis, and digital management. Micro and small enterprises can engage in cross-border trade without traditional intermediaries, thereby expanding market inclusiveness and trade volumes. In terms of value capture, digital tools allow firms to access higher-value segments of the chain, such as product design, customisation, and after-sales services, whereas routine assembly or low-skill activities may experience relative value decline. These changes collectively promote a more knowledge- and innovation-driven configuration of GVCs (Huang & Zhang, 2023). Furthermore, digitalisation enhances supply chain resilience and flexibility. Traditional GVCs are vulnerable to natural disasters, conflicts, or logistical delays. Distributed networks, predictive analytics, and real-time monitoring allow firms to respond rapidly to disruptions, re-route production, or identify alternative suppliers without halting operations. This capacity not only stabilises supply chains but also provides a competitive advantage in the increasingly unpredictable global market.

The digital economy reshapes GVCs through multiple mechanisms as shown in figure 2. By decentralising coordination and supporting networked structures via digital platforms, automation, AI, and real-time data analytics, firms can achieve greater operational efficiency, enhanced responsiveness, and reduced risk exposure. These transformations influence labour allocation, trade patterns, and value distribution, resulting in GVCs that are more knowledge-intensive, innovation-oriented, and resilient. Understanding these mechanisms provides a foundation for analysing empirical evidence on how firms, industries, and nations adapt to digitally integrated global production networks.

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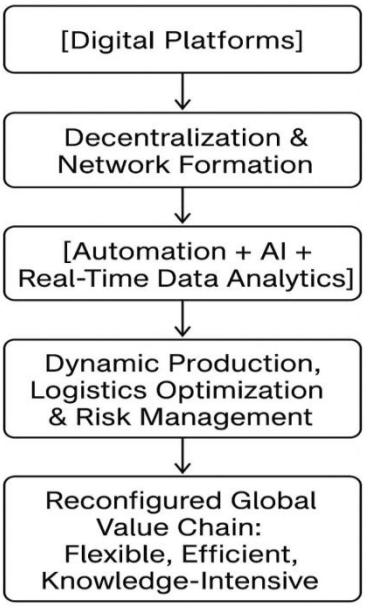

Figure 2: Conceptual Diagram Illustrate Mechanisms of GVC Reconfiguration Due to Digital Technologies (Self-Computing)

FIRM AND POLICYMAKER IMPLICATIONS

Strategic Implications of Firms

The digital economy has fundamentally altered the competitive landscape of GVCs, compelling firms to adopt strategic adjustments to leverage technological advantages and maintain relevance in global markets. A primary implication is the development of digital capabilities. To enhance operational efficiency, make timely decisions, and respond effectively to market demands, firms must invest in digital infrastructure, data analytics, AI, cloud computing, and automation. Building digital capability extends beyond technological adoption to include organisational competencies in data-driven management, cybersecurity, and coordination of digital supply chains. Firms that successfully integrate these capabilities into their operations can improve process efficiency, reduce costs, and access higher value-added segments of GVCs, facilitating functional and product upgrading (Krzywdzinski, 2021).

Another critical strategic avenue is the utilisation of digital platforms. These platforms decentralise supply chains and enable interaction between suppliers, manufacturers, and customers globally within networked environments. By engaging with digital ecosystems, firms can expand their market reach, enhance supplier and customer networks, and participate in collaborative innovation. SMEs can also access GVCs that might otherwise be dominated by large lead firms, thereby democratising international trade opportunities and value capture. Companies that strategically leverage platforms

can achieve greater agility in sourcing, production, and distribution while enhancing resilience to market fluctuations and supply chain disruptions (Loonam & O'Regan, 2022). Digitalisation also drives innovation and competitive advantage. Through AI, IoT, and real-time data analytics, firms can implement mass customisation, predictive maintenance, and accelerated product development cycles. These digital tools support innovation that enables firms to differentiate their offerings, improve customer satisfaction, and secure higher-value activities within GVCs. For example, high-tech companies that adopt digital design and intelligent manufacturing systems can shift from manual assembly to more cognitively demanding tasks, thereby increasing profit margins and strengthening global competitiveness. Conversely, firms that neglect digital transformation risk remaining in low-value segments, with diminished bargaining power and limited opportunities for upgrading within global production networks (Krzywdzinski, 2021).

