TWIN SEEDS

WORK PACKAGE 5

Recent and emerging impact of GVCs and MNEs on growth, productivity and competitiveness

Acknowledgments

This report is the fifth in the series of seven scientific deliverables of the TWIN SEEDS project, funded by Horizon Europe. The financial support of the European Union is gratefully acknowledged.

The report has been edited by Torben Pedersen (CBS), Louise Marie Busck Lumholt (CBS) and Peter Ørberg Jensen (CBS), based on the contributions from the below-listed Work Package 5 participants

Chapters	Authors	Participating organization
1,2,4,5	Torben Pedersen	Copenhagen Business School (CBS)
1,2,4,5	Peter Ørberg Jensen	Copenhagen Business School (CBS)
1,2,4,5	Louise Marie Busck-Lumholt	Copenhagen Business School (CBS)
2	Jacopo Canello	University of Groningen (RUG)
2	Mahdi Ghodsi	Vienna Institute for International Economic Studies (wiiw)
2	Michael Landesmann	Vienna Institute for International Economic Studies (wiiw)
2	Smitha Francis	Centre for Liberal Education, IIT Bombay
3	Bart Los	University of Groningen (RUG)
3	Roberta Capello	Politecnico di Milano (POLIMI)
3	Roberto Dellisanti	Politecnico di Milano (POLIMI)
3	Mitsuyo Ando	Keio University, Japan
3	Kazunobu Hayakawa	Institute of Developing Economies, Thailand
3	Fukunari Kimura	Keio University, Japan
3	Laura Resmini	University of Milano-Bicocca

This report benefitted from the comments and guidance of attendees at the TWIN SEEDS Work Package 5 workshop held in Milan, in June 2024.

Table of contents

EXECUTIVE SUMMARY 6

1. INTRODUCTION 9

2. GLOBAL VALUE CHAINS, MULTINATIONAL ENTERPRISES, AND THEIR SUPPLY CHAIN STRATEGIES 12

- CONTEXTUAL BACKGROUND AND RESEARCH OBJECTIVES 12
- METHODS OF ANALYSIS AND DATA 14
- FINDINGS AND DISCUSSION 15

3. REGIONAL AND SOCIETAL EFFECTS OF GVC RESTRUCTURING 21

- CONTEXTUAL BACKGROUND AND RESEARCH OBJECTIVES 21
- METHODS OF ANALYSIS AND DATA 23
- FINDINGS AND DISCUSSION 24

4. SUMMARY OF KEY FINDINGS 30

5. CONCLUSIONS AND POLICY IMPLICATIONS 32

6. NEXT STEPS IN TWINSEEDS 35

7. REFERENCES 36

8. TECHNICAL APPENDICES 40

- APPENDIX A: ARE THE GVCS BECOMING TOO VULNERABLE AND LESS RESILIENT? 40
- APPENDIX B: POST-COVID VALUE CHAIN RE-ALIGNMENTS AMIDST NEW DIGITALIZATION 42
- APPENDIX C: FACTORY ECONOMIES AND HEADQUARTER ECONOMIES: A NEW FORM OF RENT SHIFTING? 44
- APPENDIX D: THE CONSEQUENCES OF OFFSHORING AND RESHORING DECISIONS ON LOCAL SUBCONTRACTORS 56
- APPENDIX E: A MACRO-REVIEW OF THE RELATIONSHIP BETWEEN INTERNATIONAL FRAGMENTATION AND PRODUCTIVITY GROWTH IN GVCS 2000-2014 57
- APPENDIX F: GVCS' REORGANIZATION AND REGIONAL DISPARITIES IN EUROPE 60
- APPENDIX G: MACHINERY PRODUCTION NETWORKS THAT BRIDGE EAST ASIA AND EUROPE 66
- APPENDIX H: DISENTANGLING REGIONAL SPILLOVERS FROM GVCS 68

List of Tables

TABLE 1: SHARE OF COMPANIES THAT ASSESS THESE EXTERNAL DISRUPTIONS TO BE HIGHLY SIGNIFICANT FOR THE COMPANY (1= NO IMPORTANCE, 4= SOME IMPORTANCE, 7= VERY SIGNIFICANT IMPORTANCE)....16

TABLE A1: REGRESSION MODELS ON THE THREE STRATEGIES AND THEIR ANTECEDENTS (N=202)* ...41

TABLE C.1: FREQUENCY OF BUSINESS FUNCTIONS WITHIN FIRMS IN THE SAMPLE OF STUDY....45

TABLE C.2: CLASSIFICATION OF BUSINESS FUNCTIONS....47

TABLE C.3: ESTIMATION RESULTS USING NORMAL OLS ON THE SAME-SAMPLE OF ALL FOREIGN-OWNED SUBSIDIARIES WITH AT LEAST ONE INVESTED PROJECT....48

TABLE C.4: ESTIMATION RESULTS USING NORMAL OLS ON THE SAME-SAMPLE OF ALL FOREIGN-OWNED SUBSIDIARIES WITH AT LEAST ONE INVESTED PROJECT IN THE EU27....49

TABLE C.5: ESTIMATION RESULTS USING NORMAL OLS ON THE SAME-SAMPLE OF ALL FOREIGN-OWNED SUBSIDIARIES WITH AT LEAST ONE INVESTED PROJECT IN THE EU14 (I.E. PRE-2014 EU MEMBER COUNTRIES)....50

TABLE C.6: ESTIMATION RESULTS USING NORMAL OLS ON THE SAME-SAMPLE OF ALL FOREIGN-OWNED SUBSIDIARIES WITH AT LEAST ONE INVESTED PROJECT IN THE EU-CEE (POST 2014 EU MEMBER COUNTRIES)....51

TABLE F.1: EMPIRICAL CONDITIONS TO MEASURE HOME AND HOST NEARSHORING REGIONS....61

TABLE F.2: LIST OF VARIABLES AND DESCRIPTIVE STATISTICS....62

TABLE F.3: ESTIMATION RESULTS OF THE REGIONAL GROWTH MODEL....63

TABLE F.4: LIST OF HOST NEARSHORING REGIONS....64

TABLE H.1: DESCRIPTIVE STATISTICS....68

TABLE H.2: BASELINE RESULTS....68

TABLE H3: INTRA- AND INTER-SECTORAL KNOWLEDGE SPILLOVER WITHIN AND BETWEEN REGIONS...69

List of Figures

FIGURE 1: SUMMARY OF THE TWIN SEEDS PROJECT AND ITS WORK PACKAGES....11

FIGURE 2: PRODUCTION PROCESS OF SMALL CLIENT FIRMS: MAKE VS. BUY DECISIONS....18

FIGURE 4: GROWTH RATES OF HOST NEARSHORING REGIONS COMPARED TO OTHER REGIONS....26

FIGURE 5: INTERREGIONAL INEQUALITIES IN PRESENCE OF NEARSHORING....27

FIGURE 6: EACH COUNTRY'S MACHINERY SHARES IN TOTAL EXPORTS AND IMPORTS IN 2021....28

FIGURE C.1: SHARE OF NUMBER OF PROJECTS IN PRODUCTION BF RELATIVE TO TOTAL NUMBER OF PROJECTS INVESTED IN EACH COUNTRY IN THE SAMPLE....52

FIGURE C.2: SHARE OF NUMBER OF PROJECTS IN HEADQUARTERS BF RELATIVE TO TOTAL NUMBER OF PROJECTS INVESTED IN EACH COUNTRY IN THE SAMPLE....53

Figure C.3: Share of number of projects in R&D and ICT BF relative to total number of projects invested in each country in the sample 54
Figure C.4: Share of number of projects in Sales, marketing, logistics, and maintenance BF relative to total number of projects invested in each country in the sample 55

Executive summary

The WP5 report, titled "Recent and Emerging Trends of Global Value Chains and Multinational Enterprises on Growth, Productivity, and Competitiveness," presents new empirical findings on the diverse supply chain strategies employed by multinational enterprises (MNEs) within global value chains (GVCs) and their associated regional and societal impacts. This report builds on analyses from previous work packages: WP1, which examined trends and drivers in GVCs and the role of MNEs in globalization; WP2, which focused on GVC and MNE trends during the pandemic; WP3, which assessed the impacts of GVCs and MNEs on employment and inequality; and WP4, which explored the environmental impacts of GVCs and MNEs.

Key analyses in this report include (1) a study on MNE resilience strategies and their co-evolution within GVCs; (2) an examination of post-COVID value chain realignments in the medical electronics industry amid digitalization trends; (3) research on knowledge spillovers from GVCs, focusing on transmission channels and identifying winners and losers (4) research into the effects of offshoring and reshoring on networks of small local subcontractors; (5) a macro-review of the relationship between international fragmentation and productivity growth in GVCs from 2000 to 2014; (6) an analysis of GVC reorganization and regional disparities in Europe; (7) an investigation into machinery production networks linking East Asia and Europe; and (8) an analysis of business function allocation and rent distribution between factory and headquarters economies.

The research explores how recent developments are influencing MNEs' resilience strategies and the restructuring of GVCs within specific industries. It addresses how the distribution of business functions, including value-added, profits, and wage rates, varies across regions, and how buyer-supplier relationships are affected by sourcing decisions. The report also examines the implementation and impact of nearshoring and other shoring strategies on supply chain resilience, trade relationships, and regional economic growth. Additionally, it investigates how MNEs' external linkages contribute to regional economic development and innovation. Data collection and analysis employed both qualitative and quantitative methods, using a combination of secondary and primary data sources. The findings aim to provide a comprehensive understanding of the evolving dynamics of MNEs and GVCs in relation to growth, productivity, and competitiveness.

The key messages of the report can be summarized as:

MNE resilience strategies and GVC dynamics

- MNCs employ a variety of resilience strategies, often opting for less costly, cautious approaches rather than high-cost, fundamental changes, reflecting a careful evaluation of trade-offs.

- As GVC complexity increases, particularly with suppliers located outside Europe, MNCs enhance their analytical capabilities to counteract "liabilities of foreignness" and improve real-time information flow.
- Resilience strategies evolve dynamically with GVC conditions, illustrating a co-evolutionary relationship where firms adapt their strategies based on both internal capabilities and external disruptions.

Function specialization in GVCs

- Traditional 'Smile Curve' patterns are observed in value-added ratios, but other distributional variables, such as markup ratios and wage rates, show significant variations, revealing a more complex picture of profit margins and value distribution.
- MNCs exploit low-wage production locations while higher-value functions are typically concentrated in regions with higher labor costs, resulting in distinct patterns of value-added and profit margins across different stages of production.
- As industries shift towards greater softwarization, MNEs are prioritizing high-value activities like R&D and management in regions that can best leverage these innovations.
- Regional differences emerge, with the EU14 and EU-CEE showing varying value-added ratios and labor cost dynamics, highlighting divergent strategies and outcomes within the EU.

International fragmentation and labor costs

- Over 2000-2014, GVC distances increased significantly, indicating greater fragmentation, with the most notable increases in specific industries such as fabricated metal products.
- A negative relationship between GVC unit labor costs and distance suggests that labor costs were reduced by relocating activities to more distant locations, though the effect on overall costs is modest.

Production networks post-COVID

- East Asia demonstrated resilience during the COVID-19 pandemic, with ongoing strong inter-regional linkages and a growing importance as a supplier to Europe, particularly in machinery sectors.
- The EU increased imports from longer-distance countries rather than intensifying nearshoring, indicating that economic rather than political factors predominantly drive machinery procurement decisions.

Impacts of nearshoring on regional disparities in Europe

- Nearshoring benefits host regions by attracting investments previously made outside the EU, though the impact on regional inequalities varies, with some lagging regions missing out on growth opportunities.

- The effects of nearshoring on regional disparities are mixed, with some regions experiencing growth while others, particularly in Mediterranean countries, face challenges that could lead to a middle-income trap.

- **Shoring strategies and subcontractor dynamics**
- Local subcontractors in regions with high offshore outsourcing intensity exhibit higher survival rates and maintain long-term relationships with domestic clients, even as offshore outsourcing expands.
- Offshore outsourcing does not significantly displace local subcontractors, as many SMEs use dual sourcing strategies to balance domestic and international supply networks.
- Domestic subcontractors continue to thrive by engaging in high-value activities, while foreign subcontractors typically focus on lower-value tasks, sustaining their roles despite increasing offshore outsourcing.

Knowledge diffusion and regional innovation

- MNEs serve as crucial knowledge gatekeepers, transferring knowledge from foreign affiliates to their home regions, thereby enhancing regional growth and competitiveness.
- The contribution of MNEs to regional innovation is comparable to that of internal knowledge sources, with intra-firm mechanisms playing a significant role in knowledge diffusion.
- The effectiveness of knowledge diffusion varies, with only firms in science-based sectors, such as those in Italy, fully benefiting from MNEs' extra-regional connectivity.

Digitalization and post-COVID value chain realignments

- EU medical device subsidiaries in India increased imports from the US in the immediate post-COVID years while maintaining their reliance on Chinese imports, with import procurement predominantly coordinated within the lead firms' networks.
- Digitalization impacts GVC dynamics by integrating software and data analytics into value chain processes, elevating India's role in software development and services within the medical device sector.
- Despite the resulting increase in software/services exports from India, the Indian subsidiaries' income shares going to the EU lead firms and their subsidiaries outside India increased in comparison to the pre-pandemic levels.

1. Introduction

Global Value Chains (GVCs) have evolved significantly over the past few decades, transforming from simple international trade relationships into complex global networks of production that span multiple countries and continents. The rise of GVCs was driven by advancements in transportation and communication technologies, as well as trade liberalization policies that reduced tariffs and barriers to cross-border trade. These developments have facilitated the fragmentation of production processes across different locations, allowing companies to optimize costs by sourcing inputs globally and assembling them where it was most economically advantageous.

Geopolitics and technology are twin seeds shaping the dynamics of these GVCs by driving changes in international trade and the organization of production, influencing how MNEs interact with their supply chains and manage their global operations. Technological transformations, particularly the shift towards the Industry 4.0 paradigm, have fundamentally altered production processes. Advances in automation, artificial intelligence, and digitalization are not only enhancing the efficiency and adaptability of supply chains (Lukas Brun et al., 2019) but also potentially influencing the feasibility and attractiveness of reshoring and nearshoring strategies by reducing dependency on low-cost labor and distant suppliers (Lund et al., 2020). This new era is characterized by cyber-physical systems that integrate digitalization, automation, and robotization, enabling MNEs to enhance efficiency and innovate across their entire value chains. However, these advancements also present challenges, such as cybersecurity risks, workforce displacement, and significant capital investment requirements.

In parallel, geopolitical developments significantly impact GVCs. Changes in trade policies, political instability, international relations, and conflicts can reshape the flow of goods, services, and investments across borders. Moreover, although not a new phenomenon, the recent wave of economic nationalism has gained momentum as countries increasingly focus on protecting their domestic industries and prioritizing local economic interests in response to global uncertainties. This resurgence is characterized by the implementation of protectionist policies and trade barriers, which, while aiming to safeguard local jobs and markets, pose new challenges to the efficiencies and cost advantages traditionally provided by global supply chains (Chacko, 2021). Alongside and within these change processes, recent years have seen significant disruptions caused by COVID-19, escalating geopolitical tensions, including the US-China trade conflict and the Russian invasion of Ukraine, as well as the broader impacts of climate change (Lawrence et al., 2024). This combination of forces influencing GVCs has prompted reconsideration of the resilience and reorganization of MNEs and their supply chains across regions (Ozdemir et al., 2022).

