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GLOBAL VALUE CHAINS AS COMPLEX SYSTEMS

An evolutionary approach to global value chains: key research topics

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ABSTRACT The globalization of economic activities has led to the spatial fragmentation of production processes. Consequently, it has driven the growth of global value chains and global production networks. This means that products and services cross borders multiple times during their production. In this context, an established body of literature has effectively explained how these production processes contribute to economic development. However, recently, the literature in evolutionary economic geography has started to propose alternative methods, concepts and theories to address such issues and complement existing knowledge. This paper discusses these developments by summarising the main research areas where this cross-fertilization has occurred. Moreover, it examines these topics in detail to highlight gaps and suggest directions for future research.

KEYWORDS global value chains; evolutionary economic geography; capabilities; linkages; relatedness; economic complexity

CADENES GLOBALS DE VALOR COM A SISTEMES COMPLEXOS

Un enfocament evolutiu per a les cadenes de valor globals: temes clau de recerca

RESUM *La globalització de les activitats econòmiques ha portat a la fragmentació espacial dels processos de producció. Per tant, ha impulsat l'augment de les cadenes de valor globals i les xarxes de producció globals. Això significa que els productes i serveis travessen fronteres diverses vegades durant el seu procés de producció. En aquest sentit, existeix una bibliografia consolidada que ha explicat amb èxit com aquests processos de producció contribueixen al desenvolupament econòmic. No obstant això, recentment, la literatura sobre geografia econòmica evolutiva ha començat a proposar mètodes, conceptes i teories alternatius per abordar tals problemes i complementar la literatura existent. Aquest document participa en aquests debats en resumir les principals àrees de recerca en les quals s'ha produït aquesta fertilització creuada. A més, aquest document aprofundeix en aquests temes de recerca per subratllar les bretxes existents i proposar vies per a futures recerques.*

PARAULES CLAU *cadenes de valor globals; geografia econòmica evolutiva; capacitats; connexions; afinitat; complexitat econòmica*

Introduction

Nowadays, products and services cross borders multiple times during their production process. Some factors, such as the reduction of transport costs, the development of ICTs, and the implementation of favourable trade policies, have fostered the globalization of economic activities for many years (Antràs, 2020). This spatial fragmentation of production processes has led to the rise of global value chains (GVCs) and global production networks (GPNs) (Gereffi, 1999; Henderson *et al*., 2002).

In this regard, the literature defines GVCs as production processes in which the different stages, from product design and R&D to after-sales services, are distributed across various territories (Kowalski *et al*., 2015). For instance, consider the production of a smartphone. It could be designed in the United States, manufactured from African minerals, assembled in multiple countries across Asia, and then shipped to Europe or South America. As can be seen, it is challenging to precisely identify where this product was produced. The final product results from the aggregation of value added at different locations. Additionally, the various production stages contribute differing levels of value added (e.g., R&D typically generates more value than assembly or logistics) (Mudambi, 2008). Consequently, this has significant implications for the economic development of territories involved in GVCs.

There is extensive scientific literature analysing GVCs and GPNs. This body of work has been successful over recent decades in explaining the opportunities that such international trade structures provide for economic development. More recently, the literature in evolutionary economic geography (EEG) has contributed to debates around GVCs and GPNs by offering alternative methods, concepts and theories (Yeung, 2021; Boschma, 2022, 2024). This paper summarizes some of the topics in which the literature on GVCs and evolutionary economic geography has recently engaged. By doing so, this paper aims both to review some of the latest contributions in the field and to highlight new avenues for future research.

1. Economic upgrading and downgrading

Probably the most significant topic in the literature on GVCs is how value chains contribute to economic development (Gereffi, 1999). Therefore, when countries and regions around the world participate in GVCs, their primary aim is to climb the ladder and upgrade their value chains. This involves creating better products, producing them more efficiently and/or specializing in higher value-added functions and industries (Giuliani *et al*., 2005). Consequently, based on this definition, it is possible to distinguish between product, process, functional and sectoral upgrading.

