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Nearshoring and re-shoring in emerging markets

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Reshaping global value chains: nearshoring and re-shoring in emerging markets

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Abstract

This paper investigates the ongoing transformation of global value chains (GVCs), focusing on nearshoring and re-shoring in emerging markets. By examining the reconfiguration of production networks across Asia and Europe, the study seeks to identify the leading actors and regional production hubs driving these changes. We combine input-output analysis with network-based methodologies to map key players and characterize the structural features of GVCs within and across world regions. Our analytical framework integrates several methodological tools: Markov chain models to trace transitions in trade flows over time (Wirkierman et al., 2024); community detection techniques applied to the World Input-Output Network (Piccardi et al., 2018); value-added trade decomposition using TiVA data (Bontadini et al., 2025; Los et al., 2015); and the Pass-Through Frequency approach (Inomata & Hanaka, 2024). Through this multidimensional approach, the paper aims to shed light on the structure of intra-regional value-added flows and the evolving strategic roles of countries within global production systems.

Keywords: Global value chains, Emerging markets, Regional clusters
JEL: F14 e F6

1. Introduction

In recent years, the resilience of global production systems has become a central concern for firms, policymakers, and scholars. The unprecedented disruptions caused by the COVID-19 pandemic, followed by geopolitical tensions and trade policy volatility, have exposed the vulnerabilities of highly interconnected global value chains (GVCs). These developments have revived longstanding debates in international economics and strategic management over how production networks should be designed, governed, and geographically configured in a rapidly changing global environment.

At the heart of this debate lies the question of whether we are witnessing a fundamental reorganisation of GVCs. While some argue that globalisation is being replaced by more regional or bilateral forms of economic integration (Javorcik, 2020), others suggest that global networks are simply evolving, not retreating (Miroudot, 2020).

Europe and Asia appear to be on two slightly different trajectories. The former exhibits very strong integration on the sourcing side, despite a declining trend that has reversed since 2012, while catering increasingly to final demand from outside Europe. The latter in contrast has been on a steady path towards regionalisation strengthening both upstream and downstream linkages within Asia (Bontadini et al 2025). While most of the literature has focused on the intensity of GVC participation, empirical evidence on the *structure* and evolution of these dynamics remains limited, especially from a systemic and network-based perspective.

This paper addresses a key research gap: the lack of comprehensive, data-driven analysis of production networks' structural configuration and interdependencies involving Europe and the Asia-Pacific region. While previous studies have mapped value-added flows using input–output data (Los et al 2012, Bontadini et al 2025), few have examined these networks' topological and probabilistic dimensions or assessed their exposure to global demand shocks using a combination of input-output analysis and network theory (Amador and Cabral, 2017, Fagiolo et al 2010). In addition to this, the evidence looking at Asian countries has been particularly scant. This is despite the region having undergone the most significant changes in terms of economic growth and integration over the past two decades.

This has been characterised by the stark emergence of China as a major actor both globally and regionally which has overtaken economic incumbents such as Japan and South Korea, as well as significant strides on the part of smaller South-East Asian economies such as Vietnam, Thailand and Malaysia.

The main objective of this study is to explore how global production is organised and how dependencies are distributed across countries and sectors, with a particular focus on the Asia-Pacific region drawing a comparison with Europe. The core research question guiding this work is: *how has the structure of global*

production network in Asia and Europe changed? How have dependencies evolved over the past three decades?

This research is significant for both academic and practical reasons. From a scholarly perspective, it contributes to the growing literature on GVC resilience and restructuring by introducing a network-based methodology that goes beyond conventional trade statistics. From a managerial and policy perspective, it provides insights into the relative importance of different country-sector nodes in sustaining regional clusters. It highlights the structural constraints and opportunities for supply chain diversification.

The conceptual foundation of this study draws on theories of complex networks and input–output analysis. In particular, it builds on recent applications of Markov chains, community detection, and value-added propagation to study production interdependencies (Wirkierman et al., 2024, Piccardi et al 2018). This theoretical lens allows us to interpret the global economy as a system of probabilistic linkages, where economic flows dynamically shape structural centrality and interdependence.

Methodologically, the paper adopts a quantitative approach based on the OECD Inter-Country Input-Output (ICIO) tables, covering 76 economies and 45 sectors between 1995 and 2019. We model production networks as directed and weighted graphs. We apply a combination of absorbing Markov chains, steady-state transition models, community detection algorithms, as well as value added and pass-through frequency (PTF) measures to analyse value-added flows' structure and propagation dynamics.

The paper is organised as follows. Section 2 reviews the relevant literature and outlines the research question. Section 3 presents the data and empirical strategy, including the construction of the global input–output network and the analytical tools used. Section 4 reports the results of the analysis, structured in four parts: identification of key players, analysis of regional clusters, assessment of nearshoring and farsharing patterns, and mapping of interdependencies. Section 5 concludes with a discussion of the main findings, their implications, and avenues for future research.

2. Literature review

The growing volatility of global trade dynamics, exacerbated by recent geopolitical disruptions such as the COVID-19 pandemic and the Russian invasion of Ukraine, has reignited academic and policy debates on the resilience, configuration, and future of Global Value Chains (GVCs). Traditional models of globalisation are increasingly being challenged by the emergence of alternative patterns such as nearshoring, friendshoring, and the regionalisation of production systems (Baldwin & Evenett, 2020; Bontadini et al., 2022; 2024; WTO, 2021). These phenomena have exposed the fragility of hyper-globalised supply networks, bringing into sharper

focus long-standing questions regarding structural dependencies, production sovereignty, and the spatial distribution of economic power (UNCTAD, 2023; OECD, 2022).

Empirical studies have long debated whether the global economy is entering a phase of de-globalisation or simply undergoing a reconfiguration in the geography of production. While some evidence points to the persistence of global integration, albeit with slower momentum, recent analyses show growing regional clustering and increasing intra-regional flows of value-added, particularly in Europe and Asia (Los et al., 2015; Klimek et al., 2015; Zhong & Su, 2021; Bontadini et al., 2024). This duality is well illustrated in recent work on European trade patterns, emphasizing the co-existence of nearshoring in upstream sourcing and farsharing in downstream demand, challenging binary interpretations of global versus regional strategies (Bontadini et al., 2024).

To assess such dynamics, input–output methodologies have provided a robust analytical foundation to trace the fragmentation and recomposition of production across borders. However, traditional Trade in Value Added (TiVA) decompositions often fall short in capturing the dynamic, topological, and systemic properties of GVCs. In response, scholars have increasingly proposed combining input–output models with network analysis and stochastic processes to move beyond bilateral trade metrics and explore the deeper architecture of international production (Piccardi et al., 2018; Moosavi & Isacchini, 2017; Hou et al., 2018, Amador & Cabral 2017).

Among these emerging approaches, Markov chain models have gained traction. These methods enable the construction of transition matrices that describe the probability of value-added flowing from one country-sector to another. The resulting steady-state distributions, interpreted as eigenvectors of the transition matrix, reflect the long-run structural importance of each node in the network (Moosavi & Isacchini, 2017). In turn, absorbing Markov chains allow for the identification of final demand sinks and enable shock simulations in which key suppliers are removed, thus assessing the robustness and substitutability of global supply systems (Duchin & Levine, 2010).

In parallel, the application of network centrality measures, such as degree, eigenvector, and betweenness, has provided further insights into the role of country-sector nodes in mediating value-added flows (Blöchl et al., 2011; Wirkierman et al., 2024). While these indicators are useful in capturing influence and control in the network, they often rely on static snapshots and do not reflect economies' dynamic exposure to demand propagation.

To overcome these limitations, Piccardi et al. (2018) introduced a random walk-based framework that reveals how communities of production emerge not from institutional or geographic affiliation, but from functional

co-visitation within the input–output network. This method identifies sectoral blocs based on the frequency with which value-added passes through country-sector pairs, uncovering endogenous integration clusters.

Beyond identifying communities within input-output networks, the literature has also focussed on the importance of specific nodes in connecting suppliers and buyers. Inomata and Hanaka (2024), put forward the Pass-through Frequency (PTF) indicator, which quantifies how frequently a country-sector node is visited along the propagation paths of global demand. PTF thus offers a probabilistic measure of systemic exposure, capable of identifying which economies are structurally central to the transmission of global shocks.

These methodological innovations have also resonated with the policy community. Institutions such as the OECD (2022), WTO (2021), and UNCTAD (2023) have stressed the importance of moving beyond bilateral trade measures to monitor systemic risk, structural asymmetries, and regional interdependence in GVCs. Considering emerging technologies, environmental sustainability, and geopolitical fragmentation, these bodies increasingly promote analytical tools that account for global production's complexity, asymmetry, and path-dependence.

This paper builds on these theoretical and methodological contributions by integrating absorbing Markov chains, steady-state transition models, random walk-based community detection, and pass-through frequency metrics to analyse the structural evolution of global production networks between 1995 and 2019. In particular, the analysis proceeds along four directions: first, identifying key players in the Asia-Pacific region by applying Markov chain models to trace value-added propagation; second, mapping the internal structure of regional production communities through community detection techniques applied to the Asia-Pacific Input–Output Network; third, examining the dynamics of nearshoring and farsharing using TiVA-based indicators of backward and forward participation; and finally, evaluating interdependencies among major actors in Asia and Europe by employing the PTF indicator, which captures the frequency and exposure of nodes to global demand propagation.

In doing so, the paper contributes to academic and policy debates on how global value chains are evolving and how countries and firms might strategically reposition themselves within increasingly complex and fragmented production architectures.

3. Data and empirical strategy

3.1 Data

The empirical analysis relies on the OECD's Inter-Country Input-Output (ICIO) tables, which provide harmonised global input-output data for 76 economies and 45 industries from 1995 to 2020. The ICIO framework enables the decomposition of gross trade flows into value-added terms, thus allowing us to capture

direct trade relationships and the underlying structure of production interdependencies across countries and sectors.

The most recent release of the ICIO (2023 edition) is particularly relevant for the scope of this paper, as it includes for the first time a broader representation of emerging and developing economies, particularly in Africa (e.g. Egypt, Nigeria, Morocco, Tunisia, Cameroon, Côte d'Ivoire, Senegal, South Africa). This extended geographical coverage enables a more accurate assessment of potential shifts in global production hubs, including the role of African economies in the context of nearshoring and trade reconfiguration strategies.

All variables used in the analysis are derived from the intermediate consumption block of the ICIO table, which contains detailed bilateral input-output linkages between country-sector pairs. From this block, we construct weighted and directed networks for each year 1995–2019. Each node in the network represents a country-sector pair, and each edge corresponds to a flow of intermediate inputs from one node to another, weighted by the monetary value of the transaction. To ensure consistency in longitudinal comparisons and reduce the effect of data revisions in the most recent years, we limit the empirical investigation to the years up to 2019. Trade flows are measured in current USD, and no deflation is applied, since the core of the analysis focuses on relative network structure and topology rather than on levels.

3.2 Empirical strategy

To address the research question and investigate the structural dynamics of Global Value Chains (GVCs), the empirical strategy combines four complementary analytical approaches: (i) Markov chain modelling, (ii) community detection in input–output networks, (iii) value added flows and pass-through frequency (PTF) indicators.