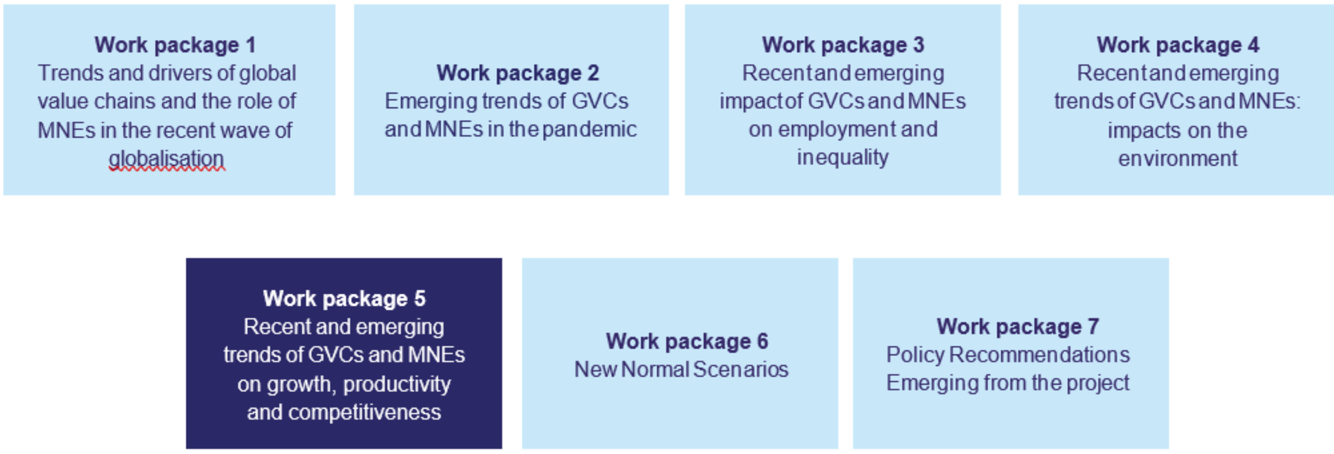
Within this context, MNEs act as change agents, constantly interacting with their supply chains to produce and distribute goods, drive innovation, manage risks, and expand markets. The relationship between MNEs and supply chains is dynamic and bidirectional; MNEs rely on supply chains for efficiency and competitiveness, while their strategies shape the supply chain's structure and functioning. To navigate the global market successfully, MNEs develop strategies that respond to geopolitical shifts, leverage technological advancements, and integrate digital tools to maintain a competitive edge. However, they must also address challenges such as cybersecurity threats, regulatory changes, and potential disruptions. Given the unpredictable nature of future developments and disruptions, MNEs have adopted a range of resilience strategies, from cautious 'wait-and-see' approaches to significant changes in their GVC configurations.

Among the more transformative approaches are reconfigurations of supply chains through shoring strategies such as near-shoring, re-shoring, de-risking, and friend-shoring. Near-shoring involves moving business operations closer to a company's home country to reduce transportation costs and improve efficiency. Re-shoring brings these operations back to the home country to create local jobs and enhance quality control. De-risking diversifies supply chains across multiple locations to minimize exposure to risks like geopolitical tensions and economic instability. Friend-shoring relocates operations to politically and economically allied countries to ensure more stable and reliable partnerships. The debate on these strategies has gained particular momentum (Pedroletti & Ciabuschi, 2023) as many policymakers aim to restore the competitiveness of manufacturing communities previously affected by offshoring and import competition by providing economic incentives to firms repatriating offshored activities (Pisano & Shih, 2012).

As a result of these complex dynamics, GVCs are expected to undergo significant transformations in the decade ahead. However, the nature, pace, and magnitude of these changes are still uncertain and influenced by a wide range of factors beyond immediate disruptions, such as policy and regulation, technological developments, and evolving market demands. Some expected changes might therefore be overestimated as MNEs gradually adapt to both external processes and internal strategic goals in a co-evolutionary process within GVCs and broader actor networks. However, when significant shifts do occur, they can have profound regional and societal effects on productivity, growth, and competitiveness, creating clear winners and losers. As global GVCs integrate countries into global production networks, they create jobs, foster economic growth, and facilitate the sharing of knowledge and innovation. This process can, in some cases, lead to regional development and reduce disparities between poorer and richer areas, while in other cases, it can exacerbate existing inequalities.

Against this backdrop, the TWIN SEEDS project aims to provide robust empirical evidence on how GVCs have been impacted by globalization and recent developments, while also examining trends in international trade, MNE behavior, and production organization in relation to the evolving policy environment and emerging technologies (the 'twin seeds'). The WP1 and WP2 reports place GVCs within the context of recent disruptions and globalization trends, while WP3 explores how these changes affect employment and inequality, and WP4 focuses on environmental impacts (see Figure 1). Building on these insights, this WP5 report investigates how disruptions, technological advancements, and geopolitical shifts are reshaping GVCs and their effects on MNEs' productivity, growth, and competitiveness. It highlights the importance of understanding the interactions between geopolitics, technology, MNE strategies, and supply chain configurations, as well as their regional and societal impacts, to effectively navigate future changes in the global business landscape.

Figure 1: Summary of the TWIN SEEDS project and its Work Packages



Source: Authors' elaboration

The report is organized into six chapters. First, the introduction provides context and background for the analytical focus of the report. The two following chapters present the results of the report which are based on eight individual research contributions that treat different aspects of GVC dynamics and associated regional and societal impacts. Chapter 2 addresses task 5.1 of the grant agreement and delves into GVC dynamics by looking at business strategies within GVCs, exploring the impacts of offshore outsourcing by SMEs on local subcontractors, the knowledge diffusion process within GVCs , and post-COVID-19 restructuring in the medical device industry influenced by new digitalization. Chapter 3 addresses task 5.2 of the grant agreement and investigates the regional and societal effects of GVC restructuring, focusing on how MNEs navigate disruptions and challenges by restructuring business operations. This involves examining empirical evidence on nearshoring and its implications for regional growth, disparities, and the distribution of rents across different business functions. Chapter 4 presents a summary of key findings from these research contributions, while Chapter 5 highlights the main concluding remarks and policy implications. Chapter 6 concludes by presenting the next steps in the TWIN SEEDS project.

2. Global Value Chains, Multinational Enterprises, and their supply chain strategies

Contextual background and research objectives

This chapter addresses task 5.1 of the grant agreement which seeks to analyse and discuss growth and competitiveness in relation to the industry and firm level effects of GVC restructuring. The processes of change within and beyond GVCs are mutually shaping each other. This co-evolution between firm-level and societal development highlights the importance of understanding both dynamics to accurately predict and prepare for various GVC scenarios in the future. For instance, external pressures such as regulatory changes and market demands significantly influence internal corporate strategies, while corporate innovations and adaptations can, in turn, reshape broader market and policy environments. This interdependence underscores the need for strategies that account for the dynamic interplay between external societal forces and internal corporate responses.

Technological and geopolitical dynamics can drive the development of new business strategies and decision-making processes at the firm level. As MNEs navigate internal goals and external pressures, their strategies are shaping not only the structure and dynamics of their supply chains but also the broader GVCs. Given the complexity and multiplicity of challenges and opportunities within GVCs, MNEs' responses are expected to be equally complex and varied, both across and within individual firms. In parallel, many industries undergo significant technological changes due to advancements in digital technologies and the resulting growing smartness (or intelligentisation) of value chains (Francis, 2018). The rise of digital technologies is transforming how MNEs operate, integrating sophisticated software and data-centric innovations into process optimization, product design, and development (Francis, 2023), which can enhance productivity through greater operational efficiency, automation, and faster decision-making. Conceptually, there is awareness of the broader interdependence between societal developments, GVCs, and MNE operations. However, we still lack a comprehensive empirical understanding of how MNEs adjust their strategies in response to change processes and how these adjustments impact their global operations differently across various contexts. In the context of geopolitical instability and digitalization, we therefore ask, how are recent developments influencing MNEs' resilience strategies and the restructuring of GVCs within specific industries?

MNEs can also influence GVC restructuring through their extra-regional linkages. These linkages, such as trade relationships, supply and demand linkages, and economic and social ties, affect the distribution of resources, technology, and knowledge, thereby impacting local economic development and innovation (Ernst & Kim, 2002; Bathelt et al., 2004; Owen-Smith & Powell, 2004; Boschma & Iammarino, 2009; Bathelt & Cohendet, 2014; Miguelez & Moreno, 2015; Iammarino, 2018; Turkina & van Assche, 2018). Regions operate as integrated systems, where actors engage in a complex web of interactions and interdependencies that facilitate the exchange and development of resources, ideas, and technologies. Scholarly research has long examined how these connections contribute to agglomeration advantages i.e. benefits arising from the clustering of firms and industries, which drive innovation and economic growth (Marshall, 1920; Storper, 1997; Cooke et al., 1997; Rodríguez-Pose & Crescenzi, 2008; De Groot et al., 2016; Faggio et al., 2017). While geographical proximity and physical co-location between foreign and domestic firms can enhance flows such as capital, labor, technology and knowledge (Moreno et al., 2005; Rodriguez-Pose & Crescenzi, 2008; Keller, 2004), the mechanisms of these interactions are complex and often transcend regional boundaries. The question is, how do the advantages MNEs' obtain from external linkages contribute to development and innovation within and beyond their own region and networks?

These strategic decisions by MNEs can create both winners and losers in the global economy. In response, policymakers in many developed economies have come up with different suggestions on how to reverse the negative effects of rent shifting and offshoring trends and strengthen domestic manufacturing sectors (Pisano & Shih, 2012). In channeling and influencing the effect of initiatives from policymakers and navigating an uncertain world of various disruptions and technological innovations, MNEs act as pivotal change agents, adapting their business strategies with diverse internal and external implications for the short- and long-term configuration of GVCs. While it is acknowledged that sourcing decisions can affect supply chain relationships, there is insufficient understanding of how these impacts differ across various scales and industries, particularly concerning how different types of firms (large vs. small) and sectors respond to these decisions. In assessing the merits of MNEs' strategic decisions, it is therefore important to look more broadly at different GVC actors' interlinked business dynamics, wherein we ask, how are buyer-supplier relationships at different scales affected by sourcing decisions?

The impact of these sourcing decisions can vary widely depending on factors such as the size of the firms involved, their role within the supply chain, and the specific industry context. Larger firms with extensive global networks may influence their suppliers differently compared to smaller firms with more localized operations. Additionally, the nature of the industry—whether it is heavily reliant on global sourcing or more focused on domestic production—also plays a crucial role. Understanding these factors helps in comprehending how sourcing decisions can shape and reshape the dynamics of entire supply chains, affecting the strategic choices and performance of both large and small actors within the GVC.

Altogether, the complexity of MNEs and their supply chain strategies within GVCs underscores the complex interplay of technological advancements, regional economic strategies, and responses to global disruptions in shaping today's global economic landscape. This chapter builds on four research papers that explore these dynamics in depth: (1) a study examining MNE resilience strategies and co-evolution within GVCs; (2) research into the impacts of offshoring and reshoring decisions on networks of small local subcontractors; (3) research on knowledge spillovers from GVCs, including transmission channels and identifying winners and losers and (4) an analysis of post-COVID value chain realignments in the medical electronics industry amid new digitalization trends. These contributions shed new light on GVC dynamics and the variety of MNE resilience approaches and short- and long-term business strategies within dynamic production networks.

Methods of analysis and data

To investigate MNEs and their supply chain strategies within GVCs, a combination of qualitative and quantitative analyses has been conducted within a variety of industries and regional perspectives. To investigate the resilience strategies employed by MNEs in response to disruptions and recent globalization trends (1), a survey was conducted among manufacturing firms in Denmark with international operations during March and April 2024. The survey, developed from a thorough literature review, focused on key themes, including current and anticipated disruptions, coping strategies, specific changes in supply chain configuration, the effects of these changes, and the mapping of global supply chain activities and locations. It was administered online using Qualtrics software. The survey targeted manufacturing firms with more than 50 employees and significant international activities, including networks of suppliers and/or subsidiaries abroad. Out of 265 responses received (a 32% response rate), 189 met the criteria for significant international operations, and these responses form the basis of our analysis. From the survey data, three resilience strategies were identified. Regression analyses were then performed to explore how MNEs' strategic choices interact with their supply chains and respond to external disruptions (*see further details in Appendix A*).

To further examine how MNEs’ strategic decisions affect GVCs under different conditions, we expanded our focus to the medical device industry (2). We investigated how trade patterns in this sector have been influenced by both the COVID-19 pandemic and new digital technologies. We analyzed global medical device trade trends over the past decade using public databases like UN COMTRADE. This helped identify shifts in major markets and supplier countries before and after the pandemic, and to understand changes in trade across four key product categories. We also looked at the Indian medical device sector using the EXIM databank of the Ministry of Commerce, Government of India. To explore how digital technologies are reshaping value distribution within GVCs, detailed case studies were conducted of two leading EU medical device subsidiaries in India. . This involved analyzing firm-level financial statements and trade data from 2018-19 and 2022-23, focusing on intra-firm and inter-firm transactions. Related party transaction analyses were then used to understand how these companies capture value within their networks. The primary data sources included financial statements from the Ministry of Corporate Affairs and trade data from The Trade Vision (*see further details in Appendix B*).

Spillovers from GVCs are investigated by looking at the case of external knowledge collected by MNEs through external linkages and how related benefits spread across regions and industries (3). These questions are investigated by looking at the innovative performance of 110 Italian NUTS-3 regions from 2007 to 2017, focusing on the manufacturing sector. Innovative performance is measured by the number of patent applications filed to the European Patent Office (EPO), normalized by population. The study further maps the international connectivity of Italian provinces using ownership ties of Italian firms and their subsidiaries, drawn from the Amadeus/Orbis dataset. Network variables are constructed on a three-year basis to account for their effect on local economic performance. Three types of regional connectivity are examined: the external network of Italian MNEs, the internal network of domestic subsidiaries of MNEs, and the national network of other Italian firms near MNE headquarters. Regions can also benefit from the international networks of neighboring regions if they host MNE affiliates. The analysis looks at patent counts and includes measures of these networks to see how they affect innovation. Various controls are used to account for differences across regions, sectors, and time (*see further details in Appendix H*).

Finally, secondary data from the clothing and footwear manufacturing industries were collected to investigate the consequences of offshoring and reshoring decisions for networks of small local subcontractors (4). These industries were chosen as they heavily rely on global sourcing and buyer-supplier relationships. The analysis employs a linear probability model with fixed effects to measure how likely it is for local subcontractors to continue operating or to grow their business over time. This was analyzed in relation to the amount of offshore outsourcing happening in their local labor market area. Data from the Italian Ministry of Economy and Finance's Annual Survey was applied, which covers micro and small Italian firms with annual revenues under 7.5 million euros from 2008 to 2015. This database helped categorize firms based on their role in the value chain, allowing the study to differentiate between small companies engaged in offshore outsourcing and the local subcontractors who might be affected by these decisions (*see further details in Appendix D*).

Findings and discussion

As MNEs navigate their business strategies within GVCs, offshoring and reshoring decisions play a critical role in shaping their internal operations and supplier networks. This chapter contributes with insights into the more internal operations and effects at firm-level and among the variety of GVC actors, while the following chapter will investigate the broader regional and societal effects of these decisions, Our findings indicate that MNEs employ a variety of strategies within their GVCs to address disruptions. These strategies range from flexibility and redundancy to robustness, reflecting how MNEs strive to maintain productivity levels while both adapting to and influencing their supply networks in response to changing conditions. According to our survey of 202 manufacturing firms in Denmark with foreign networks of suppliers and/or subsidiaries, 23% expect to experience disruptions in the next few years, rating these disruptions as likely to very likely (6-7 on a scale from 1 to 7). The table below presents the percentage of companies that assess various external disruptions as highly significant:

Table 1: Share of companies that assess these external disruptions to be highly significant for the company (1= no importance, 4= some importance, 7= very significant importance)

Likelihood scale	6-7
Fluctuations in demand	42%
Changes in price and exchange rate	37%
Regional conflicts (e.g. in Ukraine)	31%
Cyberattacks	29%
Pressure for sustainability	25%
Trade conflicts (e.g. between the USA and China)	20%
Natural disasters (e.g. floods)	13%

These findings highlight that while companies are aware of and address a variety of disruptions, more routine business challenges like fluctuations in demand (42%) and changes in price and exchange rates (37%) still receive the highest levels of concern. This suggests that MNEs prioritize disruptions that directly affect their day-to-day operations and financial performance which are critical to preserve operational efficiency and productivity.