From an evolutionary perspective, upgrading dynamics can be seen as path-dependent structural transformations. This implies that such diversification processes are not random but rather shaped by the capabilities that territories already possess. In this vein, local capabilities will be crucial to explain the upgrading trajectories of countries and regions across GVCs. In particular, the EEG literature has emphasized the importance of related capabilities in explaining diversification dynamics (Boschma, 2017). Then, economies tend to diversify into related economic activities, as measured by employment, patents, scientific publications, or export data (Hidalgo *et al*., 2018).

This evolutionary approach has recently been applied in a GVC setting by Hernández-Rodríguez *et al*. (2025a). Indeed, they found that European regions tend to diversify into related functions across GVCs. Furthermore, they observed that related capabilities also serve as a key driver for upgrading to more complex functions within GVCs. To define functional upgrading, they employed economic complexity metrics as an alternative to traditional frameworks such as the smile curve (Hidalgo & Hausmann, 2009; Stöllinger, 2021). In this context, economic complexity metrics measure the sophistication of functions in GVCs by combining the ubiquity of such functions and the diversity of regions (Balland *et al*., 2022).

Furthermore, this empirical analysis was extended to examine functional downgrading. It was found that regions with more related capabilities had fewer opportunities to experience functional downgrading. They defined functional downgrading as loosing the specialization in complex functions across GVCs. Subsequently, related capabilities serve both as a driving force to upgrade into more complex functions in GVCs and as an anchor to retain complex functions within GVCs. This adds to the existing literature on downgrading, which is still less studied than upgrading (Gereffi, 2019).

However, although these recent contributions have begun to propose new evolutionary frameworks for approaching upgrading and downgrading in GVCs, there remain many research opportunities. Firstly, the focus has been on functional upgrading and downgrading. Therefore, similar empirical approaches could be applied to product, process, and sectoral upgrading and downgrading (Giuliani *et al*., 2005). Secondly, alternative data sources could be utilized to capture functional upgrading and downgrading (e.g., Coveri & Zanfei, 2023). Thirdly, new empirical analysis at the national level can assess whether the same patterns continue to apply when zooming out from the regional scale. The geographical scope of GVCs dynamics remains a key issue within the literature (Crescenzi & Iammarino, 2017; Iammarino, 2018).

2. Complementary linkages

Global value chains mainly revolve around connections. Specifically, GVCs refer to the existing input-output linkages across territories within production processes. Such linkages serve as global pipelines of knowledge (Morrison *et al*., 2013). They can function as sources for acquiring new capabilities, which is especially important for developing countries and regions (Pietrobelli & Rabellotti, 2011).

In this context, a key concept in the GPN literature emerges: strategic coupling (Coe *et al.*, 2004). It is defined as the alignment sought between a region's assets and the needs of leading global firms. Consequently, territories can align their local capabilities with those needed by others in the global economy to build on each other and promote knowledge exchange (Yeung, 2021; Boschma, 2022, 2024). This approach is particularly effective when GVC connections are formed considering complementary capabilities. Indeed, the literature in EEG highlights the importance of complementary knowledge in diversification dynamics (Boschma & Iammarino, 2009; Balland & Boschma, 2021).

Recently, Hernández-Rodríguez *et al*. (2025b) have applied this concept of complementary capabilities to a GVC framework. It was found that European regions connected to other regions offering complementary capabilities were more likely to upgrade to more complex functions within GVCs. Furthermore, such regions were also less likely to experience functional downgrades in GVCs. These findings also considered the existence of locally related capabilities, as highlighted in the previous section.

In any case, there remain many new opportunities for further research on this topic. Specifically, additional theoretical contributions should be developed to better connect the concepts of strategic coupling and complementary capabilities. This will help link the literature on GVCs and GPNs with that on EEG. Moreover, empirical papers exploring non-direct complementary linkages, such as second-degree neighbours, will deepen the current understanding of GVC linkages. For this purpose, network methods, widely used in EEG, could provide valuable insights into the ongoing discussions within the GVC literature.