(i) Markov chain analysis is used to model the propagation of value-added through global production networks. For each year, we construct a row-stochastic transition matrix P, where each element P_{ij} represents the share of output from country-sector i that is used as input by country-sector j, following Wirkierman et al (2024), Duchin & Levine, (2010) and Moosavi & Isacchini (2017). By computing the steady-state distribution associated with each transition matrix, we identify which nodes (i.e., country-sectors) tend to accumulate the highest share of value-added over time. This allows us to quantify structural dependencies and detect persistent production hubs in Asia-Pacific and beyond.

(ii) Community detection is employed to analyse the structural organisation of regional production clusters in the Asia-Pacific and European area. We model the ICIO-based production network as a directed and weighted graph, where nodes represent country-sector pairs and edges capture the intensity of intermediate input flows. Following Piccardi et al. (2018), we apply a random walk-based community detection algorithm that identifies

group nodes with high probabilities of co-visitation, reflecting functional interdependencies in value-added exchanges, providing a snapshot of how production hubs and regional blocs are embedded within the global value chain architecture.

(iii) trade in value added (TiVA) flows have been a staple of GVC analysis in the literature, used to trace the intensity and direction of global production integration. We follow work in Bontadini et al (2025) (building on Los et al (2012), looking at foreign value added embodied in final demand to identify the extent to which final output of a country-industry relies on value added supplies by foreign partners. This measure adequately captures dependence in terms of the sheer quantity of value added that flows from one country to another, but it overlooks the dependence stemming from the fact that production chains might still pass through a country even if little value added is provided[1]. To account for this we complement our analysis with *Pass-through Frequency (PTF),* as developed by Inomata and Hanaka (2024), which captures how frequently a given country-sector appears along global value-added chains[2]. In this paper, PTF is used to assess the degree of interdependence between of both Asian and European economies vis-à-vis other countries, to identify which ones are most likely to propagate or absorb shocks within the global network.

The combination of these four methods allows us to assess not only the static topology of GVCs but also their dynamic properties, structural resilience, and potential reconfiguration paths in response to geopolitical shocks.

4. Results and discussion

4.1 Identifying key players in global value chains – the rise of China

We adopt a country-sector-specific perspective to identify the most influential actors within GVCs and apply eigenvalue centrality measures to the global production network. Following Wirkierman et al (2024) we identify the buyer and seller centrality with a Markov chain approach; these measures capture the likelihood of one dollar being absorbed by a buyer or generate by a seller. This interpretation allows us to assess the systemic importance of each country-sector pair in terms of its contribution to, or demand for, global production. The distinction between buyer and seller roles thus enables us to disentangle the dual nature of centrality in GVCs and to identify the major global buyers and sellers of value added.

[1] For example, China's contribution in value added terms – which is modest despite the large size of the Chinese economy – understates the fact that most production processes do pass through China and that should export from China come to a halt consequences for production can be significant, as it has been the case during the COVID-19 pandemic.

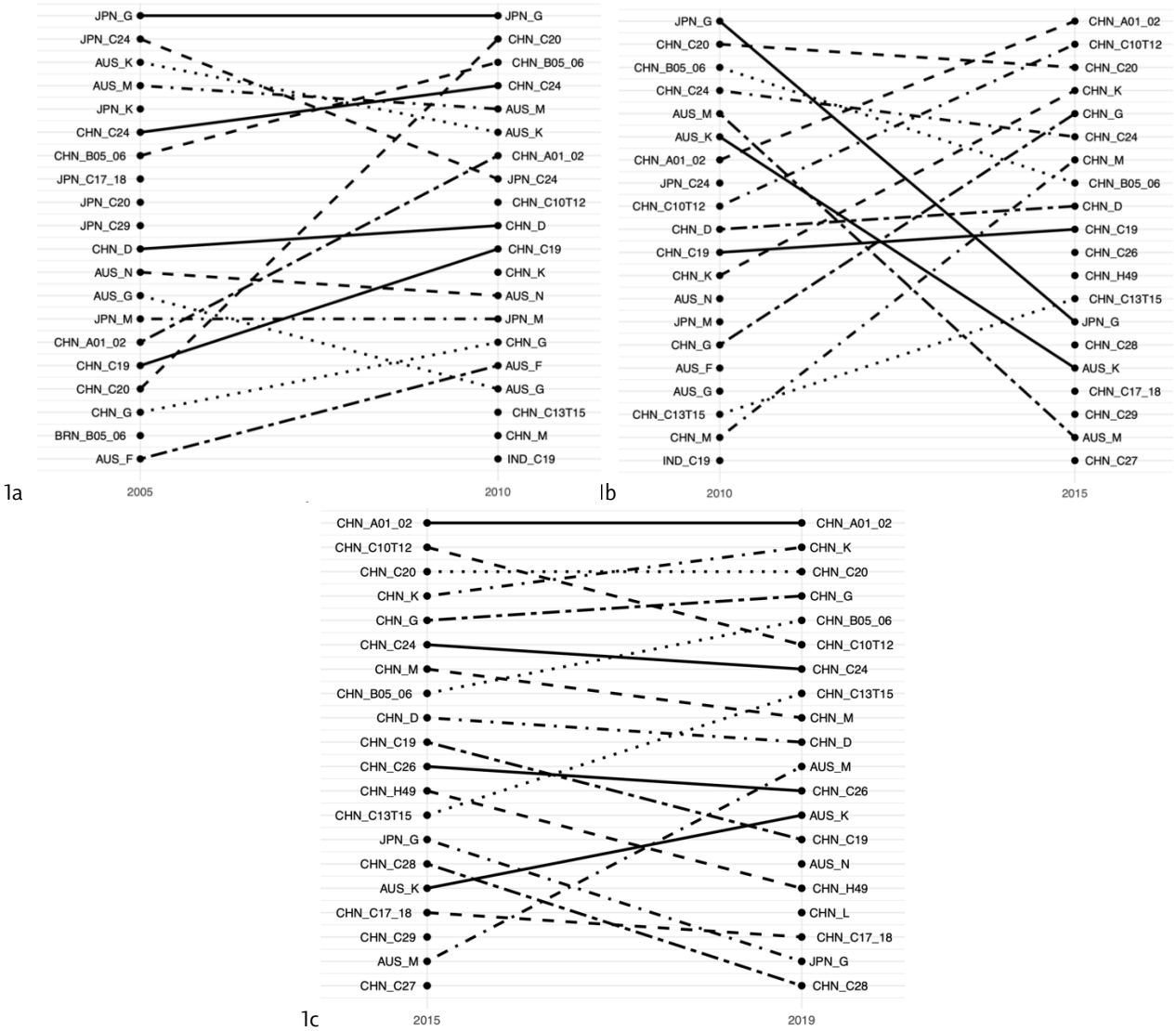
[2] Unlike standard centrality measures, PTF reflects the relative exposure of a node to value-added propagation, making it especially suited to quantify systemic importance and vulnerability to global demand shocks.

We develop this analysis over time (2005–2019) and focus on how the structure of buyers and sellers has changed at the top of the distribution, capturing changes in their strategic positions and the shifting balance of power within global production systems. By isolating country-sector pairs from economies such as China, Japan, South Korea, Thailand, Malaysia, Indonesia, Vietnam, India, and Australia, we identify the key players within this regional subset of the global production network. The analysis reveals how strategic sectors in Asia-Pacific economies have evolved in their role as both sellers and buyers of value-added within global value chains.

The steady growth in dominance of Chinese sectors is remarkable, to put this in perspective: China in 2005 had four sectors in the top 20 suppliers which has gone up to 16 by 2019. From 2010 onward, China industries have emerged as main suppliers across almost all periods with CHN_A01_02 (Agriculture), CHN_C10T12 (Food), CHN_C20 (Chemicals), CHN_K (Finance), and CHN_C24 (Basic Metals) consistently ranking in the top 10. This pattern confirms China's ascent as a multi-sectoral supplier in global networks, surpassing earlier leaders such as Japan and Australia. While Japan (JPN_G, JPN_C24, retail and basic metals, respectively) maintained prominence in 2005–2010, its ranking declined, with China increasingly centralizing the regional and global production structure.

Australia maintained a robust presence throughout the period, particularly as a supplier of financial (AUS_K) and professional services (AUS_M), although the Chinese sector gradually overtook its relative positions. Other economies like India (IND_C19 – Coke and refined petroleum) appear sporadically but do not sustain top rankings, suggesting a more volatile or specialized participation in the upstream nodes of GVCs.

Figures 1a to 1c. Top 20 Asia-Pacific sellers in GVCs: comparative ranking of sellers from 2005–2010, 2010–2015, and 2015–2019



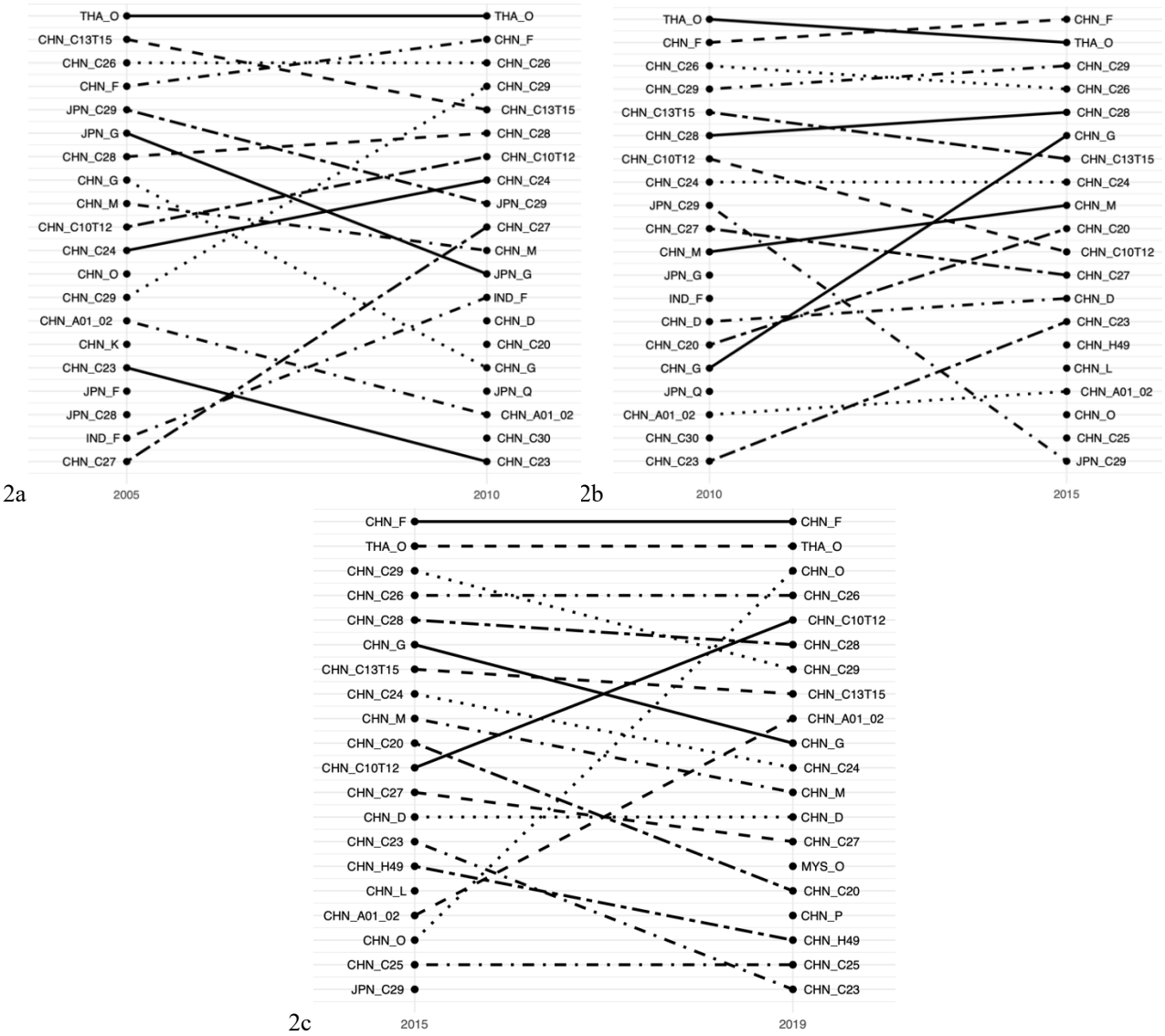
Note: Top 20 country-industries in the Asia-Pacific region for seller eigenvector centrality based on authors' own calculations on ICIO tables. Differences in line-type aim only to improve the Figure's readability.

