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Article — Published Version

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Global Networks

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Suggested Citation: Butollo, Florian; Gereffi, Gary; Yang, Chun; Krzywdzinski, Martin (2022) : Digital transformation and value chains: Introduction, Global Networks, ISSN 1471-0374, Wiley, Oxford, Vol. 22, Iss. 4, pp. 585-594, <https://doi.org/10.1111/glob.12388>

This Version is available at:
<https://hdl.handle.net/10419/262158>

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ORIGINAL ARTICLE

Digital transformation and value chains: Introduction

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Abstract

New digital technologies based on the internet of things and artificial intelligence play centre stage in contemporary discussions about the prospects for economic development and the future of work. This article summarizes theoretical and empirical contributions on how these technologies affect global value chains (GVCs). We argue that the leading paradigms that analyse global production – the GVC framework and the related global production networks (GPNs) approach – are in need of some ‘technological upgrading’ themselves. The GVC/GPN approaches acknowledge that technology is constitutive for the emergence of geographically fragmented production, but rarely address directly how technological change affects interfirm relations. The authors provide a framework that acknowledges the key role of technology while situating digital tools and systems in their social embeddedness, that is the role of human agency and institutions in shaping their development and impact. A research agenda is outlined focusing on three topics: the varieties of digitalization approaches in different world regions, the role of data as a specific form of intangible resource and the role of platform business models for industrial ecosystems. These topics are addressed in the special issue of *Global Networks* on ‘Digitalization and Value Chains’ introduced by this contribution.

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KEYWORDS

global commodity/value chains, global production networks, globalization, governance, ICT, transnational social relations

Technology plays centre stage in contemporary discussions about the prospects for economic development and the future of work. Artificial intelligence (AI) and the internet of things (IoT) are said to trigger a leap in productivity and further enhance the flexibility of economic interactions, while digital platforms represent the emergence of a mode of intermediation that substantially alters the relationship between economic actors and the way in which gains are distributed among them. The contemporary wave of digitalization may result in systemic changes that affect the governance of global value chains (GVCs) and the prospect of firms, workers and other actors to capture the gains of economic progress. Technological change affects the structure, the geographies and the social division of labour in production networks given that the core of recent breakthroughs lies in network technologies. AI and the IoT first and foremost represent a deeper integration of interactions at the level of data collection and exchange (Mayer-Schönberger & Ramge, 2018).

Yet, even if it seems natural that there is some sort of a connection between the present forms of technological change and interfirm relationships, we are only starting to unravel its specific forms and their implications. The academic discourse on digitalization does not devote much attention to interfirm relationships in existing economic sectors. The Industry 4.0 paradigm tends to focus on process and business model innovation at the level of single enterprises, often without addressing the wider issues of sectoral change. The debate on digital platforms is different in this respect since it focusses on a new mode of intermediation between economic actors. However, most attention so far was directed at certain paradigmatic fields (social media, mobility and labour platforms) and thus, the debate on how platforms relate to established players in other economic sectors and how this can be linked to GVC/global production network (GPN)¹ analyses at the level of theory is only beginning.

Furthermore, GVC/GPN research needs some 'technological upgrading' itself in order to come to terms with recent developments. As Henry Yeung observes, GPN literature has tended to examine the emergence of digital platforms, but lacks a systematic conceptualization of digital transformation and production networks in the changing context of global economy (Yeung, 2021, see also Foster & Graham, 2017) – a judgement that might well be extended to research from the GVC perspective. GVC/GPN research thus needs to tackle the paradox that technology is fundamental to its own subject, but rarely has been explicitly the object of theoretical and empirical inquiry. After all, the very existence of fragmented production networks is hardly conceivable without changes in communication and transport technologies that allow for the virtual coordination of geographically separated processes.