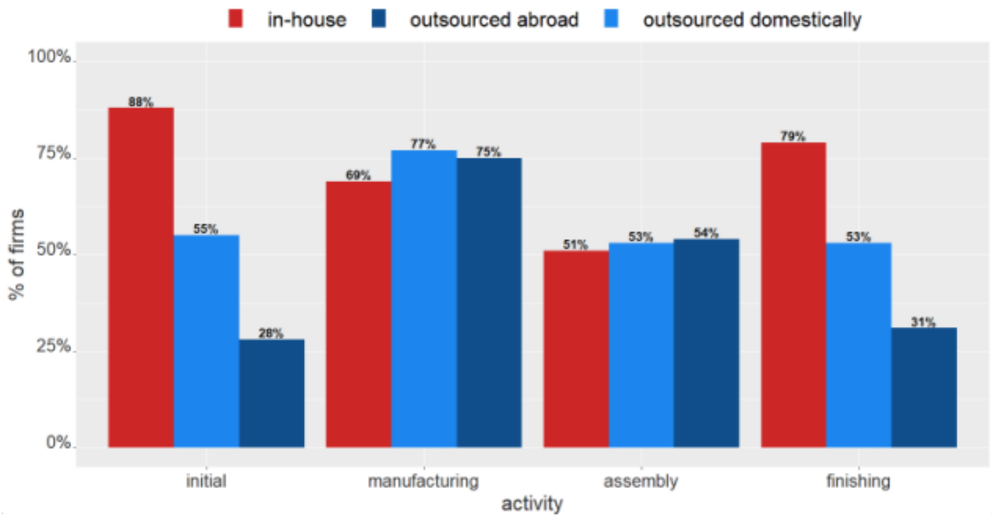
The scanning strategy, robustness strategy, and redundancy strategy each play a crucial role in navigating the various disruptions presented in the table, though they involve different levels of operational restructuring. The scanning strategy emphasizes the use of advanced analytical tools to monitor risks and performance indicators, enabling firms to quickly identify and respond to potential disruptions. This approach is especially valuable in volatile environments, such as emerging markets or regions prone to conflict, where timely information is crucial for adaptation. In contrast, the robustness strategy leverages substantial managerial and financial resources to withstand and recover from disruptions. This strategy aligns with the "engineering-based view" of resilience, focusing on maintaining stability and returning to a pre-disruption state to minimize operational downtime and maintain productivity levels. Firms employing this approach typically address temporary disruptions, such as natural disasters, by utilizing their resources to manage immediate impacts without making major changes to their GVC configurations. The redundancy strategy involves creating slack capacity within the supply chain through reconfiguration. This includes supplier replication, which broadens the supplier network to reduce dependency on individual suppliers, and geographical replication, which diversifies production locations to mitigate regional risks. This approach is particularly suited for dealing with more permanent disruptions, such as trade conflicts or regional instability, by establishing buffer capacities to handle ongoing challenges. While redundancy involves additional costs, it can protect firms from supply chain interruptions, thus safeguarding long-term productivity. Redundancy is, however, the least applied strategy among the surveyed MNEs, suggesting that drastic transitions in response to disruptions are less common than more cautious and gradual responses, such as the scanning and robustness approaches.

Moreover, our analysis reveals interesting findings regarding the dynamics of subcontractor networks within GVCs and some surprising outcomes regarding the impact of offshoring on local subcontractors. Contrary to the expectation that increased offshore outsourcing might displace local subcontractors, the analysis indicates that these subcontractors actually exhibit higher survival rates in areas with greater offshore outsourcing intensity. This suggests that local subcontractors are not only enduring but thriving in regions with high levels of offshore activity. One of the key reasons for this resilience is the prevalent use of dual sourcing strategies by small and medium-sized enterprises (SMEs). Figure 2 shows that from 2008 to 2015, client firms outsourced manufacturing and assembly activities equally to domestic and foreign suppliers. However, small firms preferred to subcontract initial and final stages, like R&D and quality control, to domestic suppliers. This strategy focuses on high-value activities domestically, reducing risks and avoiding becoming final goods producers. 89% of SMEs continue to engage with domestic subcontractors while also incorporating new international suppliers. This dual approach allows MNEs to diversify their sourcing while maintaining established relationships with local subcontractors. The roles of domestic and international subcontractors within the supply chain contribute to this stability. Domestic subcontractors typically handle high-value, complex tasks, whereas international subcontractors often focus on lower-value, specialized functions. This complementary division of labor means that domestic subcontractors continue to play a vital role in the supply chain, even as their clients expand their global networks.

Overall, these findings highlight that offshoring and reshoring strategies do not necessarily disrupt local subcontractor networks but can complement them. This resilience reflects how MNEs' strategic decisions within GVCs can, under certain circumstances, lead to a harmonious integration of global sourcing and local subcontracting, ensuring the stability and continued relevance of local suppliers within the broader global supply chain.

It is important to look beyond trade patterns when investigating GVC configurations and alternative pathways toward greater resilience and look at more intangible flows such as the distribution of knowledge and innovation across regions. Our findings show that maintaining diverse external networks through global operations and supply chains allows MNEs to access valuable knowledge, which enhances innovation in their home regions. While nearshoring might offer benefits such as reducing supply chain risks and strengthening intra-regional ties, it could restrict the regional and societal benefits of broader knowledge spillovers that MNEs gain from their extensive global networks, which likely form part of broader long-term business strategies. MNEs' broad strategic focus helps explain why more drastic responses to disruptions such as redundancy strategies are less pronounced (cf. chapter 2). Our analyses show that external knowledge captured by MNEs significantly improves innovation performance in their regions of origin. On average, increasing the size of an external network by one standard deviation boosts regional patents per thousand inhabitants by almost 8 units. This confirms a positive association between regional external connectivity and innovation performance, indicating that MNEs can act as knowledge gatekeepers, collecting and diffusing knowledge through their foreign subsidiaries.

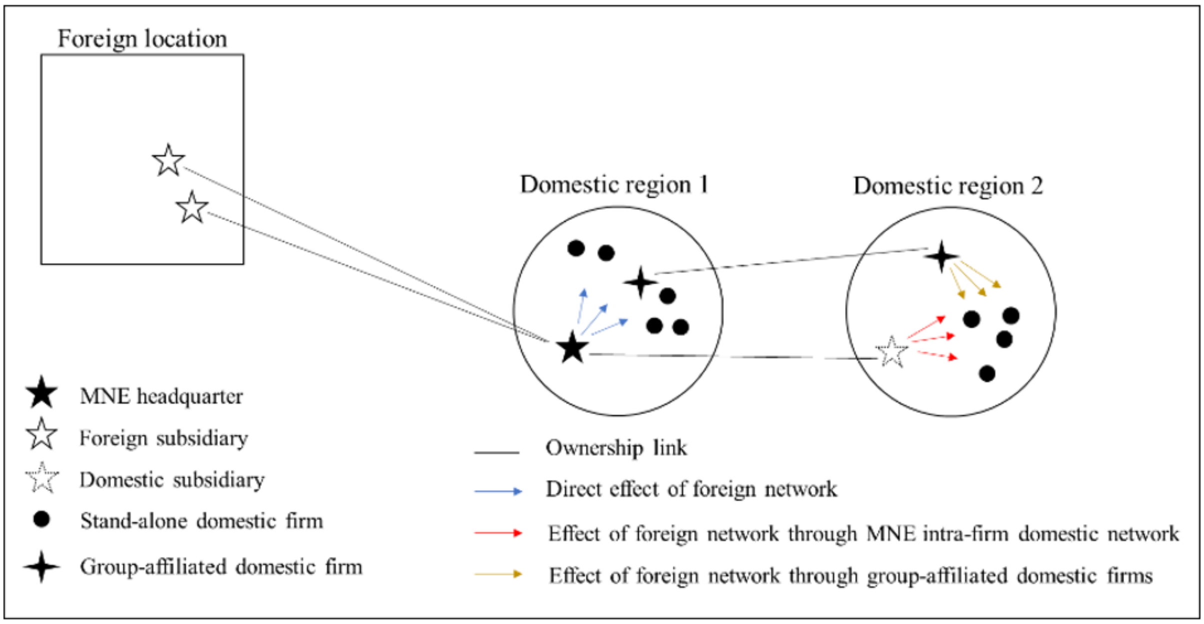
Figure 2: Production process of small client firms: make vs. buy decisions



Source: Data collected by the author

As such, external knowledge spillovers and other network benefits can extend across different locations through MNE subsidiaries, local firms, and other external networks as conceptualized in Figure 6 below. However, the influence of this knowledge on local systems is uneven, with MNEs often deriving greater benefits compared to local firms.The observation from chapter 2 that Indian subsidiaries remain net losers of foreign exchange to the lead firm group further supports this point. This variation in how knowledge flows influence local systems is related to factors such as the absorptive capacity of local firms and the nature of their relationships with MNEs. Additionally, the impact of external knowledge on innovation output differs across technological fields. In technologically advanced sectors, MNEs' external knowledge tends to drive innovation more effectively, while in less advanced sectors, the benefits are more limited. This dynamic highlights that while MNEs can leverage global networks to enhance innovation, the diffusion of this knowledge across local firms and regions varies, depending on both technological intensity and the nature of local firm capabilities.

Figure 3: Stylised conceptual model of knowledge spillover mechanisms



Source: Visualisation by the author

In turn, the case of the medical device industry provides an example of how different , such technological developments can influence global trade patterns. The trade dynamics for two major categories of medical devices—general medical instruments (such as ECG, MRI, ultrasound, and surgical instruments) and radiation machines (like CT and X-ray)—highlight these shifts. For general medical instruments, the US remains a leading global exporter, but its market share decreased between 2019 and 2023. This decline corresponds with a broader trend of MNEs relocating production to countries with lower labor costs, a move that aligns with the traditional "Smile Curve" where higher value-added stages like finance, headquarters, and R&D contrast with lower-margin production stages. Mexico rose to the second-largest exporter, surpassing Germany and China.

In terms of imports, the US continues to be the leading market for general medical instruments, but the Netherlands, Mexico, the UK, and Costa Rica saw the largest increases in import shares from 2019 to 2023. The significant increase in the export and import shares of Mexico followed by Costa Rica, Poland and the Czech Republic highlights how production and sourcing may be shifting due to their increased engagement in the medical device GVCs and in turn influencing trade dynamics and adjusting the distribution of economic rents across different countries. India's increasing import share, reaching 1.3% in 2023, also underscores its growing integration into GVCs. For radiation machines, Germany and the US remain top exporters, with the Netherlands experiencing the most significant gain in export share between 2019 and 2023. This increase aligns with the "Smile Curve" effect, where higher-value-added business functions like R&D and sales are complemented by shifts in production and sourcing. India's slight increase in export share, from 1.5% in 2019 to 1.7% in 2023, reflects its expanding role in medical device GVCs. In the case of imports of radiation machines also, the US was the largest market in 2023, followed by China, though the latter's share has declined since 2020. The Netherlands increased its import share significantly, alongside other EU countries like Spain, Italy, Poland, and the Czech Republic. India's expanding role in both importing and exporting reflects its growing integration in these medical device GVCs, driven by technological advancements and evolving EU MNE business strategies, wherein the latter are also influenced by India's recent industrial policies to promote local production. As EU medical device MNEs enhance digitalization, India's role in GVCs is expanding in software design and analytics for health systems and services. However, our case studies reveal that despite rising software exports, the income share of Indian subsidiaries going to the lead firm abroad has increased compared to pre-pandemic levels.

Altogether, our analyses reveal that the anticipated rapid shifts in offshoring and reshoring, driven by recent disruptions, have not materialized as quickly or dramatically as expected. The findings suggest that changes in GVCs and production strategies are much more gradual and complex than commonly assumed. For MNEs, shifting production or sourcing is not merely a sudden supply chain decision but a significant adjustment that must be integrated into long-term business strategy. This process involves careful consideration of various factors, including technological advancements, market conditions, and strategic goals, rather than immediate responses to disruptions. MNEs engage in a co-evolutionary process, wherein they adapt and evolve their strategies in tandem with changes in the global landscape. This means that rather than being passive victims of disruptions, MNEs actively adjust their business models and value chains over time. The slow pace of these adjustments reflects the need for MNEs to align production decisions with broader strategic objectives and technological developments. As such, while disruptions like the COVID-19 pandemic certainly influence global trade dynamics, they do not alone dictate rapid changes. Instead, MNEs' decisions are shaped by a broader range of considerations and long-term planning processes that contribute to a more gradual and multifaceted evolution in GVCs.

3. Regional and societal effects of GVC restructuring

Contextual background and research objectives

This chapter corresponds to task 5.2 of the grant agreement which seeks to analyse and discuss income distribution and regional cohesion in relation to the more aggregated effects of GVC restructuring. GVCs and their (re)configurations significantly influence the socio-economic landscapes of the regions involved. As GVCs evolve in response to technological advancements, geopolitical shifts, changes in global demand, and various disruptions, they bring about significant changes in the production, distribution, and consumption of goods and services. These shifts can have a profound impact on regional economies, influencing employment patterns, productivity levels, industrial competitiveness, and economic resilience. The configuration of GVCs can either stimulate regional development by fostering innovation and attracting investment or increase disparities by centralizing economic activities in certain areas and marginalizing others.

Since the 1990s, firms leveraged advancements in ICT, lower transportation costs, and trade liberalization to relocate activities abroad. This fragmentation of GVCs aimed to reduce production costs and boost competitiveness, which helped lower prices and enhance economic welfare. These cost reductions contributed directly to improving firms' productivity by allowing them to produce more efficiently. However, recent geopolitical tensions and major global disruptions have challenged this trend toward cost reduction, raising important questions about the future dynamics of GVCs and the extent to which these cost advantages can be maintained. As a result, regions around the world, including Europe, are reconsidering their positions within GVCs and exploring strategies to adapt to these new realities.

Given the potential for significant societal impacts and regional economic shifts resulting from changes in GVCs, Europe is actively seeking ways to adapt and build resilience. This has led to the adoption of the Open Strategic Autonomy approach by the European Union. This comprehensive framework aims to manage the profound technological and geopolitical shifts unfolding on the global stage (Cagnin et al., 2021; Miró, 2023; Tocci, 2021). Embedded within the multifaceted strategies of the Open Strategic Autonomy framework, nearshoring emerges as a key policy to fortify the resilience and autonomy of Europe's production landscape (Alfaro & Chor, 2023). The fundamental premise is clear: by geographically shortening the supply chain through a change in partners' structure, Europe aims to enhance its competitiveness and employment while asserting greater control over critical facets of its production chain. In addition to risk reduction benefits, re- and nearshoring strategies have been advocated as potential tools for growth and mitigation of regional disparities. Specifically, European nearshoring initiatives are expected to target the "factory Europe" in Eastern countries (Baldwin & Lopez-Gonzalez, 2015). However, it is still uncertain if less developed regions in Europe can attract nearshoring activities and play the role of low-labor-cost locations, and to what extent this would be necessary to realize the stated potential of nearshoring to contribute to reducing regional inequalities. Moreover, as GVCs develop and resilience strategies are implemented, the variety of economic outcomes across different regions remains unclear, especially considering existing disparities within Europe. The first question that emerges is whether nearshoring and other -shoring strategies actually are being implemented and at what pace? Second, how do shoring strategies impact supply chain resilience, trade relationships, and regional growth economies?

These processes of change and potential restructuring of GVCs also influence the strategic decisions of MNEs regarding the allocation of business functions which in turn impact the distribution of profit and value across countries and regions. As many industries increasingly shift towards greater softwarization, MNEs are prioritizing the placement of high-value activities, such as research and development (R&D) and management, in regions best suited to capitalize on these innovations. Meanwhile, areas focused on manufacturing and assembly may face different dynamics, as the distribution of value within GVCs becomes increasingly tied to digital capabilities and the ability to innovate. To improve our understanding of the relationship between external challenges and opportunities and MNEs' strategic allocation of business function, we ask, how do business functions and their distributional outcomes, including value-added, profits, and wage rates, vary across different regions?

Altogether, MNEs navigate disruptions, geopolitical and environmental challenges by restructuring different aspects of business operations which generate regional and societal effects across scale. As GVCs develop and resilience strategies are implemented, different regions may expect both positive and negative outcomes in terms of productivity, growth, and competitiveness. In Europe, where significant disparities exist both between and within countries (Camagni et al., 2020; Iammarino et al., 2019; Petrakos et al., 2005), the far-reaching regional and societal effects of GVC restructuring are especially pronounced due to the extensive scope of MNEs' supply chains. Understanding these regional and societal effects is crucial for policymakers, businesses, and communities as they navigate the complex and interconnected global economy. While extensive research has scrutinized the effects of globalization on income distribution (Krenz et al., 2021), the regional impacts remain largely unexplored. This chapter addresses these gaps from various perspectives on the regional and societal effects of different GVC configurations, represented in four key research contributions: (1) a macro-review of the relationship between international fragmentation and productivity growth in GVCs 2000–2014; (2) an analysis of GVC reorganization and regional disparities in Europe; (3) an investigation into machinery production networks that connect East Asia and Europe; and (4) an analysis of the allocation of business functions and rent distribution in factory versus headquarter economies; . By building on these research contributions, this chapter aims to provide empirical evidence and expand the theoretical discussion on the external impacts of different GVC dynamics and shoring trends.