Figures 2a to 2c present the top 20 Asia-Pacific buyers, showing the relevance of China as a demand hub even more clearly. Between 2005 and 2010, buyers like THA_O (Thailand – Public Administration), JPN_C29 (Japan – Motor Vehicles), and JPN_G (Wholesale and Retail) appear prominently. However, from 2010 onward, Chinese demand has surged across various sectors.

By 2015–2019, China dominated the buyer rankings, with CHN_F (Construction), CHN_C29 (Motor Vehicles), CHN_C26 (Electronics), CHN_G (Wholesale and Retail Trade), and CHN_C10T12 (Food) consistently at the top. This reflects of course the large size of China's final demand, which is a long-standing key destination of production. Its centrality has however only increased over the observed period of time and it is coupled with China's surge in centrality also as a supplier as documented in Figures 1a-1c.

Thailand (THA_O) maintains a stable position across all periods, reaffirming the strategic role of the Thai public sector within regional production networks. Japan's presence diminishes relatively but remains visible through sectors like JPN_C29 and JPN_Q (Health). New entries such as CHN_H49 (Transport) and CHN_L (Real Estate) in 2015–2019 further indicate China's domestic demand structure diversification.

Figures 2a to 2c. Top 20 Asia-Pacific buyers in GVCs: comparative ranking of buyers from 2005–2010, 2010–2015, and 2015–2019



Note: Top 20 country-industries in the Asia-Pacific region for buyer eigenvector centrality based on authors' own calculations on ICIO tables. Differences in line-type aim only to improve the Figure's readability

All in all, this first piece of evidence confirms China's growing a role as the key economic player in Asia and Pacific. This is only partially explained by China's large economic size. Furthermore, the evidence suggests that China has transitioned from being a large buyer to also being a key supplier to the rest of the Asian region,

reaching not only full integration but also dominance within Asian value chains. China's staggering rise within Asian value chains has coincided with the decline of other major players, especially Japan and Australia who have lost positions in the top 20.

In the Appendix we put these trends in the broader context of the global economy Figures A.1a to A.1c and A2.a to A2.c replicate our analysis looking at all countries, rather than just those in the Asia and Pacific area, looking at supplier and buyer centrality, respectively.

Here too, China's rise emerges quite strikingly, in 2005 no Chinese industry features in the top 20 sellers, by 2019 we find nine Chinese industries in the top 20. These not only include manufacturing activities but also professional and financial services.

Remarkably, only the US has retained its dominant position, while most European sectors have dropped out of the top 20 by 2015. The years after the financial crisis have seen a particularly strong churn in the ranking, with eight country-sectors dropping out of the top 20. By 2015, no European country-industry features in the top 20 anymore.

A similar pattern is observed when looking at buyer centrality where once again China goes from not featuring at all in 2005, to accounting for twelve out of 20 top buyers. What is also remarkable is that among the Chinese industries in the top 20 we find many manufacturing industries, while most other countries only see demand intensive industries such as real estate (F), public administration (O), health (Q) and distribution (G). These industries are likely to have high buyer centrality because they tend to produce very littler intermediate products and are therefore "sinks" of value added in the Markov Chain, i.e. they buy from many sectors but supply to very few. In contrast Chinese manufacturing industries like electronics (C26), food and beverage (C10T12), textile (C13T15) and automotive (C29), that do not share such characteristics, all feature in the among the top 20 buyers in 2019.

This shows, once again, China's two-sided integration in GVCs both as a buyer, not only through its large domestic final demand but also as a supplier for production reaching completion abroad.

The approach in this analysis takes into account changes at the top of the distribution of centrality. It is however important to assess production networks in their entirety, identifying which country-industries trade with one another and whether production communities emerge within Asia Pacific economies.

4.2 Structure of regional clusters in Asia-Pacific

Beyond the centrality of buyers and suppliers within production networks, it is also important to identify which countries and industries are linked to one another, forming production communities. Whit this in mind, we explore the structure of production networks within the Asia-Pacific region, applying a community detection

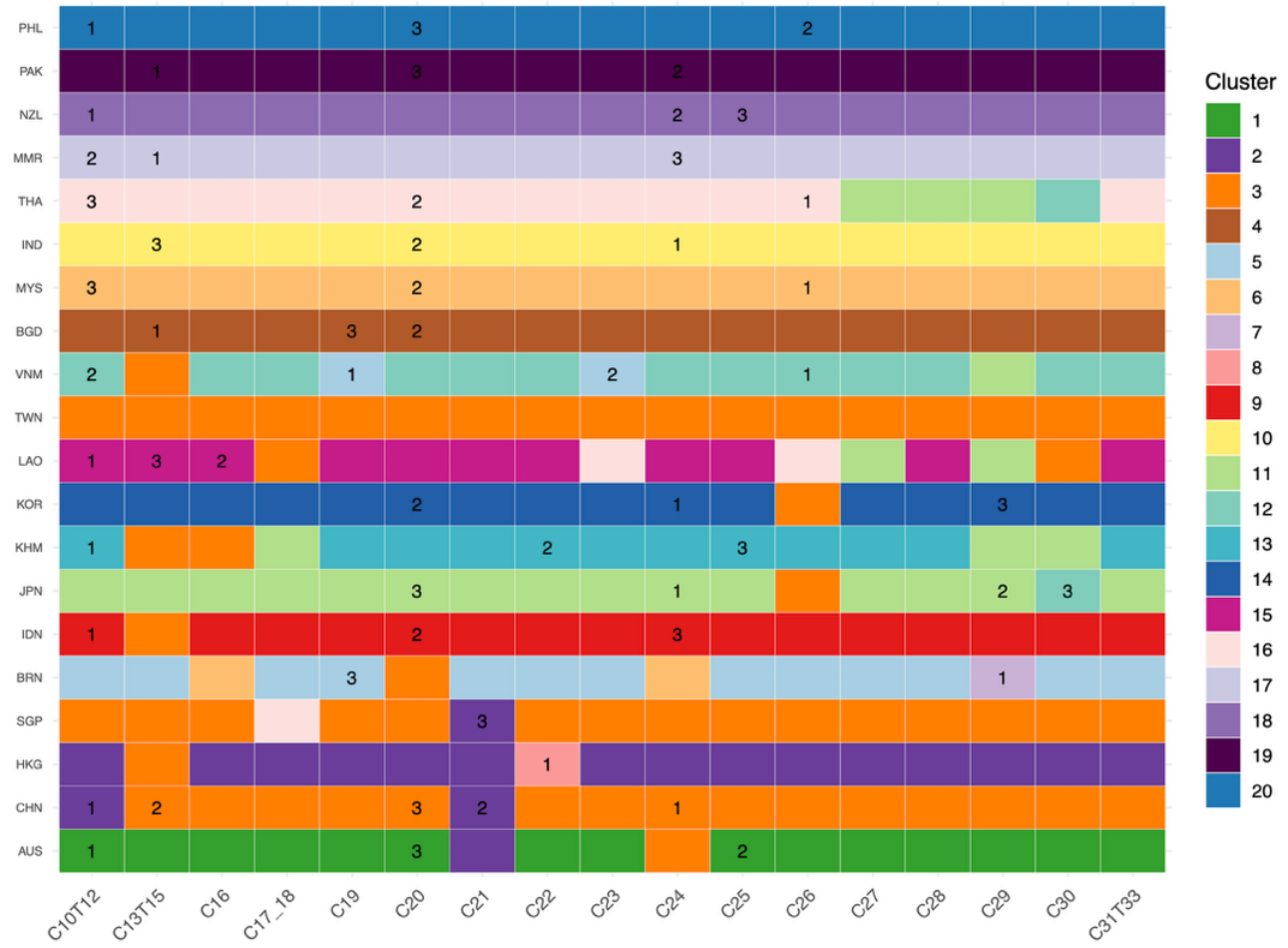
approach to the 2019 ICIO data. Following Piccardi et al. (2018), we model the global production system as a directed and weighted network, where nodes represent sector-country pairs and edges reflect the intensity of intermediate input flows between them. The resulting network, allows us to identify groups of country-sector nodes that are more densely connected among themselves than with the rest of the network, endogenously emerging production communities.

While Piccardi et al. (2018) focus on the temporal dynamics of community evolution, our analysis is cross-sectional and draws a comparison between the Asia-Pacific and the EU region. We use hierarchical clustering based on Markovian random walk distances, which captures the strength of direct linkages and indirect paths along which production flows circulate through the network. The logic behind this approach is very much in line with the analysis conducted in the previous section: nodes within the same cluster are likely to be frequently co-visited by a random walker traversing the network, indicating tighter economic interdependencies.

Each cluster detected in the Asia-Pacific subnetwork represents a functional production bloc, i.e., a set of sectors and countries with more strongly integrated intermediate input flows. The clusters do not necessarily align with geographical or institutional groupings but rather reflect the structure of value-added propagation embedded in the ICIO data. Naturally, groupings can be made based on who industries sell to or buy from, we explore and comment both in our analysis.

Figure 3 presents the community detection results for 21 Asia-Pacific economies and 18 sectors in 2019, based on seller similarity. We focus here on manufacturing industries since these significantly more exposed to international fragmentation compared to service industries. Each coloured cell indicates the cluster assignment of a country-sector pair, allowing us to trace the formation of cross-national sectoral groupings visually.

Figure 3. Community detection in the Asia-Pacific subgraph of the input–output network (2019) - Buyers



Note: Clusters detected through random walk-based community analysis applied to 21 Asia-Pacific economies and 20 ICIO sectors. Colours indicate endogenous clusters identified via co-visitation probability. Numbers within the cells denote sectoral leadership within each cluster: 3 represents the most central country-sector in that community, according to its relative share of intra-cluster flows. The figure shows communities from the perspective of buyers (i.e., intermediate demand), i.e. the intermediary flows matrix which in an input–output system represents how much sector i buys from another sector j. In this view, sectors are grouped together based on the similarity of their sellers.