Changes in the modes of coordination – and within the processes of value creation at each site – are bound to have effects. This is acknowledged at a theoretical level – many authors refer to the enabling role of technology in the emergence of fragmented production (e.g. Dicken, 2014; Gereffi, 2005). In GVC theory, distinct types of governance are constructed according to the *codifiability* of information (i.e. the way in which information can be transmitted to multiple parties efficiently without transaction-specific investments), which is one out of three variables to explain variations in interfirm relations (Gereffi et al., 2005). Also, the key concept of industrial upgrading focusses on issues of technology transfer and its role for firm capabilities (Humphrey & Schmitz, 2002).

Yet, despite this centrality of the subject of technology, research that devotes attention to concrete technologies and their impact is still scarce. Historically, there have been exceptions. An edited volume by Charles Cooper and Raphael Kaplinsky (1989) discusses possible impacts of technological change (then labelled as the 'Third Industrial Revolution') on the international division of labour. The advent of the internet age also led to some conceptual reflections, such as Gary Gereffi's considerations from 2001 on the role of the internet that sketched out issues related to the impact on GVC governance structures that remain to be explored today (Gereffi, 2001a, 2001b). Yet, such interventions were punctual and did not receive lasting attention as each technological hype cycle came to a close.

GVC/GPN RESEARCH AND THE ISSUE OF DIGITALIZATION

This situation is about to change now. The international discourse on new technologies and their economic and social effects is ubiquitous and inevitably overlaps with key topics in GVC/GPN research. This discourse is characterized by the habitual exaggerations and misjudgements of a hype (fear of imminent mass unemployment, neglect of human agency, industry per se becoming irrelevant, etc.), but the impacts of technological change are real and matter. A more systematic discussion about their impact on value chains is needed to improve existing analytical frameworks and to add to our empirical knowledge on their trajectories.

Some contributions provided important building blocks for the interpretation of the specifics of present-day technological change and its impact on governance and upgrading in GVCs. Sturgeon (2019) singled out *new* digital technologies as a cluster that includes advanced manufacturing, robotics and factory automation, new sources of data and the IoT, cloud computing, big data analytics and AI. He identifies three key business strategies related to these technologies that affect GVC governance: modularity, open innovation and platforms. Rehnberg and Ponte (2018) addressed the impact of 3D printing on upgrading and value distribution, depicting scenarios that are further explored in Jennifer Johns' contribution to this special issue. Brun et al. (2019) analyse the entry of new asset-light lead firms in GVCs that challenge the incumbents based on their command of software and data processing. Foster and Graham (2017) discuss how digital technologies condition three basic variables of GPN analysis – embeddedness, value and networks – and demonstrate the applicability of their refined understanding in a study of the East African tea industry.

A range of sectoral analyses also contributed significantly to our understanding of how digitalization facilitates industrial restructuring. Thun and Sturgeon (2019), as well as Lee and Gereffi (2021), tackle the recent trajectory of the mobile phone industry and highlight the rising relevance of software ecosystems and platforms for GVC governance, while also outlining the blurring and reconstitution of sectoral boundaries. Yang (2021) and Butollo and ten Brink (2018) trace the transition of the lighting industry towards LED technologies, which aligns manufacturing practices with those pioneered in the electronics industry. While automation and digitalization of production processes have shaped the automotive industry for several decades already (Krzywdzinski, 2021; Pardi et al., 2020), the industry is currently undergoing a profound transformation through new data-based business models and platform strategies – a shift that includes the entry of new players and fierce competition over the control of strategic positions in the value chain (Boes & Ziegler, 2021; Helper et al., 2019; Perkins & Murmann, 2018). In the apparel industry, debates on automation and reshoring have taken on renewed urgency in the COVID-19 crisis. However, evidence indicates that the penetration of automation technologies still remains limited. Yet, a plausible scenario is that brands adopt a dual-sourcing strategy in which basic, low-priced products continue to be imported, while higher-priced and customized items are made in factories with higher degrees of automation in reshored or nearshored locations (Bárcia de Mattos et al., 2021).