Methods of analysis and data

To investigate the regional and societal effects of GVC restructuring, a combination of quantitative and more qualitative methods are applied. The questions on the drivers and impacts of GVC reorganization have been approached from various perspectives.

To understand the drivers behind the reorganization of GVCs, we examine the relationship between international fragmentation and productivity growth (1) through the development of a measure for the geographical dispersion of GVCs using data from 2000 to 2014 and panel data regression methods. Fixed effects are added to control for other variables that might influence the relationship between geographical fragmentation and unit labor costs in GVCs. Data for both the dependent and explanatory variables come from the annual global multiregional input-output tables of the World Input-Output Database (Timmer et al., 2015). To construct the independent variable, we use geographic distance data from CEPII (Mayer and Zignago, 2011), which measures distances between major cities. This allows us to adapt the supply chain fragmentation indicator from Timmer et al. (2021) to create a new "GVC distance" indicator. This indicator quantifies the number of dollar-kilometers required to produce one dollar of final output, highlighting how transportation distances affect GVCs. For accuracy, we focus on changes in quantities rather than values by deflating the data using WIOD's 'previous year's prices.' Unit labor costs are analyzed as changes in nominal labor costs per unit of output in real terms, as defined by McKenzie and Brackfield (2008). We extend this concept using input-output techniques to include wage costs across all stages of production, following the approach of Herrero and Rial (2023) (*see further details in appendix E*).

As the impacts of most recent disruptions are too early to study due to the lack of macroeconomic data at regional scale, GVC restructuring patterns and regional disparities in Europe (2) are analysed through secondary data from disruptive events and reactions related to the financial crisis in 2008. This dataset has been included as proxy to gain insights on which potential restructuring patterns to expect in the wave of recent disruptions such as COVID-19. As pointed out by Baldwin and Weder di Mauro (2020), both crises share the characteristics of being severe, sudden, and synchronized. Despite the different causes of the shocks (a demand-side crisis in 2008 and a supply-side in 2020), the effects on GVCs' restructuring of the 2008 crisis are useful to understand how GVCs can change in reaction to major economic shocks as well as informing the discussion of which regions might end up as winners and losers in the process. Using MRIO Trade in Value Added Tables from the 2000-2010 EUREGIO database, nearshoring is linked to the 2008 crisis to illustrate GVC restructuring. Focusing on manufacturing in home nearshoring regions and manufacturing and services in host regions, Leontief decomposition is applied to create a matrix showing the origins of value added of exports. Comparing input sources before and after the crisis identifies home and host regions. To measure nearshoring's impact on regional growth and inequalities, a multivariate OLS regression model is used with regional GDP growth from 2013 to 2019 as the dependent variable, and a Host dummy variable broken into quality, low labor cost, and automation conditions. The Shapley decomposition procedure is then applied to assess nearshoring's impact on inequalities. Comparing regional growth with and without nearshoring using the Theil Index for 2019, the study finds the percentage difference indicating inequality changes when nearshoring is neutralized (*see further details in appendix F*).

The extent of implementation of various -shoring strategies was moreover approached by looking at the case of machinery production networks that bridge East Asia and Europe (3). Three types of "shoring" are examined across these supranational regions: near-shoring, economic friend-shoring, and political friend-shoring as explained in the technical appendix F. The latest monthly and annual international trade data until 2023 was analyzed at a finely disaggregated level to examine the impact on machinery production networks facing various risks. This analysis examined how the import sources of EU countries in machinery industries, with a particular emphasis on East Asia, evolved from the pre-pandemic to the post-pandemic period. The investigation included descriptive analysis at the industry level, as well as quantitative and qualitative analysis at the product level. Similar analyses were conducted for non-machinery industries and other regions for comparison (*see further details in Appendix G*).

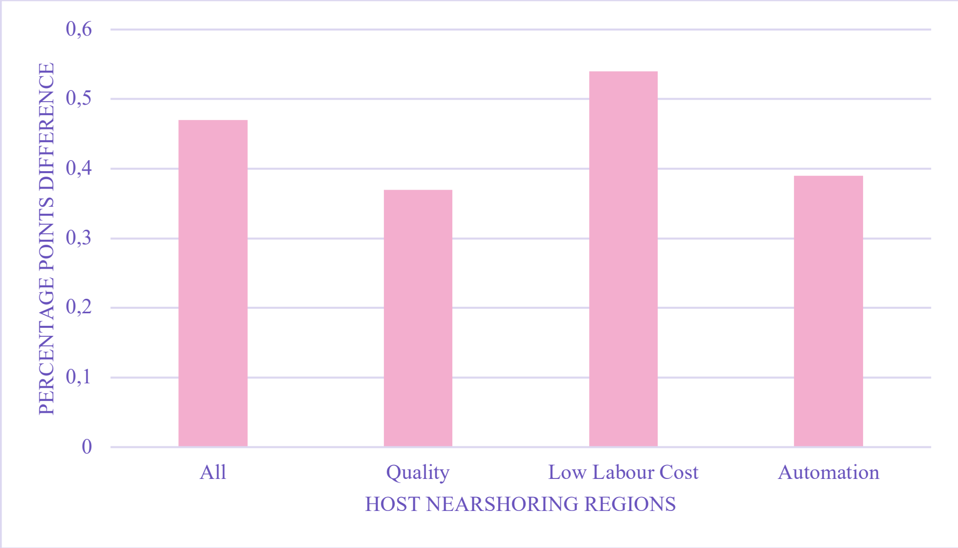
Finally, to investigate decisions regarding the allocation of business functions and rent distribution within GVCs and related outcomes (4), we investigated how rents are distributed between production-oriented and management-focused economies by analyzing data from the Orbis databases. The focus was on greenfield (new) and brownfield (existing) projects by MNE subsidiaries between 2011 and 2022, covering financial details and wage information. Projects were categorized into six key business functions, such as Corporate Headquarters, R&D, and Sales. Using specialized methods, we estimated price mark-ups over costs and assessed labor's contribution to output, with separate evaluations for advanced and developing countries. Key factors we examined included added value, mark-ups, wage rates, and labor costs, along with controls for investment, project numbers, and trade openness. Our analysis also accounted for business cycles and global trends, particularly focusing on manufacturing subsidiaries and European MNEs operating globally (*see further details in Appendix C*).

Findings and discussion

Our findings on regional and societal effects yield significant insights on both drivers and impacts of GVC dynamics and re(configuration). The analysis of the period between 2000 and 2014 reveals trends in GVC fragmentation and its effects on labor costs that pose relevant context for the expected GVC changes amidst more recent developments and disruptions. During this time, GVC fragmentation increased markedly. The GVC distance indicator, which measures the distance involved in producing final outputs, rose from 861 dollar-kilometers to 1117 dollar-kilometers across all final goods and services. For manufactured products specifically, this distance increased from 1464 to 1851 dollar-kilometers. This 25-30% rise in fragmentation reflects a major shift in how and where production activities are distributed globally. The data indicates that sectors such as "other transport equipment," "motor vehicles," and "electrical equipment" had the highest GVC distances in 2014. Among these, "fabricated metal products" saw the most significant increase in fragmentation over the study period. Our analysis found a modest reduction in unit labor costs associated with increased GVC distance. Specifically, a 10% increase in GVC distance was linked to a decrease of about 0.15 percentage points in labor costs. This implies that while relocating production to more distant locations has contributed to lowering labor costs, the effect is relatively small, with unit labor costs averaging around 54% in the sample. We also introduced a new indicator that focuses on quantity effects rather than price changes, addressing issues such as commodity price volatility, which can otherwise obscure the impact of fragmentation. Overall, while GVC fragmentation has increased, the expected substantial reduction in labor costs did not fully materialize. This suggests that other factors beyond the relocation of business activities, such as advancements in automation, have played a more substantial role in shaping labor costs within GVCs and thus in driving productivity gains.

Our analysis of these dynamics helps illuminate the drivers of different shoring strategies. Still, while nearshoring has been discussed as a means to enhance regional economic growth and resilience, our findings reveal that its implementation across Europe has been uneven and not as widespread as anticipated. Although nearshoring has driven economic growth in certain regions, the impact of nearshoring varies significantly depending on regional economic conditions and sectoral focus, with some areas benefiting more than others. Controlling for significant regional economic characteristics, European regions hosting nearshoring exhibit significantly greater growth than others. Figure 4 shows the percentage point difference in regional growth for various forms of Host nearshoring regions, illustrating that all forms of Host regions benefited from nearshoring during the 2013-2019 period. These results are based on the regression analysis detailed in Appendix F.

Figure 4: growth rates of Host nearshoring regions compared to other regions



Source: Data collected by the author

However, our aggregated analysis shows that nearshoring increases overall disparities, as reflected in a higher total Theil Index. This is mainly because nearshoring tends to widen differences between countries, with advanced regions benefiting more. Specifically, regions with advanced automation technology, often found in these advanced countries, see significant advantages from nearshoring. However, the impact within individual countries is more nuanced. Although the overall effect is smaller, nearshoring can help reduce inequalities within countries by directing investment to less developed or economically challenged areas. This means that while nearshoring amplifies global disparities, it can also contribute to a more balanced distribution of benefits within each country.

The impact of nearshoring varies depending on the type of region. In regions where companies relocate production to enhance product quality or capitalize on the reputation of certain locations, nearshoring tends to increase disparities. These regions are usually wealthier, and nearshoring in such areas exacerbates spatial inequalities both between countries and within the same country. On the other hand, nearshoring in regions with low labor costs helps reduce regional disparities within countries. This is particularly evident in growing, medium-sized manufacturing cities in Eastern countries, where nearshoring supports development and narrows the gap with larger, more advanced cities. Additionally, in areas with high automation technology, while nearshoring generally increases overall disparities, it can have a positive effect on reducing disparities within advanced countries by benefiting less developed regions within those nations. Figure 5 summarises the variation of the Theil Index compared to the reference one in the presence of nearshoring for different types of Host regions.

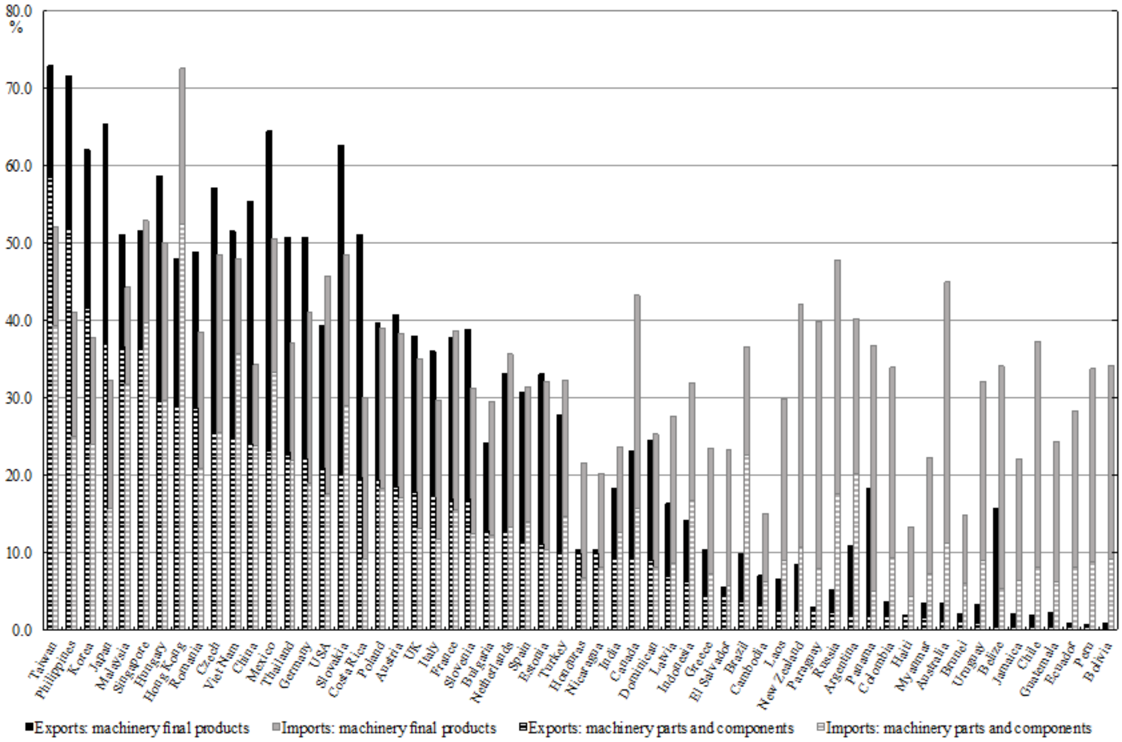
Figure 5: Interregional inequalities in presence of nearshoring

Source: Data collected by the author

Additionally, the strong trade relationship between the EU and East Asia continues to play a crucial role, indicating that economic factors such as cost-efficiency and reliability remain significant considerations in MNEs' long-term business strategies despite the anticipated momentum for nearshoring strategies. In our investigation of machinery production networks, an analysis of monthly exports of machinery parts, components, and final products reveals that East Asia experienced a smaller negative impact and quicker recovery from COVID-19 compared to the Americas and Europe, indicating a more resilient production structure. Up to 2023, East Asia's strong inter-regional linkages as a supplier have been sustained, owing to effective COVID-19 management, targeted government policies that protected crucial industrial sectors, and the region's dominance in general and electrical machinery. Additionally, the increase in e-commerce during the pandemic has further reinforced East Asia's central role in global supply chains.

Overall, East Asia has managed to maintain and even strengthen its trade ties with the EU. This trend is supported by our product-level analyses which yielded three main results. First, it shows that post-pandemic, EU countries increased imports from ASEAN and China, especially in general and electrical machinery. Second, there is no quantitative evidence of intensified near-shoring in machinery industries for the EU post-pandemic, as imports from longer-distance countries also increased. Third, it shows that EU countries prioritized friend-shoring from an economic perspective but not necessarily from a political one, indicating that economic considerations still play a significant role in machinery production networks. Overall, the trade relationship between the two supranational regions continues to be notably imbalanced, with East Asia serving as a significantly larger supplier, particularly in general and electrical machinery.

Figure 6: Each Country's Machinery Shares in Total Exports and Imports in 2021



Source: Ando, Kimura, and Yamanouchi (2024)

The strong trade ties between East Asia and the EU, highlight the resilience and continued importance of existing trade patterns and supply chains. This persistence indicates that, despite discussions around nearshoring and shifting trade routes, economic considerations such as cost-efficiency and reliability concerning long-term business strategies remain paramount.

In further examining how MNEs decide where to locate their business functions, we looked at how economic rents are distributed across different stages of production and business functions. Our analysis confirms the traditional "Smile Curve," which shows that value-added is typically higher in pre- and post-production stages—like finance, business services, headquarters, and sales/marketing—compared to the production stage. However, different variables reveal distinct patterns. Non-EU MNEs generate more value in Financial and Business Services (FBS) and achieve higher profits in Services, Management, and Logistics (SML) compared to EU-based MNEs. This means non-EU MNEs are more effective at adding value in these areas. In contrast, EU-MNEs face lower profit margins in FBS, partly due to higher wages and greater labor costs compared to non-EU MNEs. Here, the "Smile Curve" pattern is evident as functions like finance, headquarters, and R&D (including ICT) often have lower markup ratios despite higher wage rates. This reflects the tendency for MNEs to locate production in countries with lower wages, which affects profit margins across different functions. Thus, the distribution of value-added differs from other economic measures like markup ratios and labor cost shares, highlighting how MNEs' location choices impact value generation and profitability. Overall, these findings demonstrate the different specializations and comparative advantages of EU and non-EU MNEs across various business functions, influenced by their strategic decisions on where to locate production and other key activities.

Altogether, our findings on the regional and societal effects of GVCs and different restructuring strategies show that nearshoring is not a panacea for global supply chain resilience, productivity, and growth. While the strategy offers potential benefits, such as reducing risks and promoting within-region prosperity, the distribution of such benefits is uneven. Our findings illustrate the complexity of how various dynamics, such as regional economic conditions, sectoral focus, and technological capacity, can differently influence regional growth, productivity, and regional inequalities. Furthermore, the restructuring of GVCs is itself not uniform; MNEs navigate disruptions in diverse ways, driven by broader business strategies that account for a range of factors beyond shoring, such as cost-efficiency, risk management, and innovation. This diversity highlights the co-evolution of external effects and internal goals, where MNEs not only adapt to but also shape the configuration of GVCs.