3. Governance

The governance of GVCs is another vital aspect that affects both upgrading opportunities and downgrading risks. How power is allocated among the different actors within GVCs can be crucial for evaluating upgrading and downgrading dynamics (Gereffi *et al*., 2005). For instance, power may shift towards lead firms or global buyers, leading to different outcomes for other actors (Ivarsson & Alvstam, 2011; Ponte *et al*., 2019).

Traditionally, the literature on GVCs has identified five governance systems based on the distribution of power: hierarchy, captive, relational, modular, and market (Gereffi *et al*., 2005). However, from an empirical perspective, the challenge lies in how to effectively measure these power asymmetries (Dallas *et al*., 2019). This is why most contributions on this topic are qualitative, such as case studies. Therefore, to supplement these contributions with more quantitative analysis, certain methods derived from EEG can be utilized.

In particular, the use of network methods can enhance the understanding of power across GVCs. Recent contributions, such as Guan et al. (2020), have employed network centrality measures to proxy power in GVCs, including eigenvector, closeness, and betweenness centrality. These network centrality indicators consider territories as nodes connected through value-added linkages, as occurs in GVCs. Therefore, the centrality of such nodes can illuminate how

these actors hold central positions within these value-added trade networks. These indicators also benefit from publicly available databases on international and interregional input-output tables, which supply the necessary information to calculate centrality metrics (Dietzenbacher *et al*., 2013).

4. Resilience

Recent events such as trade wars, geopolitical shifts, and global pandemics have prompted us to reconsider globalization. In particular, the existing input-output relationships within GVCs have recently faced significant pressure in these turbulent times (Yeung, 2023). In this context, supply chain disruptions have jeopardized production processes through GVCs. This has sparked vigorous academic debates around concepts such as reshoring, nearshoring, friendshoring, and the resilience of GVCs (Capello & Dellisanti, 2024). These debates have also entered the public arena, especially regarding the European Commission's Strategic Autonomy policy.

However, the mainstream approach to resilience in GVCs has adopted an engineering perspective, based on the idea of bouncing back to equilibrium. This contrasts with the evolutionary view on resilience, which refers to the ability to find new development paths during times of crisis (Boschma, 2015). In particular, the literature on EEG has demonstrated how territories can initiate new diversification dynamics during such periods, building upon existing local related capabilities (Balland *et al*., 2015; Steijn *et al*., 2023).

This evolutionary approach to resilience could be applied within GVC settings. Specifically, the ability of territories to enter GVCs during turbulent times should be further studied. This would enhance understanding of crises as opportunities for engaging in global production processes. Moreover, it is not only about entering GVCs but also about maintaining them during such periods. An evolutionary approach to resilience in GVCs could thus provide insights into how territories participate in new value chains and sustain existing ones during crises.

Conclusions

This paper has emphasized how the literature on GVCs and EEG has recently converged on several issues. It has been underlined how the crossroads between both fields have offered, and still offer, many opportunities for cross-fertilization. In this vein, both fields have contributed with methods, concepts and theories to complement each other. By bridging both fields, the understanding of GVCs as engines of economic development has been improved.

In particular, this paper highlights four key research topics vital to the nexus of GVCs and EEG literatures: economic upgrading and downgrading, complementary linkages, governance and the resilience of GVCs. It emphasizes how recent contributions have begun to explore these areas, demonstrating the strong potential for linking both fields. Additionally, although some recent work has been conducted, several questions and gaps in the literature still need further investigation. This paper discusses some of these gaps.

However, it is important to emphasise that the topics discussed above do not form an exhaustive list. Many other subjects merit investigation through an evolutionary perspective. For instance, the concepts of social and environmental upgrading and downgrading are highly contentious within the literature on GVCs. Additionally, the role of institutions in influencing diversification dynamics in GVCs remains vital (Rodríguez-Pose, 2021). Furthermore, if the benefits of GVCs are greater for some regions than others, it is essential to consider spatial cohesion and convergence.

Finally, all the research topics discussed in this paper are relevant to public policies. How territories participate in GVCs, and how the benefits and costs are shared among them, are urgent issues for policymakers worldwide. Therefore, research on these topics should always remember to include this public policy dimension when exploring and deriving findings from both empirical and theoretical contributions.

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