The relationship between technology and 'reshoring' is explored theoretically and empirically by a variety of authors. Outspoken judgements about the feasibility of reshoring are made by Lisa de Propris and her colleagues (De Propris & Bailey, 2020; De Propris & Pegoraro, 2019), as well as by Kinkel (2020). These authors argue that the effects of automation would make labour cost differentials increasingly obsolete, while production systems of the Industry 4.0 kind would favour the intra-regional allocation of firms close to consumers. Others argue, however, that this is a one-sided assessment since progress in logistics and networking technologies can (simultaneously) deepen global fragmentation (Butollo, 2020; Raza et al., 2021; Sturgeon, 2019). What is more, there is also catch-up automation in emerging economies that can enhance the competitiveness of firms in these regions (Butollo & Lüthje, 2017; Krzywdzinski, 2017).

PLATFORMS AS NEW AGENTS

The role of digital platforms has caught the attention of researchers from various backgrounds. A growing body of literature on platforms has singled out their function for multi-sided intermediation that is particularly relevant for

data-based interactions. Platforms thus modify the manner of transactions and also of innovation processes as they facilitate matchmaking and the combination of modularized inputs that are sourced from decentralized networks (Cusumano et al., 2019; McAfee & Brynjolfsson, 2017). By exploiting such advantages and making use of network effects, digital platform firms emerged as powerful actors in economic sectors that rely on transactions (logistics and retail) and the distribution of intangible goods (media and software) and continue to expand in other sectors as well.

Some see platforms as the core institutions of 21st century economic organization, such as Kenney and Zysman (2016) who argue that '[i]f the industrial revolution was organized around the factory, today's changes are organized around [...] digital platforms, loosely defined'. Accordingly, many authors now speak of a 'platform economy' (Kenney & Zysman, 2016) or of 'platform capitalism' (Srnicsek, 2017). Platforms have also figured prominently in debates about the future of work as labour platforms coordinate the work of formally independent contractors, thereby often assuming a role that is equivalent to the firm but without granting secure and decent working conditions as they defy existing forms of labour regulation (Gerber & Krzywdzinski, 2019; Graham et al., 2017; Rahman & Thelen, 2019).

The debates on both issues – the general role of platforms in economic relationships and their specific impact in shaping labour relations – have resulted in lively research exchanges and considerable bodies of literature. While research on platforms originated largely outside the established debates of the GVC and GPN tradition, there is significant thematic overlap as the debate on the platform economy also deals with interfirm relations and hierarchies in production networks. We expect the lively dialogue between the two strands of literature to intensify. Coe and Yang (2021: 2), for instance, see platforms as a new type of lead firm and argue that 'the platform and GPN literatures can [...] be used synergistically to better understand the distinctive ways in which certain industries are being dramatically and rapidly restructured by the expanding scale and size of platforms. Ultimately, both are concerned with the processes through which the market power of lead firms is produced'.

The question of how a platform manages to exert control has been the subject of closer investigation in the GVC and GPN literatures. Humphrey (2018) focusses on the relationship between platforms and complementors (input suppliers) in a cross-industry study and highlights forms of indirect control of platform owners, which he then relates to the question of whether complementors can take advantage of the network's resources for industrial upgrading. Coe and Yang (2021) combine insights from the platform ecosystem and GPN literatures to demonstrate how China's Tencent has used strategies of vertical and horizontal integration to create a specific organizational form – the platform business group, in developing its market power in the global online games production networks and China's games industry. Grabher and van Tuijl (2020) explore in how far the platform model can be seen as a successor of the network form of organizing business-to-business relations – a recalibration of governance in GPNs geared to the digital age.