4. Summary of key findings

The transformation of GVCs is a nuanced and multifaceted process, shaped by a range of strategic considerations and geopolitical and technological developments. Although there has been considerable discussion about reshoring and nearshoring as immediate responses to geopolitical and economic disruptions, the reality is far more nuanced. Our report suggests that MNEs are not uniformly moving towards these strategies but are instead adopting a range of approaches tailored to specific conditions and long-term objectives. Strategies such as maintaining robust supply chains while enhancing flexibility reflect a careful balancing of risk management and cost efficiency.

The findings confirm the key trend in function specialization within GVCs. MNEs are increasingly adopting nuanced approaches to how they allocate different functions across their global operations. They are not simply reshoring or nearshoring in response to disruptions but are strategically positioning various functions to optimize efficiency, value, and new knowledge. This involves balancing high-value, complex tasks with lower-value, specialized activities, and leveraging both local and international resources.

The dynamics between function specialization, rent distribution, and uneven distribution of socioeconomic impacts from various shoring strategies further reveal a persistent tension between regional integration and global connectivity. Despite the push towards nearshoring and strengthening of regional supply chains, MNEs continue to value the benefits of maintaining extensive global networks as these networks not only provide cost advantages but also enable access to diverse pools of knowledge and innovation. The dual focus on resilience and global reach underscores the strategic complexity facing MNEs as they navigate current economic challenges.

The findings further illustrate that the impact of these strategies is not uniform across all regions, and the anticipated socioeconomic effects of GVC restructuring are often more complex than expected. For example, the expected benefits driving the fragmentation of GVCs through strategies such as outsourcing turn out to have quite a limited impact on labor costs in practice. In parallel, the advantages of nearshoring are highly dependent on the specific regions involved. The research indicates that regions with advanced technologies and a proactive approach to integration in global networks stand to benefit the most from changes in supply chain strategies. These regions can harness new opportunities for economic growth and innovation by effectively aligning their local capacities with the evolving needs of MNEs. In turn, other regions may find that disparities are exacerbated if they cannot adapt quickly enough or attract the necessary investments and skills. This trend also applies to the factors determining the winners and losers in GVC developments beyond the EU. EU lead firms and their foreign subsidiaries can utilize their strategic positions and digitalization efforts to leverage the strengths and specialization capabilities of countries outside the EU, thereby enhancing their own networks and benefiting their home regions. Even when countries like India expand their role in the EU MNEs' R&D for data-centric processes and product innovations through high-level software design skills and specialization, this does not automatically lead to a greater share of value addition for the host countries.

Overall, the findings in this report indicate that GVCs are evolving in a gradual manner, shaped by a multitude of factors including economic efficiency, regional stability, technological advancements, and the pursuit of innovation. This complex causation underscores the deeply interconnected and co-evolutionary nature of the global economy. Moreover, as GVCs adapt, they contribute to shifting patterns of economic opportunity and inequality across different regions. In this environment, MNEs are not simply reacting to disruptions in isolation; they are operating within a dynamic system where actions and decisions are continually influenced by the interconnectedness of global markets, suppliers, and customers. The idea of making rapid and substantial strategic reconfigurations is often impractical because these changes do not happen in a vacuum. The interdependence within GVCs means that MNEs cannot simply exit trade relationships or markets without significant consequences.

Strategic decisions must account for a multitude of interconnected factors, including long-standing partnerships, market commitments, and regulatory requirements. Thus, while MNEs might seek agility in response to disruptions, the reality of high entropy in their interconnected networks often necessitates a more measured and adaptive approach, balancing immediate responses with the long-term sustainability of their global operations. While major transitions of supply chains may not yet be as widespread, there are significant trends in the current GVC setup with regard to the factors driving regional and societal disparities which need to be addressed regardless of the pace of MNE-driven restructuring.

5. Conclusions and policy implications

1. **MNE resilience strategies and GVC dynamics:** MNEs adopt a cautious approach to resilience, favoring strategies that are less costly and focus on reducing uncertainty rather than drastically reconfiguring operations toward an unpredictable future. They prioritize gathering more information to enable quicker reactions to emerging developments. Policymakers can better support MNEs by enhancing technologies that improve real-time information flow and transparency within GVCs. Government agencies and embassies should also provide MNEs with detailed insights and forecasts about future market scenarios to aid in strategic planning. Improving policymakers' and practitioners' understanding of the complex environments in which MNEs operate is critical to helping these firms navigate disruptions and technological advancements, ensuring sustainable and resilient value chains.

2. **Function specialization in GVCs**: MNE subsidiaries engaged in pre- and post-production activities, such as R&D and marketing, tend to generate higher value-added, leading to higher wages and a larger share of income going to labor. This distribution of economic benefits varies depending on the region. For instance, Western European countries (EU14) are more likely to attract high-value functions like R&D and marketing, which bring better wage outcomes. In contrast, Central and Eastern European countries (EU-CEE) more often host production activities that, while profitable for companies, result in lower wages. When formulating policies to attract MNEs, it is thus crucial to consider factors beyond traditional measures like value-added. By recognizing and addressing the unique attributes and challenges of each region, policies can foster equitable growth and reduce regional disparities while enhancing overall effectiveness in attracting and retaining MNE business functions.

3. **International fragmentation and labor costs:** GVCs have become increasingly fragmented, with production spread across distant locations, especially in industries like transport equipment, motor vehicles, and electrical equipment. This global dispersion aimed to cut labor costs by tapping into cheaper markets, but the actual savings have been modest. Policymakers should recognize that the cost efficiencies of globally dispersed supply chains have been less than expected, implying that re- and nearshoring strategies may not significantly raise overall production costs.

4. **Production networks post-COVID:** Factors like price, quality, and supply chain flexibility often hold more weight in business strategies than geographic proximity, even amid geopolitical tensions. As such, policymakers should consider these carefully to avoid unnecessary costs of the interventions to

promote near-shoring. The EU's heavy reliance on imports from East Asia, particularly China, suggests that diversification is a stepping stone towards more resilient supply chains. Reducing policy-driven uncertainties, especially around trade with China, is crucial to maintaining a stable business environment while pursuing diversification efforts.

5. **Impacts of nearshoring on regional disparities in Europe**: Nearshoring stimulates economic growth in some European regions, but it can also exacerbate regional inequalities. While more advanced regions benefit significantly, less developed areas may see only marginal improvements. Policymakers and institutions should adopt a nuanced approach to nearshoring and backshoring, tailored to the diverse circumstances of different regions, including reinforcing strong regions and fostering innovative strategies for declining areas.

6. **Shoring strategies and subcontractor dynamics**
   Offshore outsourcing by small and medium-sized enterprises (SMEs) generally supports the survival of local subcontractors rather than displacing them. This contrasts with findings for larger firms, which often show reduced domestic subcontracting relationships. Reshoring policies should consider the specific dynamics of SMEs, recognizing that their dual sourcing strategies complement rather than replace local subcontracting. Supporting local subcontracting networks can enhance regional competitiveness and resilience in response to global economic shifts.

7. **Knowledge diffusion and regional innovation:** External knowledge from global networks is vital for regional innovation, with domestic MNEs acting as key knowledge gatekeepers. While benefits are more significant for internationally engaged firms, only firms in science-based manufacturing sectors are able to fully absorb and diffuse this knowledge within regions. Policies should encourage local firms to establish global connections, particularly through outward FDI, while recognizing that external linkages may not automatically deliver broad regional benefits. Additionally, attracting domestic operations of MNEs can enhance knowledge flow, especially in regions less favorable for firm internationalization.

8. **Digitalization and post-COVID value chain realignments:** Digitalization improves efficiency of the EU MNEs, but does not always translate into increased value addition for host countries like India. Despite India's growing contribution in the EU MNEs' data-centric innovations, EU firms maintain significant control over innovation and data. To address this imbalance by ensuring fair distribution of innovation benefits, the EU must enable a rights-based resource ownership regime for data, apart from promoting interoperability in medical technologies. Strengthening competition and data governance policies will support

innovation and maintain a competitive market, ensuring equitable access to healthcare in the EU and its GVC partner countries.

6. Next steps in TWINSEEDS

This WP5 has contributed to the TWINSEEDS project by examining both the ongoing and anticipated transformations in global value chains (GVCs). Driven by the need for greater supply chain resilience, technological advancements, economic nationalism, and sustainability imperatives (as outlined in WPs 1-4), WP5 investigated the extent of regionalization, reshoring, nearshoring, multi-sourcing, and reduced fragmentation in GVCs. This analysis focused on the resulting changes in GVC geography, identifying key hubs and peripheral areas, and assessed the impacts on productivity, competitiveness of MNEs, and firm-level risks and resilience.

The following WP6 aims to identify the likely GVC New Normal Scenario for Europe. This scenario will address the balance between long-term global integration and ongoing challenges, such as changing geopolitics, strategic shifts in international trade policies, environmental policies, and the impacts of the COVID-19 pandemic and the conflict in Ukraine. Finally, WP7 will build on the findings from WPs 1-6, particularly the scenarios identified in WP6. WP7 will propose potential EU policies to support the development of robust and sustainable supply chains while maintaining openness and engagement with key global partners. The objective is to balance the pressures from geopolitical and technological shifts to ensure a resilient, sustainable, and competitive European GVC landscape.

7. References

Alfaro, L., & Chor, D. (2023). Global Supply Chains: The Looming "Great Reallocation" (No. 31661; NBER Working Papers). https://doi.org/10.3386/w31661.

Baldwin, R., & Lopez-Gonzalez, J. (2015). Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. *The World Economy*, 38(11), 1682–1721. https://doi.org/10.1111/twec.12189.

Baldwin, R., & Weder di Mauro, B. (2020). Mitigating the COVID Economic Crisis: Act Fast and Do Whatever It Takes. A VoxEU.org Book. CEPR Press, London.

Bathelt, H., & Cohendet, P. (2014). The creation of knowledge: Local building, global accessing and economic development – toward an agenda. *Journal of Economic Geography*, 14, 869–882.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, 28(1), 31–56.

Boschma, R., & Iammarino, S. (2009). Related variety, trade linkages, and regional growth in Italy. *Economic Geography*, 85(3), 289–311.

Brun, L., Gereffi, G., & Zhan, J. (2019). The "lightness" of Industry 4.0 lead firms: Implications for global value chains. In Bianchi, P., Duran, C.R., & Labory, S. (Eds.), *Transforming Industrial Policy for the Digital Age: Production, Territories and Structural Change*. Cheltenham and Massachusetts: Edward Elgar.

Camagni, R., Capello, R., Cerisola, S., & Fratesi, U. (2020). Fighting Gravity: Institutional Changes and Regional Disparities in the EU. *Economic Geography*, 96(2), 108–136. https://doi.org/10.1080/00130095.2020.1717943.

Cagnin, C., Muench, S., Scapolo, F., Stoermer, E., & Vesnic Alujevic, L. (2021). *Shaping and securing the EU's Open Strategic Autonomy by 2040 and beyond*. Publications Office of the European Union. https://doi.org/10.2760/414963.

Chacko, P. (2021). A new quest for self-reliance: East Asia and Indian economic nationalism. *The Journal of Indian and Asian Studies*, 2. https://doi.org/10.1142/S2717541321400052.

Cooke, P., Uranga, M.G., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, 26(4-5), 475–491.

De Groot, H.L., Poot, J., & Smit, M.J. (2016). Which agglomeration externalities matter most and why? *Journal of Economic Surveys*, 30(4), 756–782.

Ernst, D., & Kim, L. (2002). Global production networks, knowledge diffusion, and local capability formation. *Research Policy*, 31(8-9), 1417–1429.

Faggio, G., Silva, O., & Strange, W.C. (2017). Heterogeneous agglomeration. *Review of Economics and Statistics*, 99(1), 80–94.

Francis, S. (2023). Unpacking the Industry 4.0 Narrative and its Implications. *Economic and Political Weekly*, Vol. CMLVIII, No. 10, pp. 19-25.

Francis, S. (2018). *Evolution of Technology in the Digital Arena: Theories, Firm-level Strategies and State Policies*. CWS Working Paper No. CWS/WP/200/47. New Delhi: Centre for WTO Studies.

Herrero, D., & Rial, A. (2023). Labor Costs, KIBS, and Export Performance: A Comparative Analysis of Germany and Mediterranean Economies. *Structural Change and Economic Dynamics*, 65(1), 184–198.

Iammarino, S. (2018). FDI and regional development policy. *Journal of International Business Policy*, 1, 157–183.

Iammarino, S., Rodriguez-Pose, A., & Storper, M. (2019). Regional inequality in Europe: evidence, theory and policy implications. *Journal of Economic Geography*, 19(2), 273–298. https://doi.org/10.1093/jeg/lby021.

Keller, W. (2004). International Technology Diffusion. *Journal of Economic Literature*, 42(3), 752–782.

Krenz, A., Prettner, K., & Strulik, H. (2021). Robots, reshoring, and the lot of low-skilled workers. *European Economic Review*, 136, 103744. https://doi.org/10.1016/j.euroecorev.2021.103744.

Lawrence, M., Homer-Dixon, T., Janzwood, S., Rockström, J., Renn, O., & Donges, J.F. (2024). Global polycrisis: the causal mechanisms of crisis entanglement. *Global Sustainability*, 7, e6, 1–16. https://doi.org/10.1017/sus.2024.1.

Lund, S., Manyika, J., Woetzel, J., Barriball, E., Krishnan, M., Alicke, K., Birshan, M., George, K., Smit, S., Swan, D., & Hutzler, K. (2020). *Risk, resilience, and rebalancing in global value chains*. McKinsey & Company, Washington, DC.

Marshall, A. (1920). *Industry and Trade*. London: Macmillan & Co. Ltd.

Mayer, T., & Zignago, S. (2011). Notes on CEPII's Distance Measures: The GeoDist Database. CEPII Working Paper 2011-25. Paris: CEPII.

McKenzie, R., & Brackfield, D. (2008). The OECD system of unit labour cost and related indicators. *OECD Statistics Working Paper* 2008/04. Paris: OECD.

Miguélez, E., & Moreno, R. (2015). Knowledge flows and the absorptive capacity of regions. *Research Policy*, 44(4), 833–848.

Miró, J. (2023). Responding to the global disorder: the EU's quest for open strategic autonomy. *Global Society*, 37(3), 315–335. https://doi.org/10.1080/13600826.2022.2110042.

Moreno, R., Paci, R., & Usai, S. (2005). Spatial spillovers and innovation activity in European regions. *Environment and Planning A*, 37(10), 1793–1812.

Owen-Smith, J., & Powell, W. (2004). Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science*, 15, 5–21.

Ozdemir, D., Sharma, M., Dhir, A., & Daim, T. (2022). Supply chain resilience during the COVID-19 pandemic. *Technology in Society*, 68, 101847. https://doi.org/10.1016/j.techsoc.2021.101847.

Pedroletti, D., & Ciabuschi, F. (2023). Reshoring: A review and research agenda. *Journal of Business Research*, 164, 114005. https://doi.org/10.1016/j.jbusres.2023.114005.

Petrakos, G., Rodríguez-Pose, A., & Rovolis, A. (2005). Growth, integration, and regional disparities in the European Union. *Environment and Planning A: Economy and Space*, 37(10), 1837–1855. https://doi.org/10.1068/a37348.

Pisano, G.P., & Shih, W.C. (2012). *Producing Prosperity: Why America Needs a Manufacturing Renaissance*. Harvard Business Press.

Rodríguez-Pose, A., & Crescenzi, R. (2008). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional Studies*, 42(1), 51–67.

Storper, M. (1997). *The Regional World: Territorial Development in a Global Economy*. Guilford Press.

Timmer, M.P., Dietzenbacher, E., Los, B., Stehrer, R., & de Vries, G.J. (2015). An illustrated user guide to the World Input-Output Database: The case of global automotive production. *Review of International Economics*, 23(3), 575–605.

Tocci, N. (2021). *European Strategic Autonomy: What It Is, Why We Need It, How to Achieve It*. [Publisher details needed].

Turkina, E., & Van Assche, A. (2018). Global connectedness and local innovation in industrial clusters. *Journal of International Business Studies*, 49(6), 706–728.

8. Technical appendices

Appendix A: Are the GVCs becoming too vulnerable and less resilient?

We conducted different analyses to understand clusters of practices as representing firms' strategies. By running factor analyses among the applied mitigation measures we identified the three strategies of scanning, robustness, and redundancy.