Policy Implications

Digital technologies have significant implications for policymakers due to the transformative effects they induce in GVCs. To enable firm-level adoption and seamless integration into networks, substantial investment in digital infrastructure is required, including broadband networks, cloud computing, and data centres. Such investments enhance connectivity, reduce transaction costs, and facilitate real-time coordination of production networks on a global scale. Complementary regulatory measures are necessary to support cross-border data flows, ensure cybersecurity, and harmonise digital trade practices, thereby lowering barriers to GVC participation (McIntyre et al., 2021).

Skills development is another critical policy consideration to sustain digital adoption and competitiveness. The integration of automation, AI, and other digital solutions shifts labour demand toward high-skill roles, including programming, data analytics, digital management, and innovation. Policymakers should design educational curricula, vocational training, and lifelong learning initiatives that equip workers with the competencies required in digitalised GVCs. Enhancing digital literacy and technical expertise ensures that firms can adopt new technologies, contributing to productivity gains and value creation. SMEs, in particular, face challenges due to limited resources, capital, and technological capabilities, which may restrict their participation in digital GVCs. Policy interventions such as digital adoption grants, tax incentives for technology investment, shared digital platforms, and mentoring programmes can support SMEs in integrating into global production networks. Facilitating SME involvement not only promotes inclusive economic growth but also enriches network diversity within GVCs, improving resilience and fostering innovation (Lin et al., 2021).

Policy frameworks should also be forward-looking and adaptable to evolving market conditions. Harmonisation of digital trade regulations, intellectual property protection,

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and technical standards can reduce friction in international transactions. Engagement in regional and international digital trade agreements can create new market opportunities, enabling domestic firms to participate more effectively in cross-border value chains. Policies that encourage innovation systems, collaborative research and development, and government-business partnerships further strengthen the capacity of firms to capture value within restructured GVCs (Wu & Liu, 2021). In conclusion, digital transformation requires coordinated actions at both the firm and policy levels.

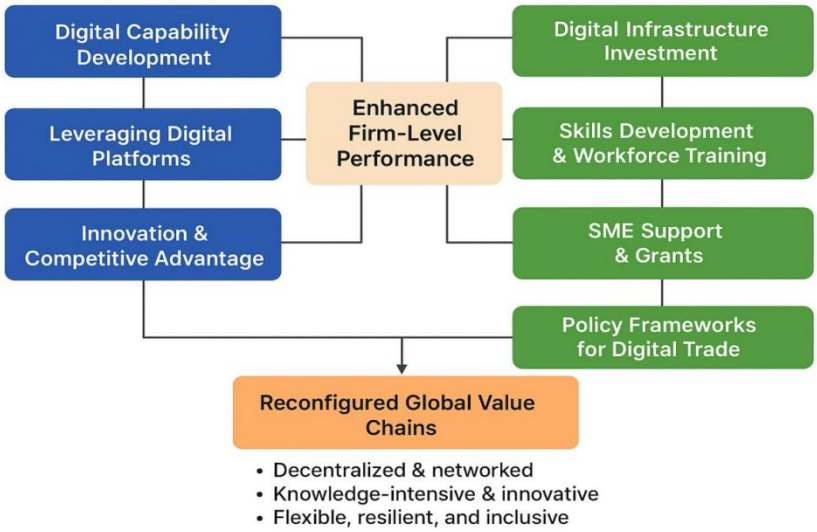

Figure 3: Implications for Firms and Policymakers in GVC Reconfiguration (Self-Computing)

Firms must develop digital capabilities, strategically utilise platforms, and foster innovation to achieve upgrading and maintain competitive advantage in GVCs as shown in figure 3. Simultaneously, policymakers play a pivotal role in ensuring widespread participation and equitable value distribution by providing digital infrastructure, developing workforce competencies, supporting SMEs, and implementing enabling regulatory frameworks.

CHALLENGES AND FUTURE RESEARCH DIRECTIONS

The rapid integration of digital technologies into GVCs has created substantial opportunities for firms, industries, and nations. However, this transformation also brings a range of critical challenges that must be carefully managed to ensure inclusive and sustainable participation. Key concerns include data privacy, cybersecurity, the digital divide, and unequal access to GVCs. Additionally, the continual emergence of new technologies necessitates ongoing research to understand their potential impacts and strategic implications for global production networks.