One of the most salient clusters is the cluster 3, which brings together China, Singapore, and Taiwan. Within this community, China emerges as the dominant hub in several sectors, including chemicals (C20), basic metals (C24), fabricated metal products (C25), and textiles (C13T15). The numbers in these cells indicate the level of leadership within the cluster. It denotes the node with the most significant intra-community weight in value-added flows. This configuration highlights China's systemic role as a manufacturing powerhouse and key upstream supplier within regional value chains.

An interesting case is the C21-pharmaceutical products sector, where we observe the formation of a cluster number 2 that includes China, Hong Kong, Singapore, and Australia. This suggests a tightly integrated functional community possibly structured around complementary specialisations: manufacturing (China), logistics and re-export hubs (Hong Kong and Singapore), and high-tech or R&D segments (Australia). Once again, China leads the cluster, indicating growing influence even in sectors with higher technological intensity.

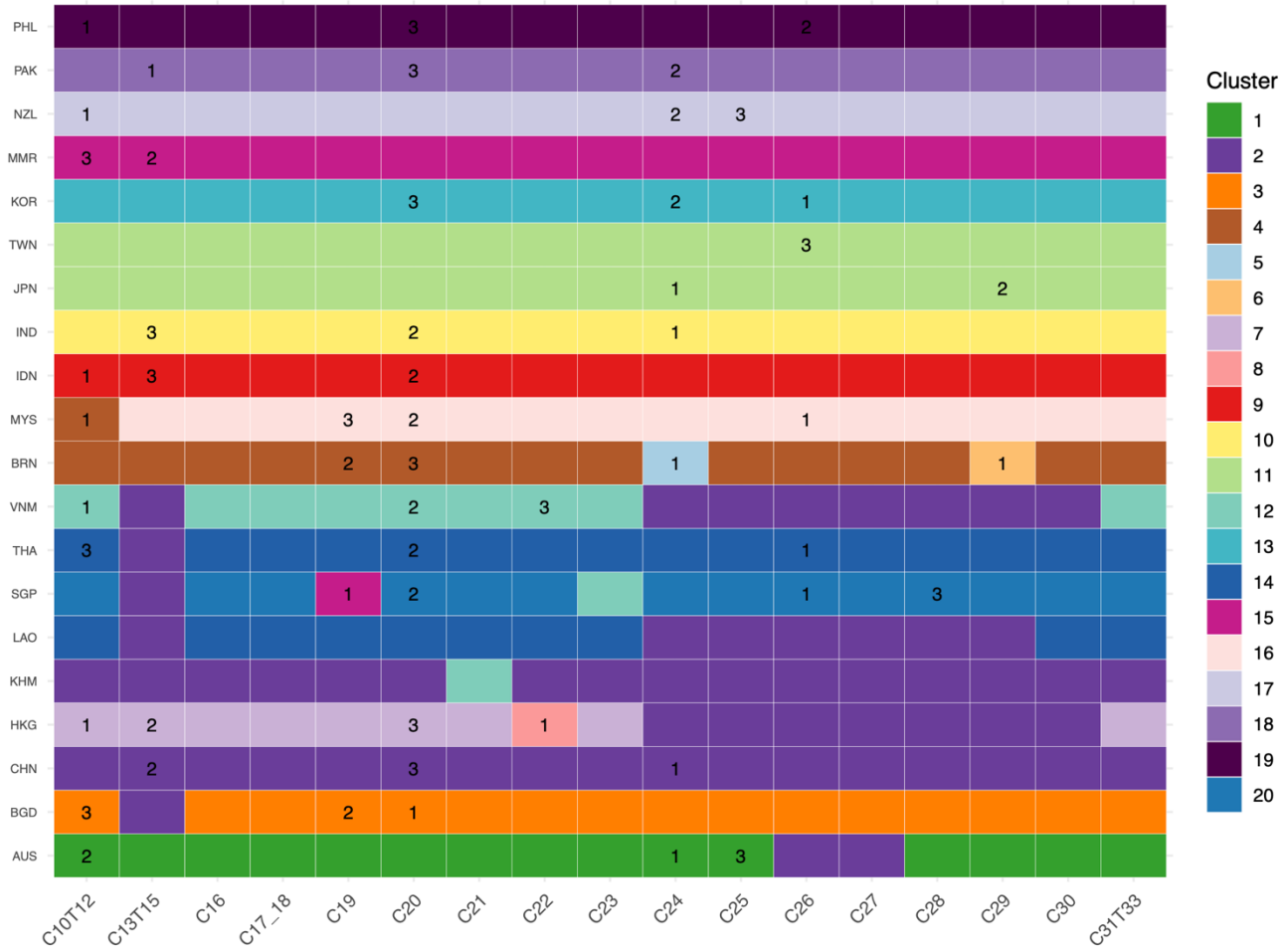
Another interesting finding is the cluster10 centred around industry C29 – transport equipment manufacturing – bringing together Japan, Vietnam, Thailand, Cambodia, and Laos. Although economically diverse, these countries are part of a broader regional production bloc likely structured around Japan as a central hub for assembly or design, with South-East Asian countries playing supporting roles in component production and intermediate processing. This pattern shows the coexistence of established hubs like Japan with emerging economies gaining relevance within the regional manufacturing system.

Figure 3 supports previous research findings, confirming that production communities are not necessarily national but form around value-added flows and functional integration. The Asia-Pacific network appears multipolar, with China acting as the dominant hub, while other countries such as Japan, Singapore, and Vietnam play structurally important roles within distinct clusters.

When we turn to the similarity in terms of buyers we find strikingly different patterns, a significant number of country-industries are grouped in a cluster dominated by China. This includes most of the manufacturing industries in Laos and Cambodia, half of those in Vietnam and many textile industries across the continent – such as Thailand, Singapore and Bangladesh.

Interestingly, this evidence also reflects some of the geopolitical alignment of countries. Taiwan which was clustered with China based on the supplier side, is now clustered with Japan. Hong Kong is also largely in a separate country from China and so are South Korea, Australia, India and New Zealand. Overall, it seems that the Asian-Pacific continent has sourcing (i.e. based on seller similarity) linkages cutting across the region shaped by input requirements while sales (i.e. based on buyer similarity) clearly identifies a cluster led by China and a constellation of more segmented clusters along country boundaries.

Figure 4. Community detection in the Asia-Pacific subgraph of the input–output network (2019) - Sellers



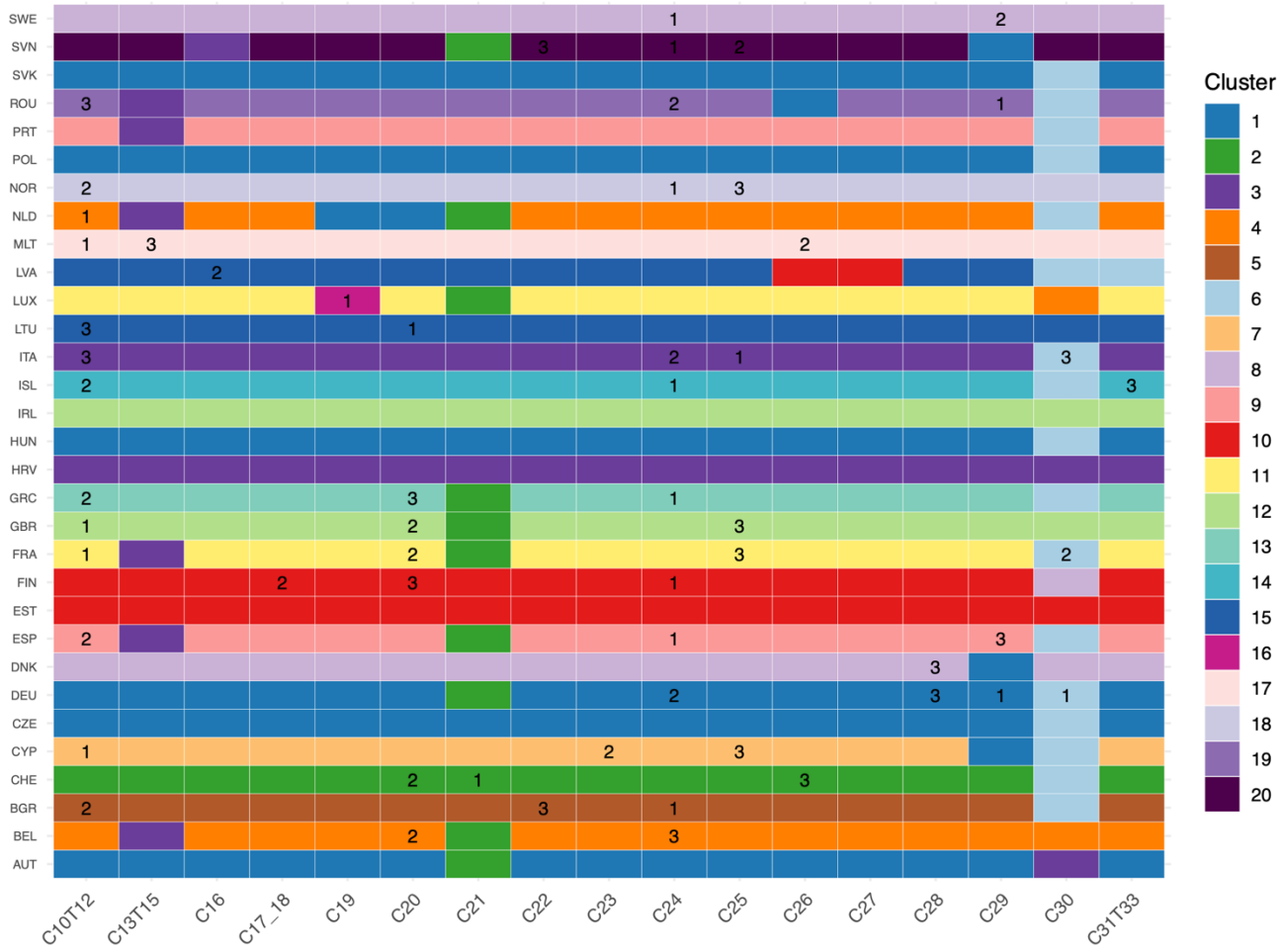
Note: Clusters detected through random walk-based community analysis applied to 21 Asia-Pacific economies and 20 ICIO sectors. Colours indicate endogenous clusters identified via co-visitation probability. Numbers within the cells denote sectoral leadership within each cluster: 3 represents the most central country-sector in that community, according to its relative share of intra-cluster flows. The figure shows communities from the perspective of buyers (i.e., intermediate demand), i.e. the transpose of the intermediary flows matrix which in an input–output system represents how much sector j sells to another sector i. In this view, sectors are grouped together based on the similarity of their buyers.