Below are listed the items that form each of the three strategies (all items are measured on a 7-point scale). Listed is also the Cronbach alpha-value and the mean value for each strategy:

Scanning strategy (Cronbach alpha: 0.72 – mean: 4.52):

- Does your company conduct ongoing risk assessments in relation to various external factors?
- Are you familiar with your suppliers in the 2nd and 3rd tiers?

Robustness strategy (Cronbach alpha: 0.75 – mean: 4.75):

- How well do you consider the company is equipped for unforeseen events in your business environment?
    - We have the skills and resources to adapt to unforeseen events
    - We have the financial strength to address minor disruptions
    - Our market position enables us to withstand unforeseen event

Redundancy strategy (Cronbach alpha: 0.83 – mean: 4.30):

- We have multiple suppliers that we can easily switch between
- We have extra production capacity that can be quickly utilized

It is noteworthy that each of the three strategies is a variable that varies for each company, which implies that a company can mix the three strategies. As such we are not measuring a single strategy for each company, but the extent to which each of the three strategies are applied in the companies. The robustness strategy turned out to have the highest mean of 4.75 indicating that it is the most used strategy, while the redundancy strategy is the least used strategy with a mean of 4.30.

We then conducted three separate regression models to test how the prevalence of the three resilience strategies varies with exposure to potential disruptions associated with the GVC configuration and different external conditions. Applying regression models allows us to control for the effect of other potential disruptions.

The results of the regression models with the relation between the resilience strategies and the contextual factors are shown in Table 1. In the table, we list eight antecedents to the strategies (four reflecting the configuration of the GVC and four external conditions in the form of potential disruptions).

Table A1: Regression models on the three strategies and their antecedents (N=202)*

	Scanning	Robustness	Redundancy
Configuration of the value chain			
Number of employees VIF=1.27	**0.50*** std=0.24 (p=0.04)	**0.27** std=0.23 (p=0.24)	**0.40** std=0.27 (p=0.14)
Number of countries with suppliers VIF=1.28	**-0.16** std=0.25 (p=0.51)	**0.57**** std=0.24 (p=0.01)	**-0.35** std=0.27 (p=0.21)
If suppliers in Europe VIF=1.31	**-0.46** std=0.28 (p=0.11)	**-0.26** std=0.27 (p=0.34)	**-0.17** std=0.28 (p=0.58)
If suppliers in Emerging markets VIF=1.54	**0.72**** std=0.27 (p=0.01)	-**0.25** std=0.25 (p=0.33)	**0.56** std=0.27 (p=0.05)
External conditions			
Trade conflicts as potential disruption VIF=1.45	**0.38** std=0.26 (p=0.16)	**-0.23** std=0.25 (p=0.36)	**0.69**** std=0.30 (p=0.01)
Natural disasters as potential disruption VIF=1.44	**0.01** std=0.26 (p=0.96)	**0.60**** std=0.24 (p=0.01)	**0.36** std=0.27 (p=0.21)
Regional conflicts as potential disruption VIF=1.22	**0.44*** std=0.24 (p=0.05)	**0.31** std=0.22 (p=0.17)	**0.72***** std=0.26 (p=0.001)
Changes in price and exchange rate VIF=1.38	**0.52*** std=0.25 (p=0.04)	**-0.18** std=0.24 (p=0.45)	**0.04** std=0.28 (p=0.90)
Intercept	3.52 std=0.36 (p=0.001)	4.67 std=0.34 (p=0.001)	3.44 std=0.40 (p=0.001)
R-square F-value	0.35 6.37*** (p=0.001)	0.18 3.93** (p=0.01)	0.22 4.53** (p=0.01)

**The table lists for each strategy the coefficients, the standard deviation of the coefficients, the p-value, and the Variance Inflation Factor for each variable.*

The model fit with the data is good as the F-value for all three models is significant at 1%-level with the F-value spanning from 3.93 to 6.37. The level of variance explained in the three strategies is also good as it spans from 18% for the robustness strategy to 35% for the scanning strategy.

Appendix B: Post-COVID value chain re-alignments amidst new digitalization

The study used a mixed method approach, combining primary and secondary data analyses with qualitative information. The latter used detailed semi-structured interviews with company officials and medical device industry domain experts, as well as secondary sources such as newspaper reports and company press releases on digital transformation strategies, annual market performance, etc.

The first research question was examined through industry-level trade analyses to capture any changes in aggregate trade patterns in the medical device industry from GVC re-alignments. This was carried out through an analysis of the trends in global and Indian medical device industry trade over the last decade using public databases, towards capturing the changes if any in the nature and/or direction of global medical device exports and imports. Trade analysis at the global level was done using data from the UN COMTRADE database, while the analysis for Indian medical devices industry trade was done using the EXIM database of the Ministry of Commerce and Industry, Government of India. The former helped us identify the top countries involved in global medical devices trade over the past decade, and the changes, if any, in the major markets and supplier countries' relative positions in the pre- and post-Covid years. We also used the global analysis to identify changes, if any, in the composition of medical devices trade. Indian trade data analysis similarly provided us with an understanding of composition and direction of the country's medical devices trade. The medical device industry trade analysis was carried out in terms of its four major sub-segments (HS 9018, 9019, 9021 and 9022) as listed below.

HS 9018-ECG, MRI, Ultrasound, surgical instruments
HS 9019-Mechano-therapy appliances, oxygen therapy apparatus, etc.
HS 9021-Hearing aids, pacemakers, etc.
HS 9022-CT, X- ray and other radiation machines

The second research question of how the value chains of medical electronics firms are being influenced by digitalisation and the related central propositions were examined using standardised in-depth case studies of two of the leading EU medical device subsidiaries in India.
The latter involved detailed analyses of how their value chain dynamics has been evolving since 2018-19, using firm-level financial statements and customs trade data to examine their intra-firm and inter-firm transactions as well as interviews.

Detailed analyses of Related Party/RP transactions in goods and services were used to capture intra-firm (or within-group) networks based on the methodology developed in Francis and Kallummal 2020 and Francis 2021, to help us understand the lead firm group's value capture.

Related parties include the ultimate holding company, holding company, fellow subsidiaries and associate firms.[1] That is, related parties are the 'participations' of the lead firm globally & domestically, other than the selected Indian subsidiary.

Analyses of overall company financials along with related party transactions in both financial statements and customs trade data were used to arrive at trends in the value added capture by the EU lead firm within its own group.

The major sources of data for the case study analyses were the annual financial statements of companies available from the Ministry of Corporate Affairs (MCA), which were downloaded using the service provider eformdownloader.com. The firm-level trade analysis was carried out using customs trade data for two years 2018-19 and 2022-23 from the commercial market research firm, The Trade Vision.[2]

It is relevant to discuss some of the possible data issues arising in the course of the case study analyses. In India, it is mandatory to report only 'material' related party transactions, or those transactions above a particular threshold value, in the Annual Financial Statements (AFS). For example, that for Philips, only those RP transactions that are valued above INR 1 million == USD 12,050 == Euro 11,075 are reported by the Indian subsidiary in the AFS. Even for 'material' transactions, we face significant issues with missing data. The details of foreign exchange earnings and expenditure and related party transactions in goods and services are frequently under-reported, unreported or reported as 'Nil' by even these large companies. AFS in some years do not even report import/ export values or other foreign exchange transactions, even when RP transactions may be reported under some aggregate level. This may preclude the calculation of value share of the lead firm (ultimate holding company) & fellow subsidiaries in the Indian subsidiary's revenue share and net forex earnings. On the other side, the identification of inter-firm networks is constrained by the fact that the disclosure of unrelated party transactions is not mandatory in India.

In firm-level customs trade data used to overcome these data issues, foreign supplier and buyer names/addresses, and ports of origin/destination can also be unreported, wrong or incomplete. The latter can be known only after commercially purchased data for any particular firm is bought, cleaned and standardised. Further, the ability to obtain specific information on local non-related parties of the case study firms (that is, their Indian suppliers/buyers) and the case study firms' networks for all their services transactions (including digital services) is dependent on the willingness of interviews to share such information.

[1] Given that our objective is to capture transactions within the lead firm's group, we do not include 'key management personnel' as related parties in the analysis of lead firm's intra-firm transactions.
[2] The Trade Vision, www.ttv.com

Appendix C: Factory economies and headquarter economies: A new form of rent shifting?

Methodology followed to arrive at econometric estimates:

The underlying databases give us financial information of foreign-owned subsidiaries that have greenfield and brownfield projects invested by MNCs (GUOs … global ultimate owners) across the globe over the period 2011-2022.

On the basis of this information we can estimate mark-ups linked to these projects, following the methodology proposed by De Loeker et al. (2020).

$$\boldsymbol{\mu_{ft}} \equiv \frac{\boldsymbol{P_{ft}}}{\boldsymbol{c_{ft}}} = \frac{\boldsymbol{P_{ft}Q_{ft}}}{\boldsymbol{c_{ft}Q_{ft}}}$$

where firm $\boldsymbol{f}$ produces its final output $\boldsymbol{Q_{ft}}$ in year $\boldsymbol{t}$ with an unobservable price $\boldsymbol{P_{ft}}$ with a marginal cost of $\boldsymbol{c_{ft}}$ as a function of its capital $\boldsymbol{K_{ft}}$ and a variable input $\boldsymbol{V_{ft}}$, whose price $\boldsymbol{P^{v}_{ft}}$ should be optimally equal to its marginal product. Since prices are not observable, the markup of firm $\boldsymbol{f}$ can be calculated as follows:

$$\boldsymbol{\mu_{ft}} = \boldsymbol{\theta^{v}_{ft}} \frac{\boldsymbol{P_{ft}Q_{ft}}}{\boldsymbol{P^{v}_{ft}V_{ft}}}$$

De Loeker et al. (2020) use costs of goods sold as a proxy for the variable cost. However, the coverage of this variable is not comparable across countries with many poor and reliable data from many economies. Therefore, we opt for the costs of employees $W_{ft}L_{ft}$ as the variable cost in the calculation of markup as follows:

$$\mu^{y}_{ft} = \theta^{l,y}_{ft} \frac{Y_{ft}}{W_{ft}L_{ft}}$$

However, since the operating revenue/turnover Y_{ft} of the firm includes the value of materials used in the production, in a new definition of markup, we use the value added AV_{ft} reported in the financial reports. We identify this markup as follows:

$$\mu^{av}_{ft} = \theta^{l,av}_{ft} \frac{AV_{ft}}{W_{ft}L_{ft}}$$

To retrieve the estimated output elasticity of labour $\theta^{l,y}_{ft}$, and estimated value-added elasticity of labour $\theta^{l,av}_{ft}$, we estimate the production functions of all firms in the global economy, including both local and foreign-owned firms within each two-digit NACE sector in each year since 2011 following the methodology proposed by Ackerberg et al. (2015).

In the estimation of production functions, values are converted to 2014 USD using the available exchange rates and deflators from the WDI of the World Bank.

Since technologies could differ between developing and advanced economies, the samples of estimation of production functions are separated by their level of development into the advanced and developing economies.

In the next stage, the data is limited to the sample of foreign-owned subsidiaries that had been invested by their parent GUOs during the period 2011-2022, we analyse the distribution of values across 'business functions' of the invested projects.

Some subsidiaries in the sample of study could be invested in all five categories of 'business functions' as the table below shows the number firms with their number business functions:

Table C.1: Frequency of business functions within firms in the sample of study

Number of business functions	Number of firms
1	14,966
2	2,907
3	886
4	338
5	58
Total	19,155

We then estimated the generation of various distributional variables generated by the foreign-owned subsidiary to identify how they are distributed across business functions in an equation as follows:

$$y_{fict} = \alpha_0 + \alpha_1 \sum_{j=1}^{5} BF_{fj} + \alpha_2\, arc\, FDI_{fictj}^{k,n,l} + \alpha_3\, arc\, kl_{fict} + \alpha_4\, arc\, L_{fict} + \alpha_5\, arc\, TFP_{fict} + \alpha_6\, arc\, TO_{ict} + \alpha_7\, arc\, T_{ict}^{EU} + \omega_{ct} + \omega_{it} + \varepsilon_{fict} \quad (1)$$

Where y_{fict}, could be either of these dependent variables as follows:

Added value relative to total turnover: $av_{fict} = \frac{AV_{fict}}{Y_{ftict}}$

Markup in turnover μ_{fict}^{y}

Markup in value added μ_{fict}^{av}

Average wage W_{fict}

Share of labor cost in turnover $c_{fict}^{l,y} = \frac{W_{fict}L_{fict}}{Y_{fict}}$

Share of labor cost in value added $c_{fict}^{l,av} = \frac{W_{fict}L_{fict}}{AV_{fict}}$

- BF_{fj} is a dummy variable indicating whether firm f is invested for a project in business function j among the five categories. The benchmark category is Production business function.
- arc $FDI_{fictj}^{k,n,l}$ the arcsine (hyperbolic sine) transformation of either the amount of capital k, or the number of projects n, or the estimated jobs created l, in projects invested in business function j in year t in firm f located in country c and NACE two-digit industry i.

- kl_{fict}, L_{fict} and TFP_{fict} are respectively the capital-to-labour ratio, number of employees, and the value of TFP for firm f estimated from the global sample of all available firms.
- TO_{ict} is the total trade (exports plus imports) relative to total value added in sector i and country c in year t retrieved from the OECD TiVA.
- T_{ict}^{EU} is the trade with the EU relative to total trade of country c in sector i in year t.
- ω_{ct} is country-year fixed effects to control for business cycles within countries.
- ω_{it} is sector-year fixed effects to control for the global demand and supply and technological shocks.
- ε_{fict} is the robust standard error.

Equation is estimated using the normal OLS.

In a second specification we interacted the amount of investment $FDI_{fictj}^{k,n,l}$ with the business function categorical dummies. The equation for this specification is as follows:

$$y_{fict} = \alpha_0 + \alpha_1 \sum_{j=1}^{5} arc\, FDI_{fictj}^{k,n,l} \times BF_{fj} + \alpha_2\, arc\, kl_{fict} + \alpha_3\, arc\, L_{fict} + \alpha_4\, arc\, TFP_{fict} + \alpha_5\, arc\, TO_{ict} + \alpha_5\, arc\, T_{ict}^{EU} + \omega_{ct} + \omega_{it} + \varepsilon_{fict} \quad (2)$$

The estimations have been run:

- across all global subsidiaries as well as on
- the sub-sample of global firms active in manufacturing; plus
- those subsidiaries located in Europe only; again across all industries and
- only those active in manufacturing

In a robustness check analysis we excluded the UK as a host of subsidiaries, as these subsidiaries active in financial services were particularly strongly represented in the overall Orbis dataset and we wanted to check our results were strongly affected by such a strong representation of the UK firms active in financial services.