More fundamentally, it seems useful for the GVC/GPN approaches to incorporate research on platform ecosystems. Contributions on this subject have focused on the interactions between different user groups (customers and complementors) and the platforms themselves (cf. Jacobides et al., 2018; McIntyre et al., 2021). This involves key mechanisms of platform governance, the nature of transactions and pricing, the modularization of platforms and the extent to which platforms are open or closed. Research on platform ecosystems also addresses the specific role of technologies. Claussen et al. (2015), for instance, discuss the role of baseline technology of platforms: high-quality technologies can attract stronger complementors and more customers, but are also associated with higher investment costs. Cennamo et al. (2018) highlight the role of the platforms' technological complexity for the relationships between different actors in the platform ecosystem. They argue that high complexity creates opportunities for more specific products and services associated with specialized business strategies, which is not the case in ecosystems based on simple technology. Finally, questions of compatibility of technologies and switching costs arise – issues that are also addressed in the emerging debates on platform regulation and alternatives (Friederici & Lehdonvirta, 2021).

Such concepts offer promising starting points for GVC/GPN research as they discuss the variables that affect governance in platform ecosystems that increasingly shape economic sectors. Given the variation of platform business models and fields of activity, systematic research on their impact on GVCs is only at the beginning. As with the general platform discussion, this task for GVC/GPN researchers is complicated by ambiguities around the meaning of the term 'platform'. It is ubiquitous in public discourse but often lacks a clear definition that is valid across platform business

models in diverse areas that cover labour intermediation, credit card services, retail, mobility services, industrial data and many others.

VARIETIES OF DIGITAL CAPITALISM, INTANGIBLES, PLATFORMS: INSIGHTS FROM THE CONTRIBUTIONS OF THIS SPECIAL ISSUE

This special issue on 'Digital Transformation and Value Chains' aims to deepen our theoretical understanding of the relationship between present day digitalization and geographically fragmented production by means of conceptually oriented papers and empirical case studies.

The common point of departure for all contributions is an acknowledgement of the relevance of current technological changes that must be analysed in their social embeddedness. They focus on what is specific about the present wave of technological change, which is rather obscured by the catch-all phrase digitalization. After all, digitalization has been expanding steadily over several decades, thereby consecutively opening up new possibilities for automating and coordinating economic processes, such as the proliferation of computerized numerical control equipment for industrial automation (Krzywdzinski, 2021), the emergence and widespread use of the internet (Gereffi, 2001b; UNCTAD, 2017; Wu & Gereffi, 2018) and the proliferation of enterprise software (Bloom et al., 2014; Zuboff, 1988). In the context of this special issue, however, we are more specifically addressing the impact of a bundle of new technologies and organizational forms related to IoT and AI, themselves inextricably interwoven, which we interpret as new base technologies for economic development. Even though technology-centric projections of new industrial revolutions and disruptions of work should be handled with care (cf. Briken et al., 2017; Butollo & Schneidmesser, 2021), we maintain that these technologies represent more than a hype as they represent lasting opportunities to take economic advantage of data (Lee, 2018; Mayer-Schönberger & Ramge, 2018; Sturgeon, 2019).

By choosing the term 'digital transformation', we focus not on the analysis of technologies as such, but on the economic and societal consequences of technological change, which is always socially mediated. Building on insights from science and technology studies (MacKenzie & Wajcman, 1999), technology is understood as socially constructed and implemented in conjuncture with organizational and social innovations in *sociotechnical systems*. The resulting discourses affect priorities of activity and investments are always institutionally shaped, be it at the level of research funding, political regulation or workplace-based bargaining. Consequently, digitalization should not be treated as a monolith, as a set of pre-defined practices that hit society as if it would originate outside of it. There is always variation and there are alternatives to each choice. Digitalization should be understood as a realm of possibilities that can be taken up by agents with their distinct interests and ideas in the context of given social relations.