To help put this evidence in perspective, we also look at subgraphs for the European region – this includes 31 countries, i.e. the EU27 plus Norway, Switzerland and the UK. Naturally, Asian-Pacific and the European region are very different from one another with the latter being part of a much more regionally integrated economy and including high-income countries. The comparison is still meaningful to the extent that the EU can be viewed as a frontier of regional economic integration. In line with this, we find industries to be significantly more integrated across country lines both when looking at seller and buyer similarity.

Looking at the former, we find a big cluster headed by Germany that pulls in many other Eastern EU economies such as Poland, Czechia, Slovakia and Hungary. Italy heads another cluster that bleeds into the textile secotr (C13T15) of many other countries, i.e. France, Spain, Belgium, Romania and the Netherlands. In addition, a pharmaceutical (C21) cluster also emerge, tightly related to Switzerland. Finally, and remarkably, we find a

transport equipment manufacturing (C30, excluding vehicles) that cuts across most countries in the EU region headed by the three largest economies, i.e. Germany, France and Italy.

Figure 5. Community detection in Europe subgraph of the World Input–Output Network (2019) - Buyers

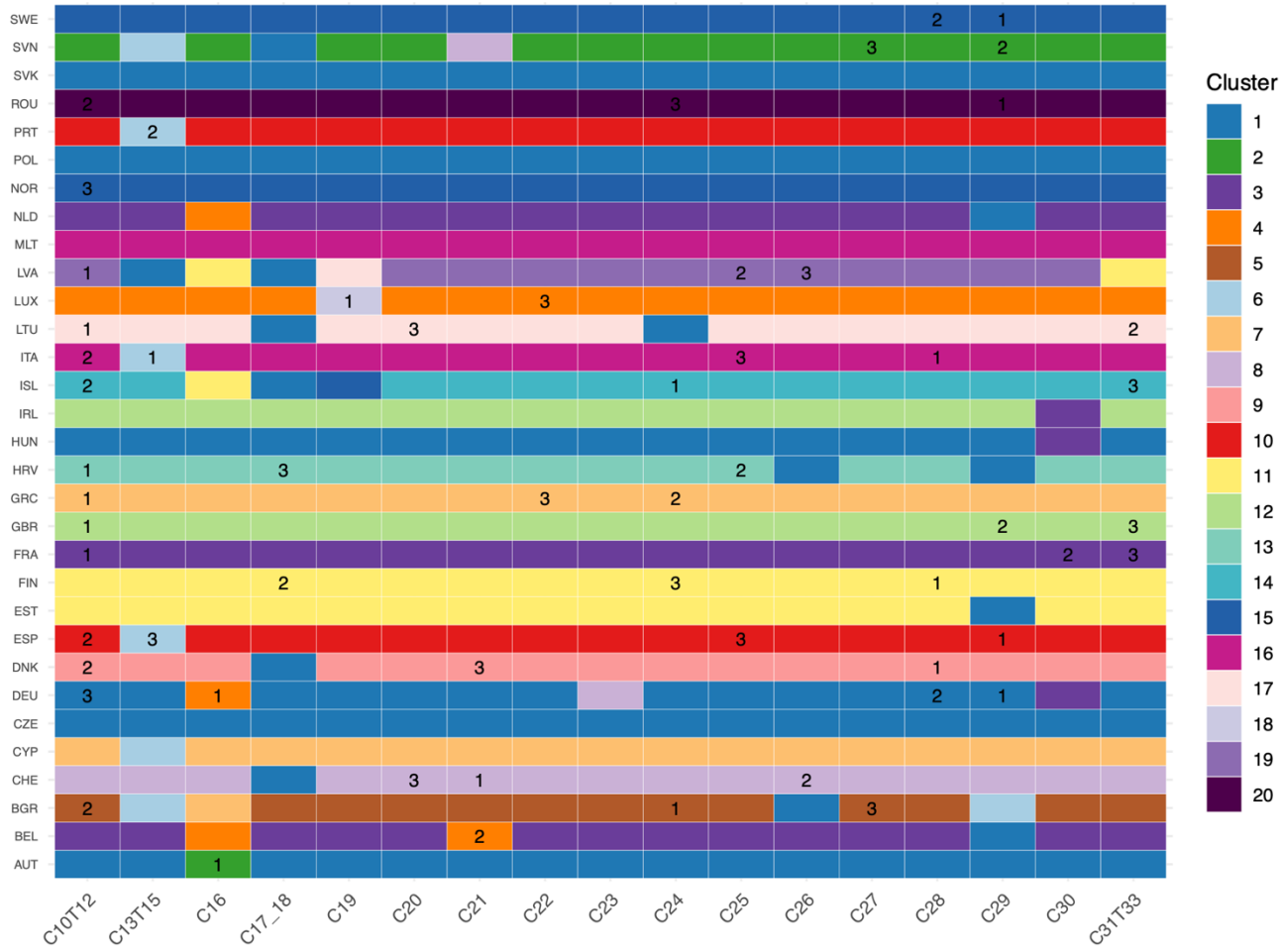


Note: Clusters detected through random walk-based community analysis applied to 31 EU-region economies and 20 ICIO sectors. Colours indicate endogenous clusters identified via co-visitation probability. Numbers within the cells denote sectoral leadership within each cluster: 3 represents the most central country-sector in that community, according to its relative share of intra-cluster flows. The figure shows communities from the perspective of buyers (i.e., intermediate demand), i.e. the intermediary flows matrix which in an input–output system represents how much sector i buys from another sector j. In this view, sectors are grouped together based on the similarity of their sellers.

In Figure 6 we look at clusters based on buyer similarity, i.e. the destination of output, we find a very large cluster (cluster 1), headed again by Germany and including large parts of Eastern European economies. This confirms previous evidence on the tight ties existing between the manufacturing industries of Germany and neighbouring Eastern European countries that remarkably form a cluster both in terms of source and destination of output. Furthermore, cluster 2 includes the Netherlands and France, along with Belgium. Italy instead is only part of the same cluster as Malta, with its textile industry linking with its homologues in Spain, Portugal and Croatia.

This resonates with the notion of headquarter and factory economies put forward by Baldwin and Lopez-Gonzalez (2015). Macro-regions in the global economy are characterised by intricate and tight sourcing ties that link headquarter economies with factory economies supplying inputs to them. On the selling side, we observe a more concentrated and fragmented picture with the headquarter economy (Germany in Europe and China in Asia) dominating the region's trade patterns.

Figure 6. Community detection in Europe subgraph of the World Input–Output Network (2019) - Sellers



Note: Clusters detected through random walk-based community analysis applied to 31 EU-region economies and 20 ICIO sectors. Colours indicate endogenous clusters identified via co-visitation probability. Numbers within the cells denote sectoral leadership within each cluster: 3 represents the most central country-sector in that community, according to its relative share of intra-cluster flows. The figure shows communities from the perspective of buyers (i.e., intermediate demand), i.e. the transpose of the intermediary flows matrix which in an input–output system represents how much sector j sells to another sector i. In this view, sectors are grouped together based on the similarity of their buyers.

4.3 Nearshoring and farsharing dynamics (TiVa)

To explore the degree of regional integration and global engagement, we analyse the positioning of economies as regional hubs or trans-regional intermediaries using TiVA indicators. These indicators provide insights into how economies rely on intra-regional value-added while exporting to external markets. By tracing the evolution of these patterns, we assess the shifting roles of countries within the GVC landscape and identify emerging nearshoring or farsharing trends (Bontadini et al 2025) that reflect strategic adaptations to geopolitical or economic pressures.

4.4 Dependencies among key players: the role of passthrough frequency (PTF)

Finally, we examine the interdependencies between leading actors in Asia and Europe looking at two distinct, albeit complementary measures. On the one hand we rely on foreign value added as a share of final demand, i.e. the amount of value added that is supplied to satisfy a country's final demand from other countries, which we compute as in Bontadini et al (2025). On the other hand, we look at dependencies in terms of the number of times that value added flows through a country in order to reach another country's final demand (Inomata & Hanaka, 2024).

The key difference between these two measures is that the former accounts for the share of value added that a country sources from another partner in order to produce its final output. To give the intuition, this answers the question of the amount of Chinese value added that is embodied in a Japanese car and therefore identifies countries that are large suppliers of value added.

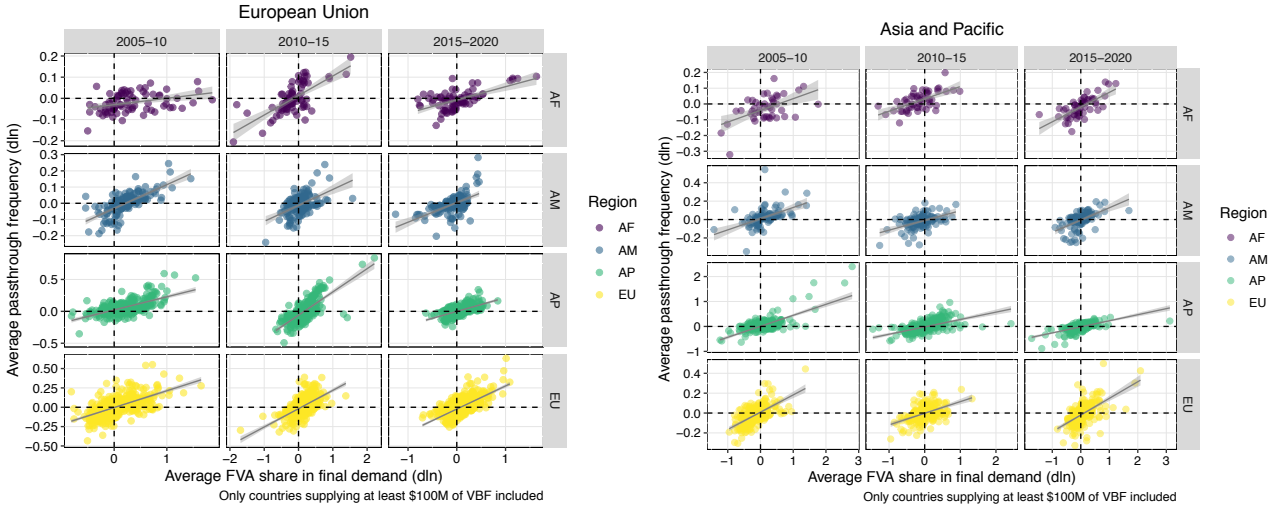
However, a country may supply relatively small quantities of value added to a final product but contribute to several production stages of a value chain, with intermediates flowing many times through it. This is particularly relevant for small countries that due to their size can only contribute so much value added to value chains but might still be crucial hubs with value added often flowing through them.

To capture this second aspect we resort to the measure of Passthrough Frequency (PTF) developed by Inomata and Hanaka (2024). PTF quantifies the frequency with which supply chains pass through specific regions, thereby highlighting the degree of dependence that key players have on external partners. In doing so we focus on Asian countries but explore their ties to the global economy, distinguishing among macro-regions: EU, North and Latin America (NLA) and Africa (AF).