Mapping of business functions (as available in Orbis Cross-border Investment database) into 5 categories used in analysis:

Table C.2: Classification of business functions

Project business function	GVC business function broad
Banking & Finance	Finance and Business Services
Business Services	Finance and Business Services
R&D Centre	R&D ICT
Testing Centre	R&D ICT
Education & Training	R&D ICT
Regional Headquarters	Headquarters
Data Centre	R&D ICT
ICT infrastructure	R&D ICT
Software Development Centre	R&D ICT
Logistics, Distribution & Transportation	Sales marketing logistics maintenance
Manufacturing	Production
Recycling	Production
Customer Contact Centre	Sales marketing logistics maintenance
Maintenance & Repair	Sales marketing logistics maintenance
Retail	Sales marketing logistics maintenance
Sales Office	Sales marketing logistics maintenance
Shared Service Centre	Sales marketing logistics maintenance
Technical Support	Sales marketing logistics maintenance

Econometric results from estimating equation (1)

Estimations results for the whole sample:

Table C.3: Estimation results using normal OLS on the same-sample of all foreign-owned subsidiaries with at least one invested project

Dependent variable y_{fict}:	av_{fict}	μ^{y}_{fict}	μ^{av}_{fict}	W_{fict}	$c^{l,y}_{fict}$	$c^{l,av}_{fict}$
Finance and Business Services	0.060***	-0.15***	0.024	0.14***	0.048***	0.015**
	(0.0076)	(0.013)	(0.015)	(0.010)	(0.0044)	(0.0075)
Headquarters	0.018**	-0.089***	-0.042***	0.094***	0.013***	0.024***
	(0.0069)	(0.012)	(0.013)	(0.0095)	(0.0040)	(0.0069)
R&D ICT	0.0071	-0.062***	-0.018	0.085***	0.022***	-0.0069
	(0.0062)	(0.011)	(0.012)	(0.0086)	(0.0036)	(0.0062)
Sales marketing logistics maintenance	0.013***	-0.011	0.0042	0.036***	0.000023	0.0071
	(0.0049)	(0.0084)	(0.0095)	(0.0067)	(0.0028)	(0.0049)
arc FDI^{k}_{fictj}	-0.0013	-0.0034	-0.0015	0.00097	0.0015*	-0.0021
	(0.0013)	(0.0022)	(0.0025)	(0.0018)	(0.00076)	(0.0013)
arc kl_{fict}	0.11***	0.15***	0.27***	0.27***	-0.019***	-0.084***
	(0.0013)	(0.0022)	(0.0025)	(0.0018)	(0.00075)	(0.0013)
arc L_{fict}	0.025***	0.046***	0.11***	-0.053***	-0.030***	0.010***
	(0.00099)	(0.0017)	(0.0019)	(0.0014)	(0.00058)	(0.00099)
arc TFP_{fict}	-0.00037	-0.016***	0.0045***	0.0022***	-0.0036***	0.00042*
	(0.00026)	(0.00044)	(0.00014)	(0.00035)	(0.00015)	(0.00026)
arc TO_{ict}	-0.0036	-0.074***	-0.069***	0.074***	-0.013***	0.011*
	(0.0065)	(0.011)	(0.013)	(0.0089)	(0.0038)	(0.0065)
arc T^{EU}_{ict}	0.17***	-1.10***	-0.72***	0.74***	-0.056***	0.11***
	(0.029)	(0.050)	(0.057)	(0.040)	(0.017)	(0.029)
Constant	-1.43***	0.49***	-2.73***	7.80***	0.73***	1.53***
	(0.024)	(0.042)	(0.048)	(0.034)	(0.014)	(0.024)
Observations	115475	115475	115475	115475	115475	115475
R-squared	0.181	0.636	0.391	0.634	0.204	0.168
Adjusted R-squared	0.138	0.617	0.359	0.614	0.162	0.125
AIC	187467.0	311586.3	341932.2	262255.5	63230.4	187187.7
BIC	187573.2	311692.5	342038.4	262361.7	63336.6	187293.9

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Note: in all estimations, Production business function is the benchmark category; av_{fict} is the added value relative to total turnover; μ^{y}_{fict} is the markup in turnover; μ^{av}_{fict} is markup in value added; W_{fict} is the average wage; $c^{l,y}_{fict}$ is the share of labor cost in turnover; and $c^{l,av}_{fict}$ is the share of labor cost in value added.

Estimations results for the sample of subsidiaries in the EU27:

Table C.4: Estimation results using normal OLS on the same-sample of all foreign-owned subsidiaries with at least one invested project in the EU27

Dependent variable y_{fict}:	av_{fict}	μ^{y}_{fict}	μ^{av}_{fict}	W_{fict}	$c^{l,y}_{fict}$	$c^{l,av}_{fict}$
Finance and Business Services	0.073***	-0.14***	0.023	0.090***	0.053***	0.00033
	(0.012)	(0.016)	(0.017)	(0.010)	(0.0067)	(0.010)
Headquarters	0.029***	-0.060***	-0.013	0.067***	0.017***	0.030***
	(0.010)	(0.014)	(0.015)	(0.0092)	(0.0059)	(0.0090)
R&D ICT	0.013	-0.045***	-0.0021	0.067***	0.032***	-0.013
	(0.0095)	(0.013)	(0.014)	(0.0085)	(0.0054)	(0.0083)
Sales marketing logistics maintenance	0.010	0.029***	0.015	0.0069	-0.0024	0.0060
	(0.0071)	(0.0100)	(0.010)	(0.0063)	(0.0040)	(0.0062)
$\text{arc}\,FDI^{k}_{fictj}$	-0.0011	-0.0074***	-0.0035	0.0032*	0.00058	-0.0015
	(0.0020)	(0.0028)	(0.0030)	(0.0018)	(0.0012)	(0.0018)
$\text{arc}\,kl_{fict}$	0.12***	0.16***	0.26***	0.25***	-0.018***	-0.090***
	(0.0018)	(0.0025)	(0.0026)	(0.0016)	(0.0010)	(0.0015)
$\text{arc}\,L_{fict}$	0.016***	0.018***	0.063***	-0.010***	-0.033***	0.013***
	(0.0015)	(0.0021)	(0.0022)	(0.0014)	(0.00087)	(0.0013)
$\text{arc}\,TFP_{fict}$	-0.0024***	-0.017***	0.026***	0.0058***	-0.0082***	0.0014***
	(0.00051)	(0.00072)	(0.00033)	(0.00046)	(0.00029)	(0.00045)
$\text{arc}\,TO_{ict}$	0.0039	-0.016	0.019	0.0032	-0.026***	0.0095
	(0.012)	(0.017)	(0.018)	(0.011)	(0.0068)	(0.010)
$\text{arc}\,T^{EU}_{ict}$	0.27***	0.011	0.035	-0.22***	0.082**	-0.058
	(0.058)	(0.082)	(0.086)	(0.052)	(0.033)	(0.051)
Constant	-1.54***	-0.21***	-2.74***	8.59***	0.72***	1.73***
	(0.042)	(0.060)	(0.063)	(0.038)	(0.024)	(0.037)
Observations	66388	66388	66388	66388	66388	66388
R-squared	0.217	0.604	0.455	0.629	0.201	0.177
Adjusted R-squared	0.157	0.573	0.413	0.601	0.139	0.113
AIC	119527.8	164966.9	171955.6	105157.8	45365.7	102274.8
BIC	119627.9	165067.1	172055.7	105257.9	45465.9	102375.0

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Note: in all estimations, Production business function is the benchmark category; av_{fict} is the added value relative to total turnover; μ^{y}_{fict} is the markup in turnover; μ^{av}_{fict} is markup in value added; W_{fict} is the average wage; $c^{l,y}_{fict}$ is the share of labor cost in turnover; and $c^{l,av}_{fict}$ is the share of labor cost in value added.

Estimations results for the sample of subsidiaries in the EU14:

Table C.5: Estimation results using normal OLS on the same-sample of all foreign-owned subsidiaries with at least one invested project in the EU14 (i.e. pre-2014 EU member countries)

Dependent variable y_{fict}:	av_{fict}	μ^{y}_{fict}	μ^{av}_{fict}	W_{fict}	$c^{l,y}_{fict}$	$c^{l,av}_{fict}$
Finance and Business Services	0.084***	-0.14***	0.021	0.084***	0.058***	0.0071
	(0.012)	(0.015)	(0.017)	(0.011)	(0.0066)	(0.011)
Headquarters	0.022**	-0.053***	-0.030**	0.051***	0.019***	0.028***
	(0.011)	(0.013)	(0.014)	(0.0096)	(0.0058)	(0.0094)
R&D ICT	0.0011	-0.029**	-0.0099	0.054***	0.030***	-0.017**
	(0.0099)	(0.012)	(0.014)	(0.0090)	(0.0054)	(0.0088)
Sales marketing logistics maintenance	0.0090	0.024***	0.0033	-0.0030	-0.00061	0.0052
	(0.0074)	(0.0091)	(0.010)	(0.0067)	(0.0041)	(0.0066)
$\text{arc}\, FDI^{k}_{fictj}$	-0.00093	-0.0052**	-0.00081	0.0030	-0.00079	-0.00086
	(0.0021)	(0.0026)	(0.0029)	(0.0019)	(0.0012)	(0.0019)
$\text{arc}\, kl_{fict}$	0.13***	0.16***	0.26***	0.25***	-0.021***	-0.088***
	(0.0018)	(0.0022)	(0.0025)	(0.0016)	(0.00099)	(0.0016)
$\text{arc}\, L_{fict}$	0.012***	0.058***	0.064***	-0.0073***	-0.043***	0.014***
	(0.0016)	(0.0020)	(0.0022)	(0.0015)	(0.00090)	(0.0014)
$\text{arc}\, TFP_{fict}$	-0.012***	0.078***	0.039***	0.021***	-0.032***	0.0062***
	(0.0011)	(0.0013)	(0.00038)	(0.00096)	(0.00058)	(0.00094)
$\text{arc}\, TO_{ict}$	0.030**	0.011	-0.027	0.034***	-0.019***	0.028**
	(0.013)	(0.016)	(0.018)	(0.012)	(0.0071)	(0.011)
$\text{arc}\, T^{EU}_{ict}$	0.14**	0.074	-0.087	-0.20***	0.027	-0.090
	(0.063)	(0.078)	(0.087)	(0.057)	(0.035)	(0.056)
Constant	-1.51***	-0.93***	-2.77***	8.55***	0.92***	1.70***
	(0.045)	(0.055)	(0.061)	(0.041)	(0.025)	(0.040)
Observations	59678	59678	59678	59678	59678	59678
R-squared	0.229	0.676	0.526	0.554	0.231	0.183
Adjusted R-squared	0.167	0.650	0.488	0.518	0.169	0.117
AIC	106603.9	131192.1	144203.1	95224.7	35406.5	92093.9
BIC	106702.8	131291.1	144302.0	95323.7	35505.4	92192.8

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Note: in all estimations, Production business function is the benchmark category; av_{fict} is the added value relative to total turnover; μ^{y}_{fict} is the markup in turnover; μ^{av}_{fict} is markup in value added; W_{fict} is the average wage; $c^{l,y}_{fict}$ is the share of labor cost in turnover; and $c^{l,av}_{fict}$ is the share of labor cost in value added.

Estimations results for the sample of subsidiaries in the EU-CEE (EU-Central/Eastern Europe):

Table C.6: Estimation results using normal OLS on the same-sample of all foreign-owned subsidiaries with at least one invested project in the EU-CEE (post 2014 EU member countries)

Dependent variable y_{fict}:	av_{fict}	μ^{y}_{fict}	μ^{av}_{fict}	W_{fict}	$c^{l,y}_{fict}$	$c^{l,av}_{fict}$
Finance and Business Services	-0.072*	0.15*	-0.18**	0.069**	-0.026	-0.063
	(0.043)	(0.079)	(0.080)	(0.035)	(0.029)	(0.042)
Headquarters	0.079*	0.088	0.070	0.13***	-0.0078	0.056
	(0.041)	(0.075)	(0.077)	(0.033)	(0.028)	(0.040)
R&D ICT	0.080**	-0.090	0.0028	0.094***	0.069***	0.027
	(0.032)	(0.059)	(0.060)	(0.026)	(0.022)	(0.031)
Sales marketing logistics maintenance	0.051**	0.026	0.082*	0.038*	0.018	0.016
	(0.024)	(0.044)	(0.044)	(0.019)	(0.016)	(0.023)
$\text{arc}\, FDI^{k}_{fictj}$	-0.010	-0.022*	-0.034***	0.00024	0.0092*	-0.014**
	(0.0071)	(0.013)	(0.013)	(0.0057)	(0.0048)	(0.0069)
$\text{arc}\, kl_{fict}$	-0.026***	0.25***	0.086***	0.21***	-0.029***	-0.12***
	(0.0085)	(0.016)	(0.016)	(0.0068)	(0.0058)	(0.0082)
$\text{arc}\, L_{fict}$	0.023***	0.0037	0.065***	0.032***	-0.032***	0.023***
	(0.0054)	(0.0099)	(0.0100)	(0.0043)	(0.0037)	(0.0052)
$\text{arc}\, TFP_{fict}$	0.00071	-0.050***	0.015***	0.0056***	-0.0036***	-0.00081
	(0.0012)	(0.0022)	(0.0012)	(0.00097)	(0.00082)	(0.0012)
$\text{arc}\, TO_{ict}$	-0.10**	0.075	0.12	-0.085**	-0.060**	-0.17***
	(0.044)	(0.081)	(0.083)	(0.036)	(0.030)	(0.043)
$\text{arc}\, T^{EU}_{ict}$	0.60***	-1.26***	-0.042	0.29*	0.62***	-0.43**
	(0.20)	(0.37)	(0.38)	(0.16)	(0.14)	(0.20)
Constant	0.15	-0.099	-0.39	7.77***	0.45***	2.27***
	(0.18)	(0.33)	(0.33)	(0.14)	(0.12)	(0.17)
Observations	5702	5702	5702	5702	5702	5702
R-squared	0.536	0.759	0.609	0.660	0.544	0.363
Adjusted R-squared	0.391	0.684	0.487	0.554	0.403	0.165
AIC	7231.0	14204.5	14388.0	4795.1	2901.7	6883.4
BIC	7304.1	14277.7	14461.1	4868.2	2974.9	6956.5

Robust standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.
Note: in all estimations, Production business function is the benchmark category; av_{fict} is the added value relative to total turnover; μ^{y}_{fict} is the markup in turnover; μ^{av}_{fict} is markup in value added; W_{fict} is the average wage; $c^{l,y}_{fict}$ is the share of labor cost in turnover; and $c^{l,av}_{fict}$ is the share of labor cost in value added.

Selection of Figures on business function specialisation

Figure C.1: Share of number of projects in Production BF relative to total number of projects invested in each country in the sample

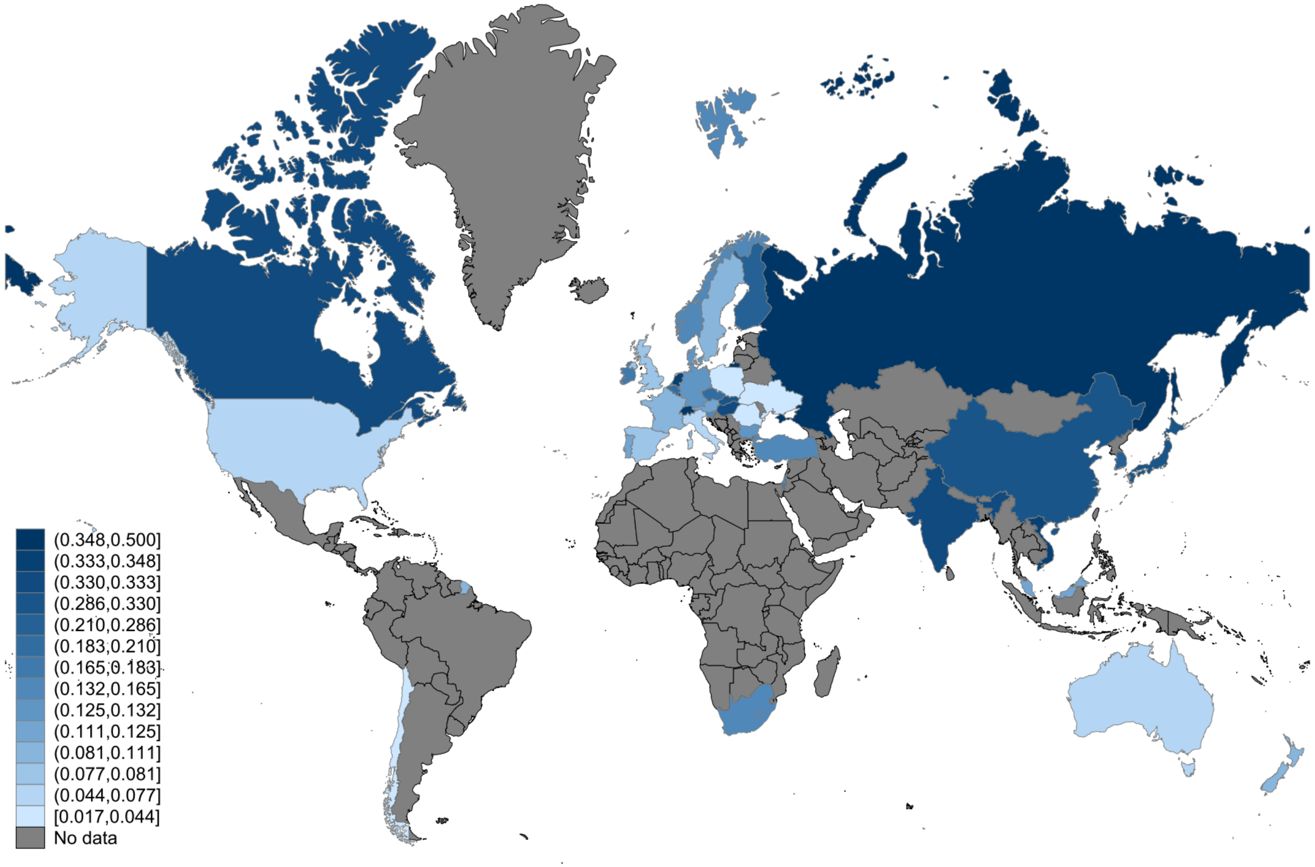


Figure C.2: Share of number of projects in Headquarters BF relative to total number of projects invested in each country in the sample