New paradigms can evolve in a competitive manner out of experimental modes of innovation. In a slight adaptation of a well-known metaphor by Piore and Sabel by which they describe their pragmatic perspective on enterprise strategies, digitalization can be conceived of as a 'branching tree – yet the limbs of this tree thrive or wither according to the outcomes of social struggles, not some natural law of growth' (2000: 15). For research perspectives addressing globally fragmented production today, this insight about the heterogeneity and variation of *digitalizations* is particularly relevant. Given the considerable range of political choices concerning regulation and the path dependencies in different world regions, we believe it is useful to speak of *varieties of digital capitalism*.

This issue of regional variation cuts across the contributions in this special issue. Yang provides insights in the cross-border investments by the tech giant Alibaba in South-East Asia and thereby provides testimony to the strength of Chinese internet companies that have begun to significantly shape retail in Asia. The contributions by Butollo and Schneidmesser (2022) as well as by Lechowski and Krzywdzinski (2022) address the emergence of industrial internet platforms in Germany where they expand based on the traditional strengths of German manufacturing that is experiencing a digital update. Sancak (2021) also highlights regional varieties in digitalization as she compares the interaction of Turkish and Mexican firms at supplier platforms of major automotive firms and finds considerable variation, especially concerning the governance approaches by lead firms from Germany, Japan and the United States.

A second leitmotif that runs through several contributions is the question of whether the centre of gravity of value creation and distribution is shifting towards greater relevance of non-material or intangible service activities. This theme, addressed in *Butollo and Schneidmesser's* account of industrial internet platforms (2022), echoes prior debates about the role of intangible assets. As data come to be indispensable for innovative purposes and transactions, industrial internet platforms become important service providers and intermediaries in industrial value chains. *Lechowski and Krzywdzinski* (2022) focus on the role of data in industrial value chains as well, by showing how competition about the control of data and the struggles to avoid proprietary lock-ins are shaping the strategies of actors and become an important theme of industrial policies. In the garment industry, as analysed by *López et al.* (2021), and the fresh fruits industry, as described by *Yang* (2021), the capture of data is instrumental for matchmaking and distributive functions that are key competences in supply chains that are geared towards greater responsiveness to fluctuations in market demand. Also in the 3D printing industry, the trajectory of which is investigated by *Johns* (2021), the capture of data and the ability to control design processes is of critical importance for competitiveness in the evolving value chains. Data are also transforming firm strategies in a different way: as *Gallemore et al.* (2022) argue, the availability of deforestation intelligence affects the governance of mining, forestry and agricultural industries. The outcomes depend on whether the data are provided in proprietary or open innovation systems.

An issue of utmost political relevance concerns the question of whether platform business groups can accumulate power and emerge as new lead firms in GVCs. *Howson et al.* (2021) do a deep dive into the anatomy of platform business models, which they investigate in the case of labour platforms. Based on extensive action-based research associated with the globally organized Fair Work Network, they argue that digital labour platforms are a new type of lead firm that (1) optimizes production capabilities while externalizing ownership and costs; (2) accumulates both monetary and nonmonetary forms of value; and (3) concentrates power at the global scale in both existing and new sectors. *Yang* (2021) interprets platforms as a new type of lead firm as well. She analyses the cross-border expansion of Chinese platform conglomerates in the fresh fruits industry and shows how a vertical integration of the supply chains cuts out intermediaries, such as traditional traders, leading to dramatic restructuring in the sector. In other economic segments, the case seems less clear. As *Butollo and Schneidmesser* argue (2022), data privacy and asset specificity constitute obstacles for industrial internet platforms to acquire market dominance. They constitute a form of specialized service provider rather than a new kind of lead firm.

OVERVIEW OF THE CONTRIBUTIONS

López et al. (2021) analyse fast-fashion retailers' digital supply chain management strategies directed at enhancing supply chain speed, responsiveness and cost-efficiency, and at advancing the integration of offline and online sales channels. They highlight how, as a consequence, labour process transformations in garment manufacturing, logistic and retail heightened work intensity, not only in manufacturing, but also in logistics and sales functions.