Figure 7 plots the relationship between changes in our two measures for the EU and the Asia-Pacific region, distinguishing by region of origin of the suppliers and time period. We find a strong and positive relationship across all quadrants. As a country-industry supplies more value added to its partner's final products it also becomes a more frequent hub through which value added flows. This holds for both the EU and the Asia-

Pacific reason, although there is some significant variation around the line of best fit, suggesting that some country-industries might have seen their importance as pass-through hub diverge from their importance as value added supplier, in line with the findings in Inomata and Hanaka (2024).

Figure 7. Relationship between foreign value-added shares and Passthrough Frequency (PTF) across regions and selected countries (2005–2020)



Note: scatterplot of average foreign value added (FVA) in final demand and passthrough frequency delta-logs using ICIO tables. Each dot in the figure identifies the growth in FVA in final demand and PTF linking each country pair in the relevant region, over the periods 2005-2010, 2010-15 and 2015-2020. PTF and FVA shares are aggregated at the country level using weighted averages with final output as weight.

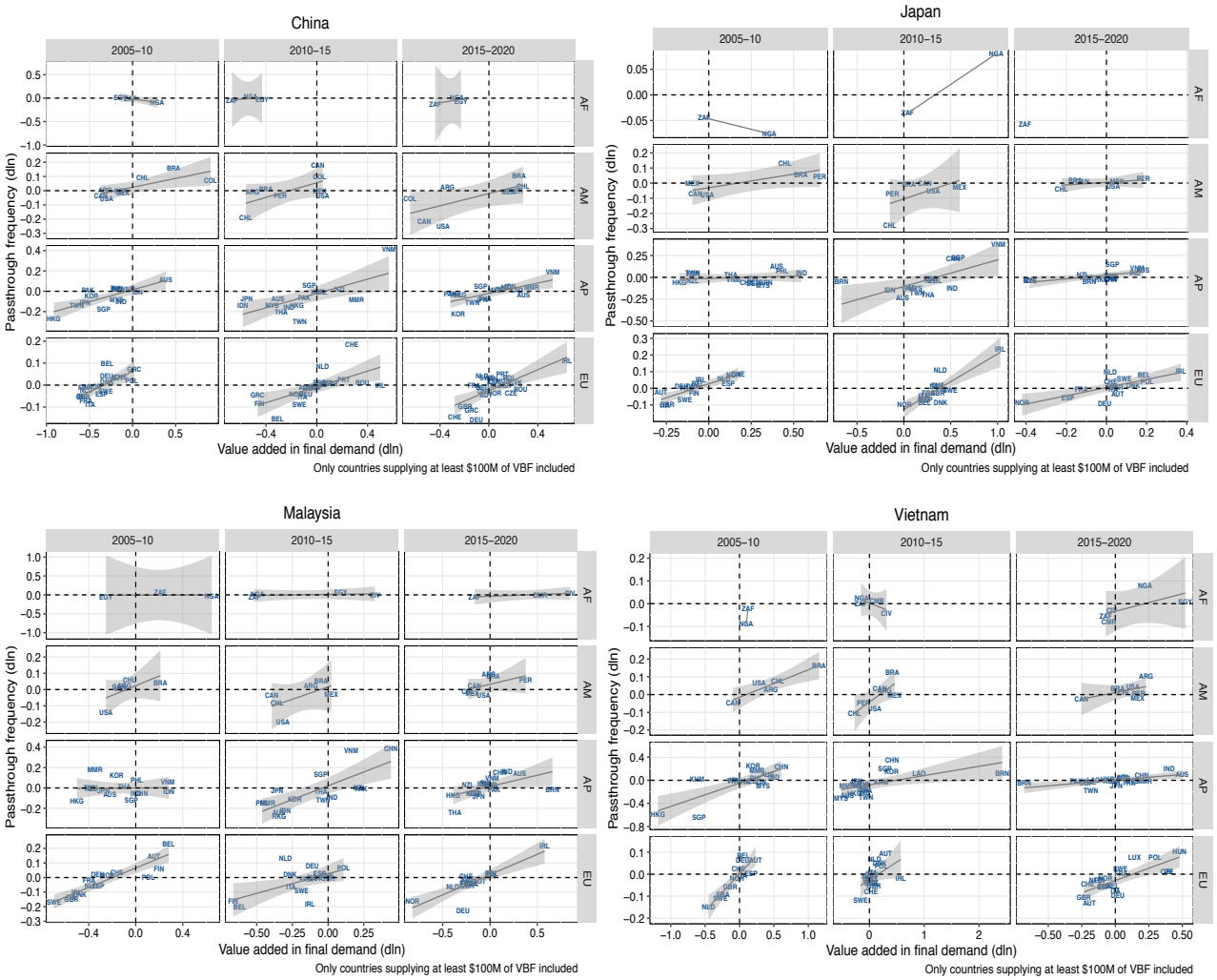
To better explore these patterns, we look at the relationship between individual countries and their suppliers. Figure 8 reports for a selection of four Asian-Pacific countries (China, Japan, Vietnam and Malaysia) and its suppliers divided by macro-region of origin, the growth rate in value added in final demand and the PTF.

We find again a positive relationship but much more heterogeneity in patterns. The four Asian economies show much closer ties with Europe, and of course other Asian economies, than with either Africa and North and Latin America. Focussing on the patterns of intra-regional integration we find Vietnam and China to be the two countries that have seen their relevance for the rest of the economy increase the most[3]. Both lie above the line of best fit suggesting that their importance has grown more in terms of pass-through frequency than as a supplier of value added. Furthermore, the relationship between PTF and foreign value added share seems to appear stronger in the 2010-15 period. This suggests, albeit in a speculative way, that significant restructuring of GVCs in Asia has taken place in the years after the global financial crisis, where final demand in Europe and, to a lesser extent, in the North and Latin America was contracting (Bontadini et al 2025). In contrast, the relationship between the four Asian economies and Europe has grown strongly over the three

[3] This is also true when looking at a larger number of countries, which are not reported here but available upon request.

periods, interestingly we find the largest growth in small, open, service oriented economies such as Belgium, the Netherlands and Ireland that host many multinational headquarters, hinting at the role of such large firms as coordinators of international trade flows.

Figure 8. Relationship between foreign value-added shares and Passthrough Frequency (PTF) across China, Japan, Malaysia and Vietnam (2005–2020).

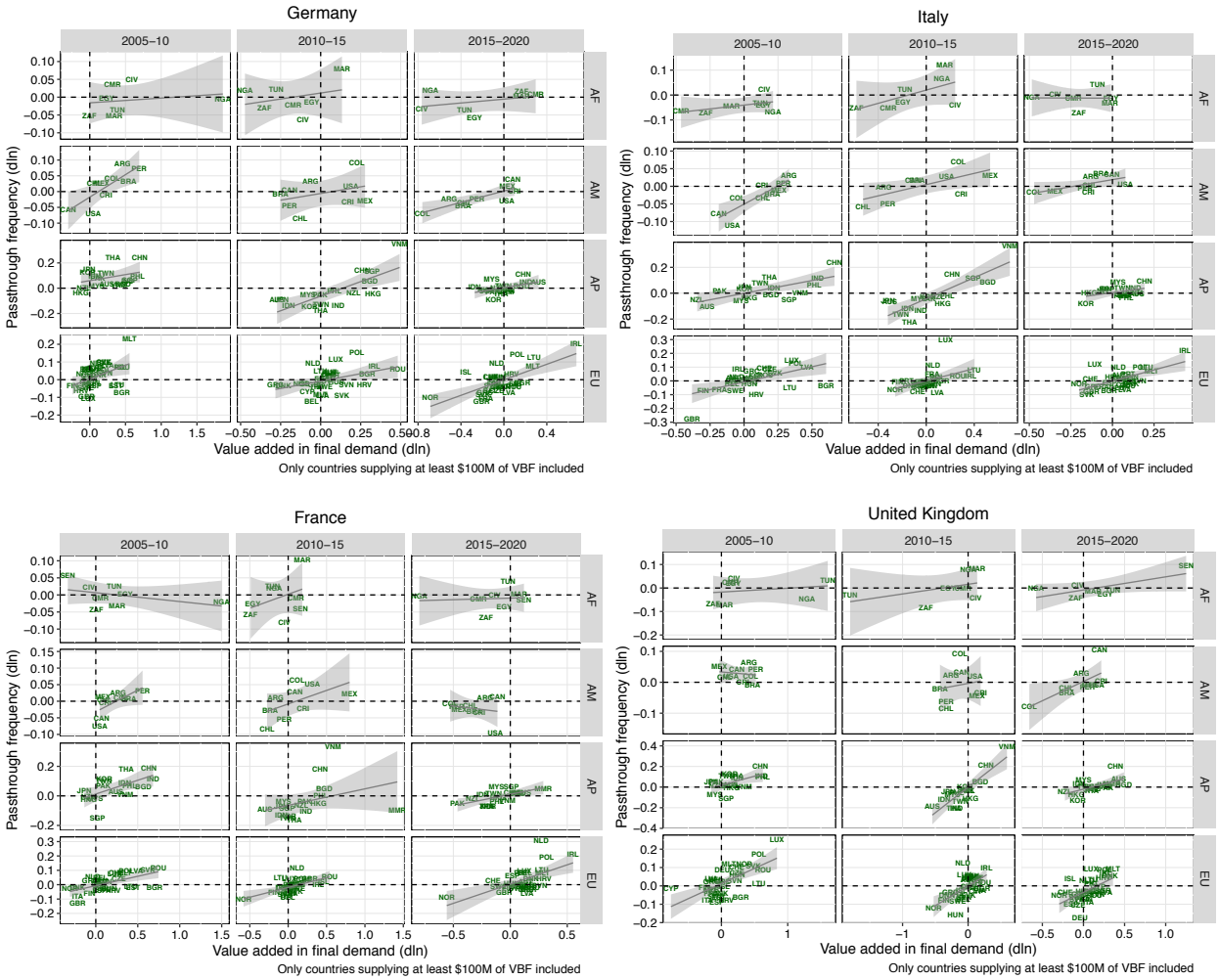


Note: Average passthrough frequency and value-added contributions to final demand are shown for key global suppliers, disaggregated by macro-region (EU, Asia-Pacific, Africa, and the Americas) and country (China, Japan, Malaysia and Vietnam). Panels report linear trends and highlight regional differences in structural dependencies and value-added transmission patterns across three sub-periods.

When we turn to the four major European economies (Germany, Italy, France and the United Kingdom) we find again strong evidence of the growing linkages between Europe and Asia. China and Vietnam, along with other South-East Asian economies, are among the countries that have grown the most as suppliers for all four EU countries both in terms of share of foreign value added in final demand and pass-through frequency.

Instead, North and Latin America and Africa show a more mitigated picture. The relationship remain positive for NLA while results are mixed for Africa. Furthermore, it seems that Africa's share of value added in final demand has decreased in many countries and that seems to be the case for many Latin American countries. This is certainly explained, in part, by the end of the commodity super-cycle which has seen natural resource prices decrease[4], but overall it points towards a shift of trade flows and a strengthening of the GVC linkages between Europe and Asia, leaving significant room for improvement in terms of linkages with Africa and Latin America.

Figure 9. Relationship between foreign value-added shares and Passthrough Frequency (PTF) across Germany, Italy, France and the United Kingdom (2005–2020).