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Data Privacy, Cybersecurity, and Digital Divide

Data privacy and robust cybersecurity represent central challenges in the digital integration of GVCs. Firms are increasingly reliant on cloud computing, the IoT, and digital platforms to manage production, logistics, and customer interactions. This reliance exposes sensitive business information, intellectual property, and customer data to cyber threats and potential breaches. Inadequate cybersecurity can disrupt supply chains, undermine trust between partners, and result in substantial financial losses. For instance, attacks on industrial control systems within manufacturing or ransomware targeting logistics networks can halt production and delay global deliveries (Verhoef et al., 2021). The digital divide also poses a significant barrier to equitable participation in GVCs. Access to high-speed internet, advanced digital tools, and skilled personnel varies widely both between and within countries. In developing economies, firms often face limited infrastructure, low digital literacy, and high costs associated with technology adoption, constraining their ability to integrate effectively into global production networks. These disparities contribute to the concentration of high-value, high-profit activities in digitally advanced countries, while firms with limited digital capacity remain marginalised (Mao, 2020).

Inequalities in GVC Participation Due to Digital Readiness

Uneven adoption of digital technologies can lead to structural inequalities within GVCs. Firms that rapidly implement digital solutions, such as AI-driven analytics or blockchain-enabled supply chain transparency, are more likely to move into higher-value segments, secure greater returns, and enhance their innovative capabilities. Conversely, companies that lag in digital adoption may remain confined to low-value, labour-intensive operations. These disparities have broader consequences for regional economic development and industrial upgrading, particularly in countries heavily reliant on GVCs for employment and export growth. Addressing these inequalities requires targeted policy measures, including investment in digital infrastructure, capacity-building initiatives, and training programmes designed to enhance the absorptive capacity of firms across diverse contexts (Angelopoulos et al., 2023).

Need for Longitudinal and Multi-Country Empirical Studies

Despite the growing body of research on digitalization and GVCs, significant gaps remain. Most empirical studies are cross-sectional or confined to a single country, sector, or type of firm. Longitudinal research is particularly valuable to capture the evolving nature of digital adoption over time, including its effects on upgrading trajectories, resilience to disruptions, and shifts in competitive positioning. Moreover, multi-country investigations can provide comparative insights into how digital infrastructure, regulatory frameworks, and national policies influence GVC integration. Such studies are crucial for developing generalisable theories and policy

recommendations that account for variations in economic, technological, and institutional contexts (Liu et al., 2021).

Emerging Technologies and Their Potential Impact

Emerging technologies such as AI, blockchain, digital twins, and 5G connectivity hold substantial transformative potential for GVCs. These innovations can enhance transparency, optimise resource allocation, and enable real-time coordination across geographically dispersed networks. However, their adoption also raises new research questions. For instance, how do AI-driven decision-making systems affect supplier relationships and risk management? To what extent does blockchain improve traceability without compromising cost efficiency? Investigating such questions is crucial for understanding the next phase of GVC reconfiguration and the role of the digital economy in promoting sustainable and equitable global trade (Raza et al., 2021). To fully capitalise on the benefits of digitalisation, challenges such as data privacy, cybersecurity, the digital divide, and unequal participation in GVCs must be addressed. Future research should prioritise longitudinal and multi-country studies to assess the implications of emerging technologies. Additionally, these studies should examine how these innovations can guide firms, policymakers, and international organisations in navigating the evolving landscape of digital GVCs.

CONCLUSION

This review highlights the pivotal role of the digital economy in reshaping GVCs by combining theoretical and empirical insights. Digital technologies, including AI, blockchain, IoT, and digital platforms, enhance connectivity, coordination, and transparency, enabling firms to reposition, pursue upgrading opportunities, and improve efficiency, competitiveness, and resilience. Evidence across firm, industry, and national levels confirms these effects. At the firm level, digital adoption deepens GVC participation, fosters innovation, and supports value capture through process optimisation and product differentiation. Industry analyses show structural shifts toward flexible manufacturing, digitally-enabled services, and high-tech, knowledge-intensive activities. Nationally, strong digital infrastructure and supportive policies allow developed economies to benefit more than developing countries. Digitalisation is thus a central driver of GVC transformation. Firms should invest strategically in digital capabilities, researchers should conduct longitudinal and cross-national studies, and policymakers must prioritise infrastructure, education, and regulatory frameworks to ensure inclusive participation and address the digital divide. Emerging technologies, including AI-driven analytics, blockchain, and 5G, will continue to shape GVCs, improving efficiency, innovation, and resilience while highlighting the need for cybersecurity, data privacy, and equitable access. The digital economy functions as a structural enabler of more innovative, competitive, and adaptable global value chains.

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