Sancak (2021) discusses the use of online supplier portals (OSPs) operated by lead firms in the global auto parts automotive value chains on suppliers. She finds that OSPs reinforce existing governance structures as they are used in the context of arm's length relationships that do not require a lot of formalized exchange. OSPs can undermine upgrading opportunities since direct interactions are reduced to a formalized manner of communication.

Johns (2021) contributes an in-depth study of the additive manufacturing industry from a GVC perspective. She focusses on the current practices of 3D printing and finds that the relevance of this technology varies greatly across industries. It can amount to a replacement to former technological paths (as in dental implants) or be used in a complementary manner along traditional production methods. However, even in the latter case, supply-chain restructuring can be a result as suppliers can reposition themselves vis-à-vis the lead firms by using additive manufacturing to change their product and service offerings.

Gallemore et al. (2022) discuss the immediate impact of new digital tools for monitoring forest- and land-cover change on GVC governance as companies adapt these technologies and they become a de-facto standard. The authors

argue that monitoring technologies' effects on GVCs will likely depend on their accessibility. Proprietary technologies favour large-scale operations and already established lead firms, while open technologies could support more inclusive, equitable and sustainable value chains.

Yang (2021) traces the dramatic restructuring of the Southeast Asia – China fresh fruits export trade and distribution networks because of the penetration of digital platforms. She analyses a cross-border expansion of Chinese platform conglomerates and shows how a vertical integration of the supply chains cuts out intermediaries, such as traditional traders. She sheds light on the power of digital platforms as new types of lead firms in the emergence of China market-oriented Southeast Asian fresh fruit production and trade networks.

Similar to Yang's contribution, Howson *et al.* (2021) interpret platforms as a new type of lead firm. Based on extensive action-based research associated with the globally organized Fair Work Network finds that digital labour platforms (1) optimize production capabilities while externalizing ownership and costs, (2) accumulate both monetary and nonmonetary forms of value and (3) concentrate power at the global scale in both existing and new sectors.

The contributions by Butollo and Schneidmesser (2022) and Lechowski and Krzywdzinski (2022) both deal with the impacts of newly emerging industrial internet of things (IIoT) platforms on industry governance. Butollo and Schneidmesser (2022) analyse power relations between IIoT platforms and industrial companies and conclude that processes of power accumulation on the side of the platforms are possible, but not as evident as in the consumer-oriented internet.

Lechowski and Krzywdzinski (2022) present case studies of established German firms that have developed IIoT platforms or components for cloud-based 'smart manufacturing' services and describe the firms' positions within the multi-layered IIoT stack. They argue that control of bottleneck technologies represents an important source of power in the IIoT value chains and they discuss if novel national and EU-level industrial-policy initiatives may reshape these power relations.

As a whole, the contributions underline that the digital transformation of industries not only affects production technologies at the single-company level but also amounts to systemic changes that concern the mechanism of coordination between firms and thus key aspects of governance and industrial upgrading. This set of findings is of great practical importance because they highlight key aspects of firm strategy, industry governance and political regulation that need to be addressed.

This is a beginning. New questions will emerge concerning the rise of tech companies across multiple industries in the natural resource, manufacturing and service sectors and whether this creates a new digital divide in terms of social and environmental upgrading and development. The frameworks used in this special issue should help us address these topics.

CONFLICTS OF INTEREST

None of the authors has any conflicts of interest related to this manuscript.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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ENDNOTE

¹ Since the need to relate the issue of technological change with theories on fragmented globalized production relates from both 'schools of thought' – GVC and GPN research –, we use the respective terms interchangeably here, notwithstanding their theoretical differences. The contributions in this special issue vary with regard to which framework they relate.

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How to cite this article: Butollo, F., Gereffi, G., Yang, C., & Krzywdzinski, M. (2022). Digital transformation and value chains: Introduction. *Global Networks*, 22, 585–594. <https://doi.org/10.1111/glob.12388>