Note: Average passthrough frequency and value-added contributions to final demand are shown for key global suppliers, disaggregated by macro-region (EU, Asia-Pacific, Africa, and the Americas) and country (Germany, Italy, France and the UK). Panels report linear trends and highlight regional differences in structural dependencies and value-added transmission patterns across three sub-periods.

[4] It is worth stressing here that ICIO tables are at current prices and do not allow to disentangle quantity and price effects in our measures.

5. Conclusions

This paper has provided novel evidence to characterise the evolution of the structure of global production networks, focussing especially on Asia and Europe. We have deployed a range of network analysis techniques to better qualify the topography of trade flows within and across these two regions.

We find that Asia, and China in particular, has emerged as a new hub of the global economy, replacing many European countries in terms of centrality. The Asian region also exhibits significant integration within itself, with clusters emerging around China, but also Japan and Vietnam on the sourcing side. In contrast, in terms of destination of output the continent appears to be more fragmented with one large cluster dominated by China while other major players – such as Japan, South Korea and Taiwan – trade with different partners, possibly reflecting geopolitical alignments. This patterns of larger integration on the sourcing side, coupled with dominance of one cluster on the selling side is also mirrored in Europe, reflecting the notion of factory and headquarter economies.

Finally, we find evidence of strengthening linkages between Asia and Europe both in terms of the share of foreign value added embodied in final demand and the relevance in terms of pass-through frequency. This strengthening is accompanied by a sluggish growth of linkages with Africa and Latin America, which reflects in part the decline in commodities' prices, as well as the economic growth of Asian economies which has led to shift in the centre of gravity of trade and production networks.

These results suggest on the one hand that Asian economies are likely to become more crucial partners for European countries but also highlights the room for improvement in fostering new trade relationship with other emerging economies such as Africa and Latina America.

Acknowledgments

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Appendix

Figures A.1a to A.1c show the comparative ranking of the top 20 global sellers in global value chains (GVCs) across six time points from 1995 to 2019. Each node represents a country-sector pair, and the evolution of their rank over time highlights significant patterns in the global distribution of production and trade influence.

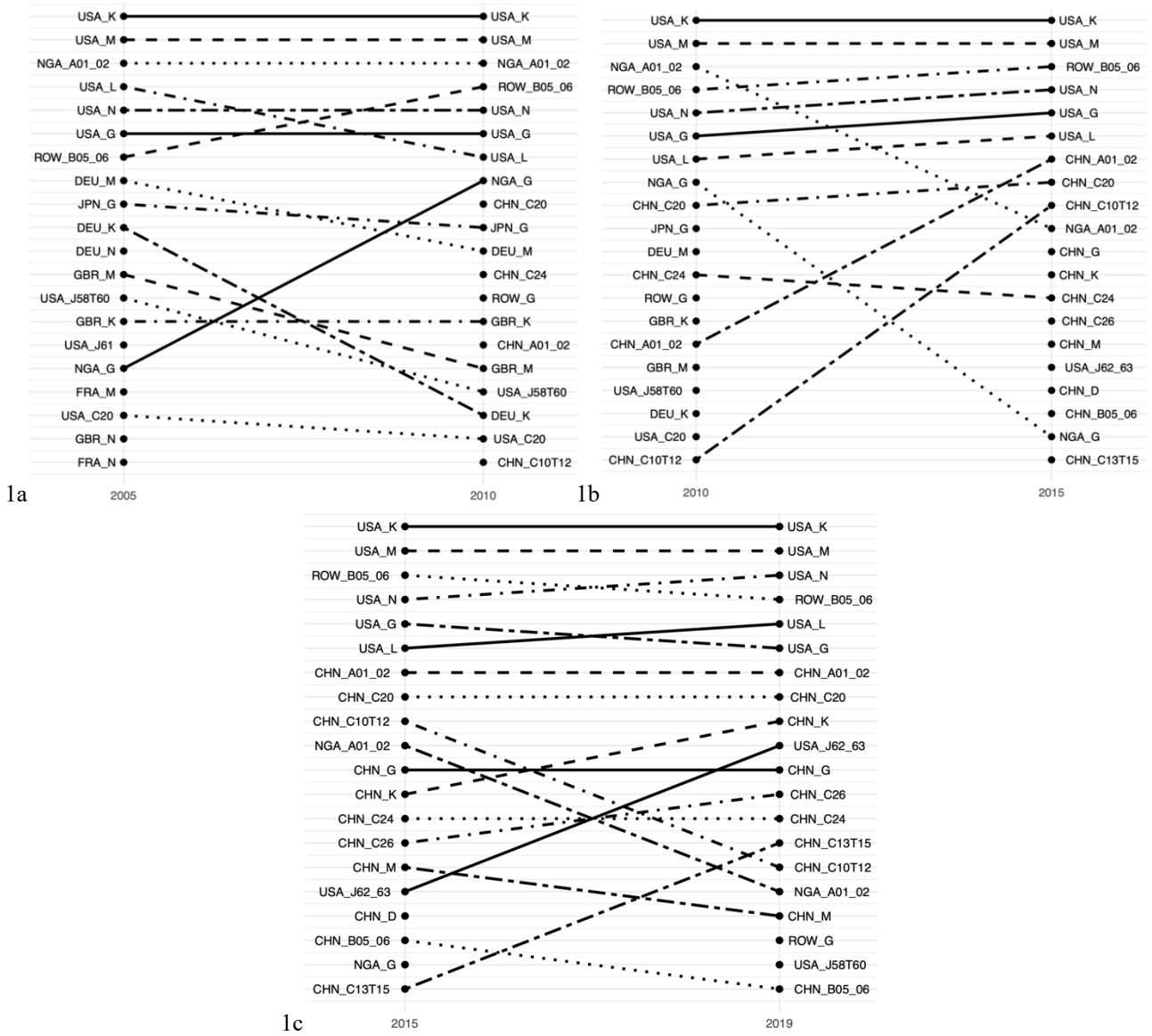
A consistent feature across the entire period is the dominance of the United States – Financial and Insurance Activities (USA_K), which remains the top-ranked seller in the global network from 1995 through 2019. Closely following, USA_M, representing Manufacturing, persistently holds the second position, underscoring the enduring centrality of the U.S. economy across both industrial and financial domains.

Another interesting trajectory is observed in NGA_A01_02 (Nigeria—Agriculture, Forestry, and Fishing), which starts in eighth place in 1995, ascends to third in 2005 and 2010, then declines to 10th in 2015 and disappears from the top 20 by 2019. This suggests a temporary surge in Nigeria's upstream positioning within GVCs, potentially due to raw material exports, followed by a relative decline.

China's rise is also apparent. The first entry appeared in 2010 with CHN_C20 (Manufacture of Chemicals and Chemical Products), followed by a rapid expansion in presence. By 2015 and 2019, multiple Chinese sectors entered the top 20, including CHN_A01_02 (Agriculture), CHN_K (Finance), CHN_C26 (Electronics), and CHN_C24 (Basic Metals), reflecting China's growing influence and diversification within global production networks.

Other emerging trends include the growing visibility of Germany (DEU_K, DEU_M), Great Britain (GBR_K, GBR_M), and the Rest of the World – Mining (ROW_B05_06), each showing fluctuations in rank over time but maintaining a steady presence across most periods.

Figures A.1a to A.1c. Top 20 global sellers in GVCs: comparative ranking of sellers from 2005-2010, 2010-2015 and 2015-2019



Figures A.2a to A.2c illustrate the evolution of the top 20 global buyers in global value chains (GVCs) across the same time points. These figures trace how national sectors integrate into the upstream segment of production networks as dominant importers of value-added, reflecting their centrality in global demand.

Throughout the period, USA_O (United States – Public Administration and Defense; Compulsory Social Security) consistently occupies the top position, highlighting the stable role of the U.S. public sector as a major buyer in the global economy. Closely behind, USA_Q (Human Health and Social Work Activities) emerges as another long-standing top buyer, reflecting the size and demand intensity of the U.S. healthcare system.

The persistence of U.S. dominance is evident, with multiple other sectors from the country regularly appearing in the top rankings, including USA_K (Financial activities), USA_M (Manufacturing), and USA_C29 (Motor

vehicles). This highlights the complex nature of demand across the service sector and industry in the United States.

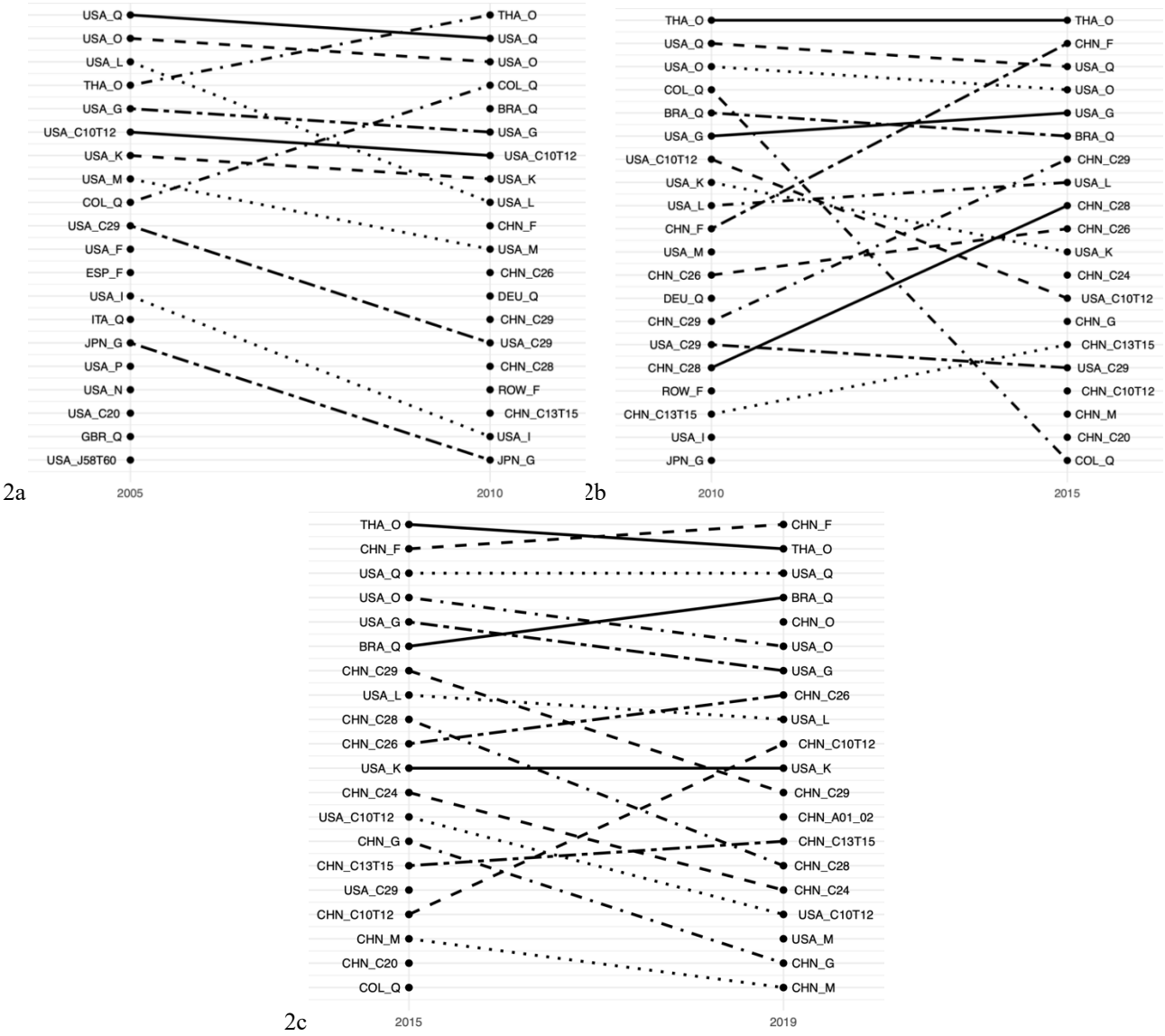
However, beginning in 2010, a structural transformation became visible with the rise of China as a major buyer. For instance, CHN_F (Construction) entered the top ranks and continued to climb through 2015 and 2019. By 2019, Chinese sectors like CHN_C26 (Electronics), CHN_C29 (Motor Vehicles), CHN_G (Wholesale and Retail Trade), and CHN_C101T12 (Food products) will emerge as leading global buyers. This transition reflects China's shift from a purely export-oriented model to one driven by substantial internal demand and intermediate imports aligned with its industrial upgrading.

Among other emerging economies, Brazil appears with BRA_O (Public Administration) and BRA_Q (Health and Social Work) from 2005 onwards, while Colombia maintains a presence via COL_O (Public Administration) and COL_Q (Health), suggesting increasing integration into value chains through government-related demand.

Thailand (THA_O) also stands out for its stability, remaining in the top ranks throughout the period. This underlines the strategic role of its public sector in regional production networks in Asia.

These figures illustrate the ongoing dominance of U.S. demand across various sectors, the rise of China as a key buyer in global value chains (GVCs) since 2010, and the gradual integration of certain emerging countries into the global demand framework. This is especially evident in public services, construction, and industrial transformation sectors.

Figures A.2a to A.2c. Top 20 global buyers in GVCs: comparative ranking of sellers from 2005-2010, 2010-2015 and 2015-2019

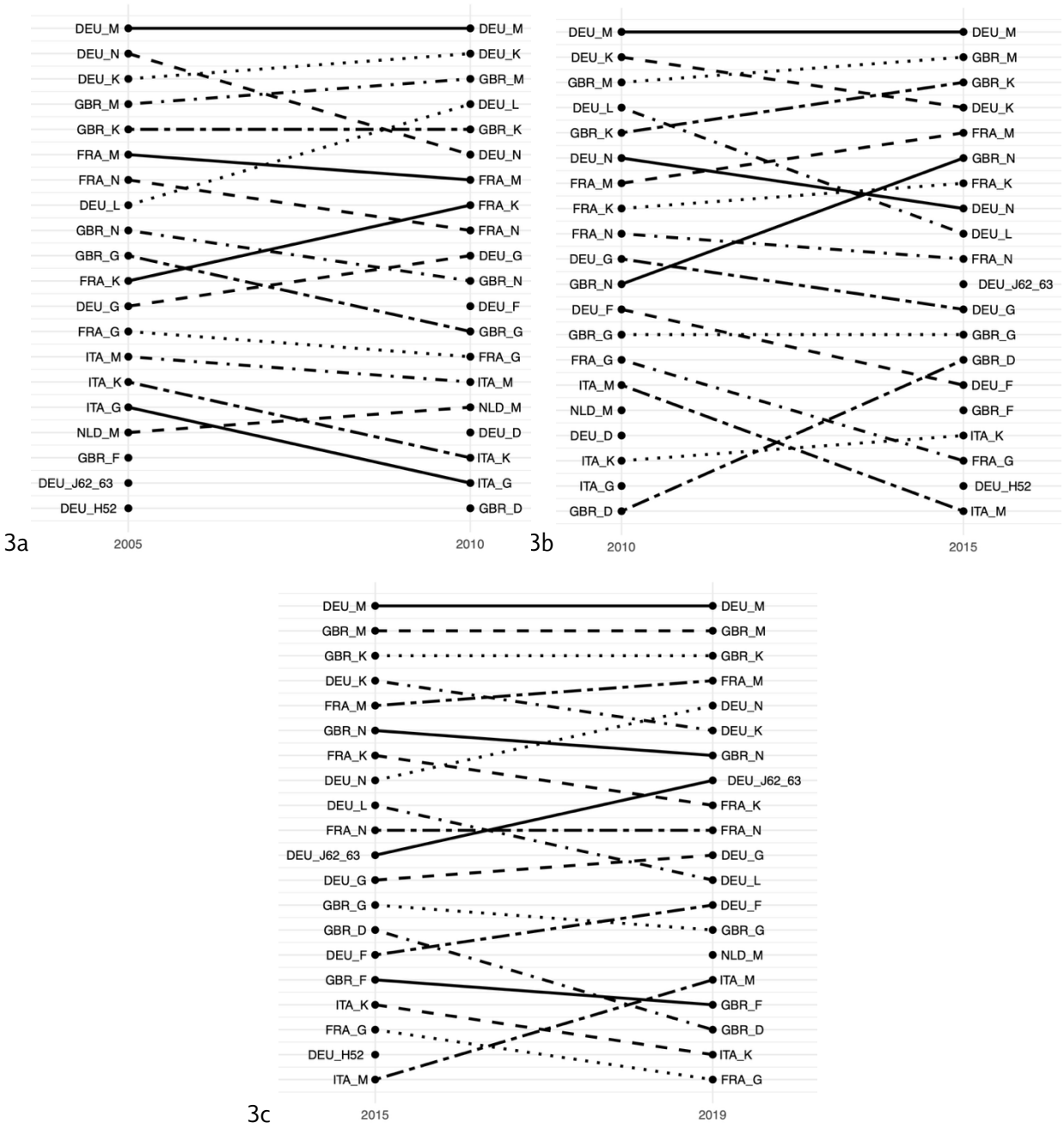


In Figures A.3 and A.4 replicates the analysis above for European countries. Looking at sellers, it is remarkable how the most central actors in the networks are all service suppliers – e.g.: , no manufacturing sector features among the top 20, despite manufacturing industries being much more likely to integrate in GVCs. This reflects the fact that our analysis includes domestic linkages as well as international ones and that EU countries' economic structure is much more significantly skewed towards services than Asia-Pacific industries. Still, this evidence highlights the stark difference in specialisation patterns across EU high-income economies and Asia-Pacific emerging ones and speaks to the relocation of manufacturing activities across the globe.

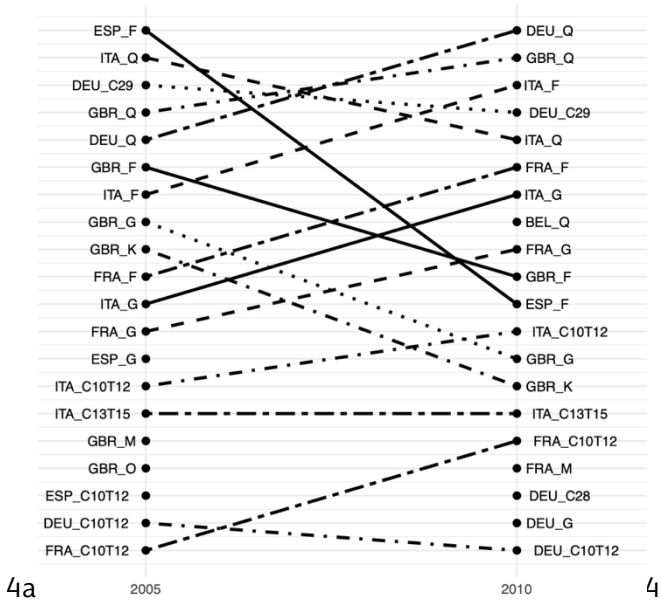
When we turn to buyers' centrality, we find that while professional services still dominate the EU production network structure, some significant changes emerge, with respect to seller. The health sectors (Q) to play a

major role, which reflects EU Welfare State and its aging population and some manufacturing industries. In particular these are food and beverage (C10T12) which provides largely consumption goods but also two high-tech manufacturing industries producing machinery (C28) and vehicles (C29).

Figures A.3a to A.3c. Top 20 Europe sellers in GVCs: comparative ranking of sellers from 2005–2010, 2010–2015, and 2015–2019



Figures A.4a to A.4c. Top 20 Europe buyers in GVCs: comparative ranking of buyers from 2005–2010, 2010–2015, and 2015–2019



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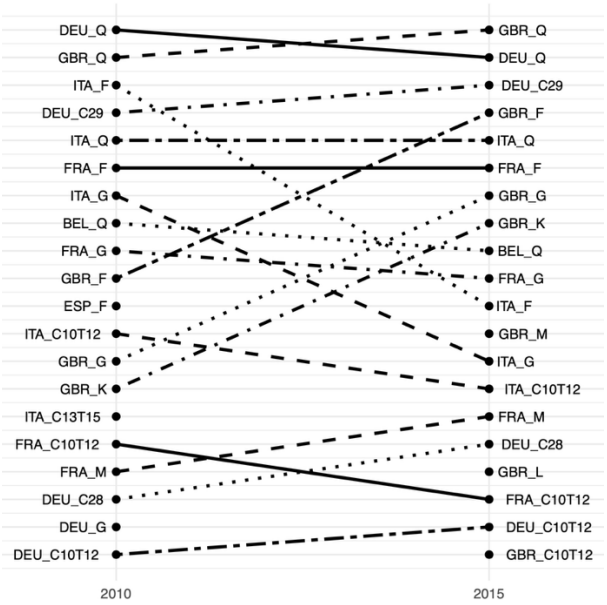

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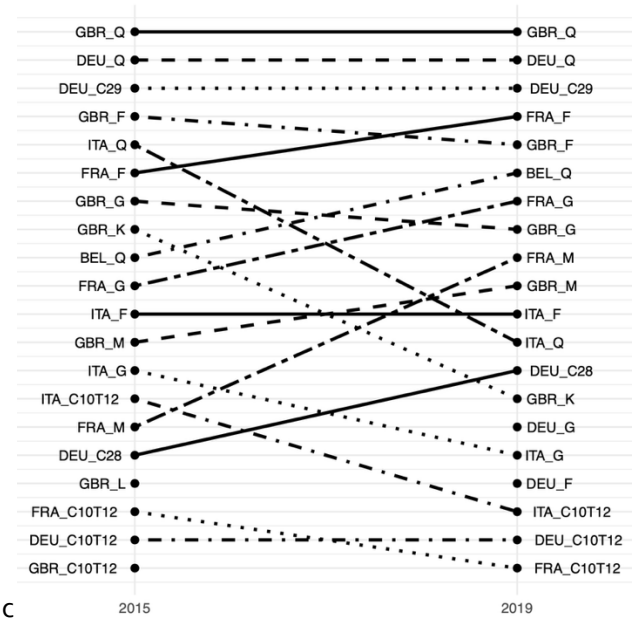

4c