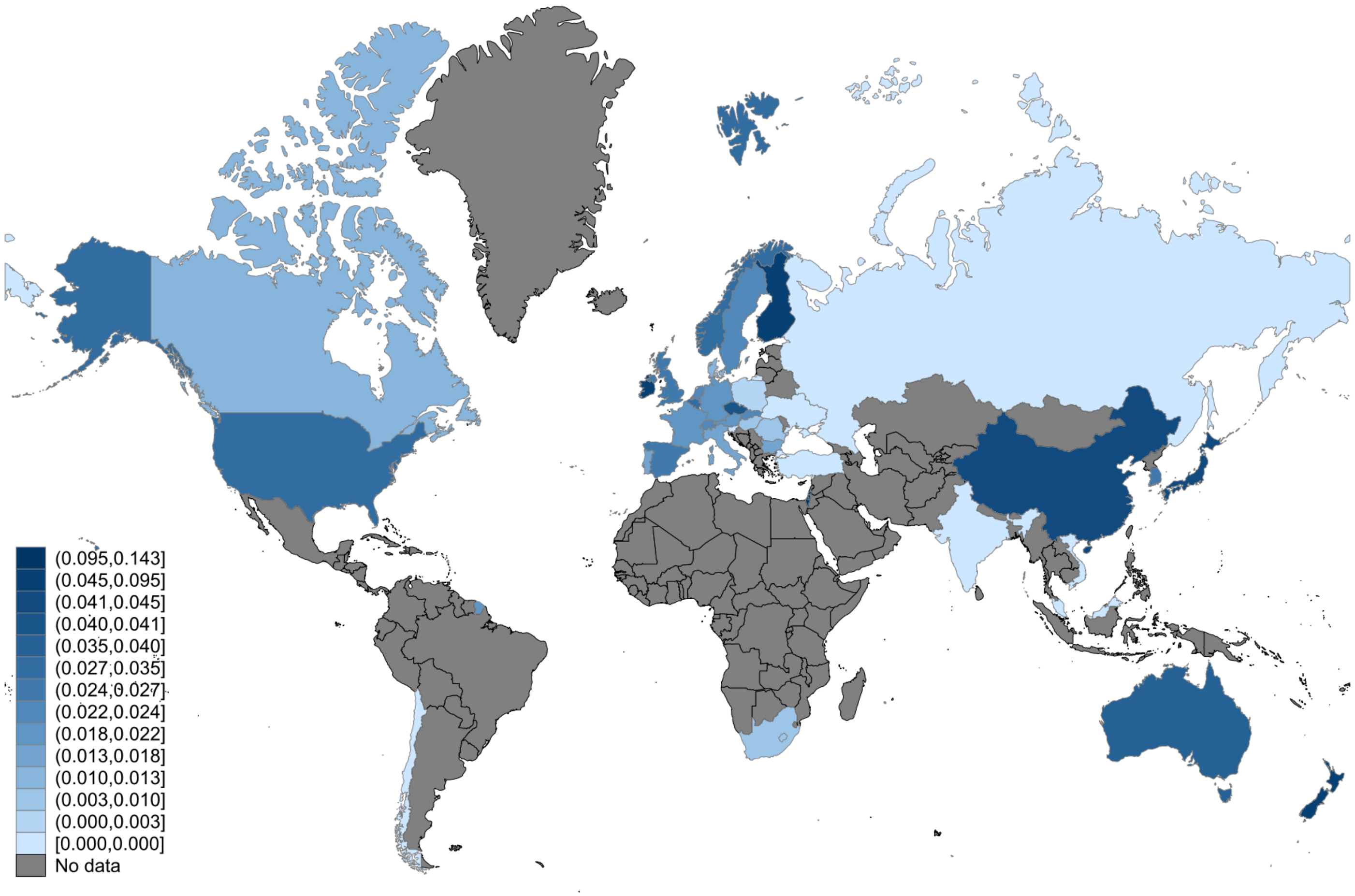


Figure C.3: Share of number of projects in R&D and ICT BF relative to total number of projects invested in each country in the sample

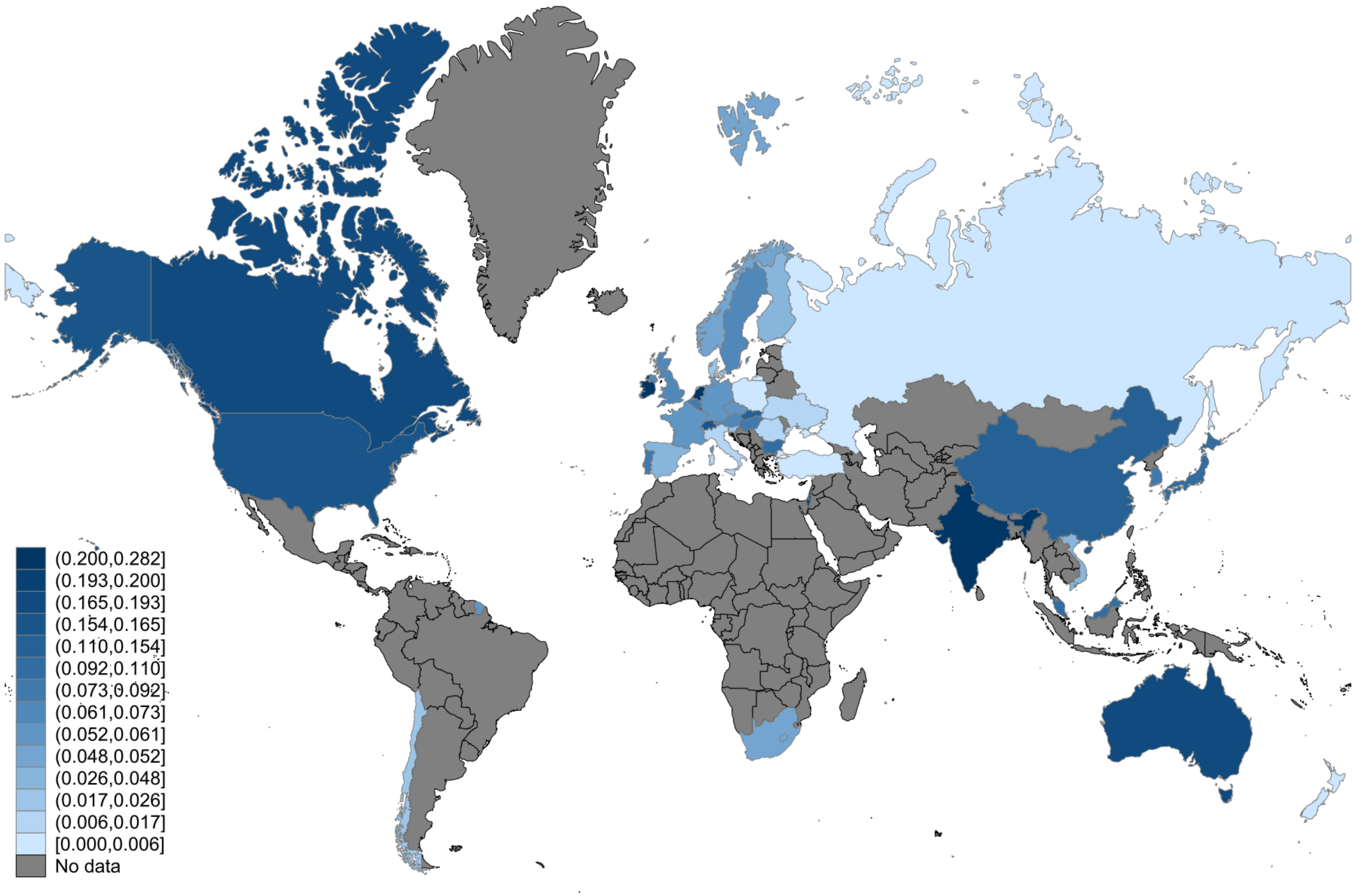
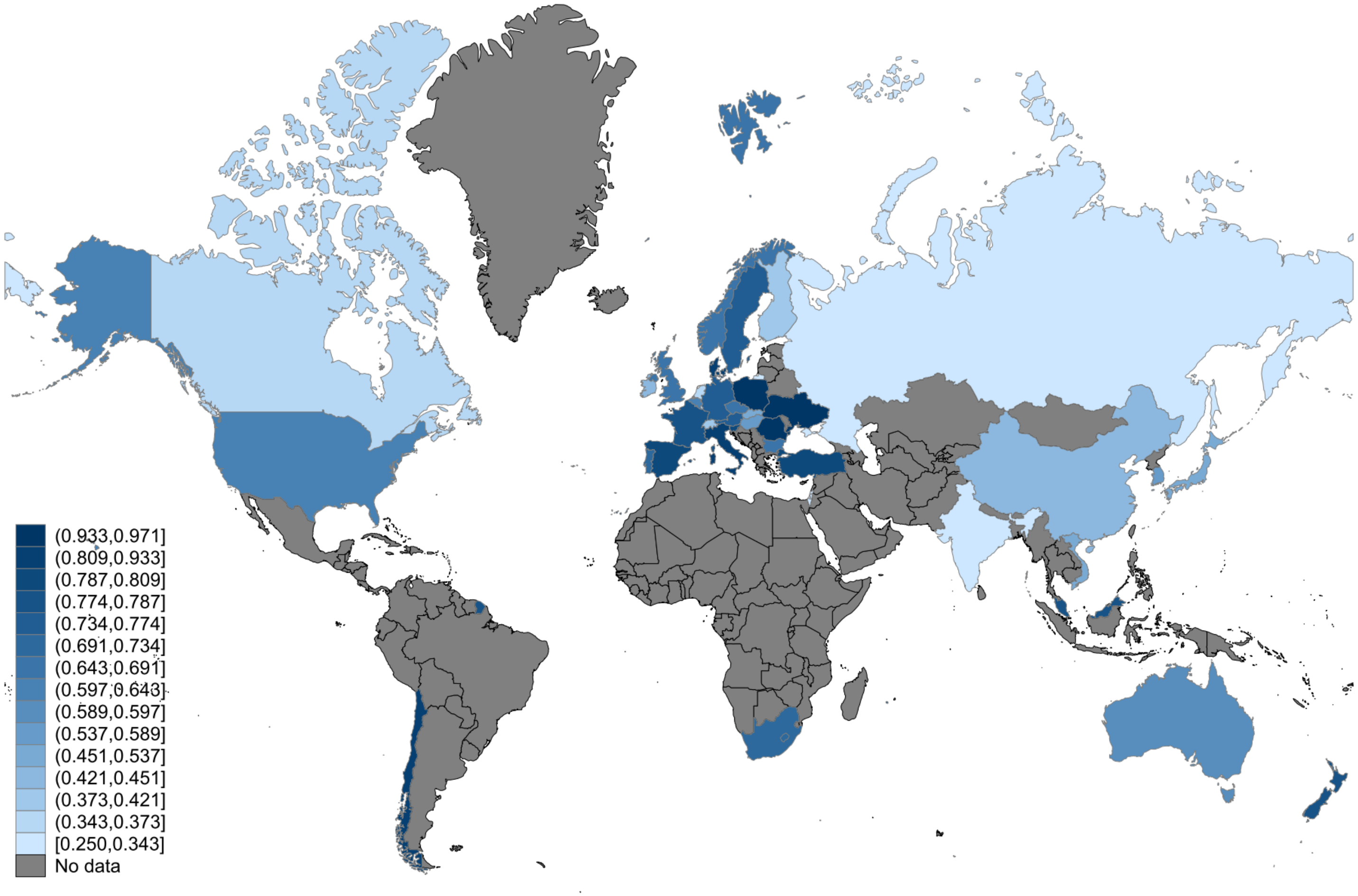


Figure C.4: Share of number of projects in Sales, marketing, logistics, and maintenance BF relative to total number of projects invested in each country in the sample



Appendix D: The consequences of offshoring and reshoring decisions on local subcontractors

The empirical analysis presented in this work aims to inspect the impact of offshore outsourcing on local subcontractors' survival and upgrading strategies. These aspects are evaluated using a linear probability model with fixed effects, in order to exploit the panel structure of the IMEFAS database. The aim is to evaluate the relationship between offshore outsourcing initiated by SMEs operating in a specific region and two main outcomes observed in the local subcontracting network.

The empirical investigation is implemented on the sample of subcontractors specialized in the clothing and footwear industry and operating for clients located in the same Local Labour Market Area. For this sample of firms, the probability to survive or upgrade at time t+1 is modelled as a function of a set of financial, structural and territorial variables measured at year t. The two main outcomes are local subcontractors' failure and upgrading. The definition of upgrading used in the empirical analysis is tailored on the peculiar characteristics of phenomenon under investigation and is associated with a) the decision to connect to a value chain located outside the region or b) the transformation into a final firm. This definition deviates from the traditional fourfold classification of upgrading, and follows the recent claim by Blazek (2016) to reconsider the original categories, identifying upgrading strategies that are consistent with the specific research setting. In the case of local subcontractors, upgrading possibilities tend to be confined to market diversification towards buyers located in other geographic contexts and moving to a more rewarding position within the value chain. Both strategies are consistent with the idea of channel and supply chain upgrading.

In the empirical analysis, local subcontractors are observed in different time periods T, where T depends on the number of years in which the firm is active. For this reason, the preferred specification is a linear probability model with fixed effects, where the conditional probability that firm i experiences the analysed outcome at time $t+1$ can be modelled in the full specification as follows:

$$Y_{i,t+1} = \alpha + \beta_1 OFFOUT_{j,k,t} + \gamma X_{i,t} + \delta Z_{j,t} + \lambda_i + \tau_t + \omega_{k,t} + \varsigma_{j,t} + \rho_{j,k} + \epsilon_{it}$$

where Y_{it} is a dummy variable equal to 1 if the firm survives or upgrades at time t+1, $X_{i,t}$ are the set of firm-level time varying control variables, $Z_{j,t}$ are the set of LLMA-level time varying control variables, λ_i , τ_t represent the firm and year fixed effects, $\omega_{k,t}, \varsigma_{j,t}$, $\rho_{j,k}$ represent the interactive fixed effects used in the specification and ϵ_{it} is the error term. The main independent variable of this model is $OFFOUT_{j,k,t}$, defined as the intensity of offshore outsourcing in LLMA j and industry k at time t. Offshore outsourcing is measured as the total costs associated with activities subcontracted to foreign suppliers and reported by micro and small client firms filling out the IMEFAS questionnaire in the reference year.

TWIN SEEDS

Appendix E: A macro-review of the relationship between international fragmentation and productivity growth in GVCs 2000-2014

Computation of GVC distances

We define a GVC as all the activities required to produce a final product (i.e., a consumer product or a capital good). Each final product is identified by the country in which the last stage of production takes place (*s*) and the industry in which this happens (*i*). This implies that we consider the GVCs for, e.g., German motor vehicles and Chinese electronics. Note that our data do not contain information on ownership of production activities, only on their location.

For ease of exposition, we make use of matrix notation. **A** denotes a matrix of intermediate input requirements per unit of industry output with dimensions C*NxCN*. *C* is the number of countries and *N* is the number of industries in each of these countries. The elements of **A** can be derived directly from a global input-output table, like those in the World Input-Output Database. This exposition is based on Timmer et al. (2021), but extended with geographical distances.
We require information about both the value of sales along the GVC of a particular final product *(s,i)* and the distance between the associated sellers and buyers. Let **f** be a (*CN*x1) vector with element *(s,i)* set to one and zeros elsewhere. The last stage of production requires intermediate inputs from first-tier suppliers, which are given by $\mathbf{A\bar{f}}$. Since $\mathbf{\bar{f}}$ is a diagonal matrix with the elements of **f** on the main diagonal, $\mathbf{A\bar{f}}$ is a *CN*x*CN* matrix containing the values of the sales of each first-tier supplier to the final producer. because we are interested in the distances covered by these sales. As we want to include information on distances, we construct a *CN*x*CN* matrix **D** with distances between each of the selling and buying industries, derived from the CEPII GeoDist database. The numbers of dollar-kilometers associated with the sales of first-tier suppliers are then given by the *CN*x*CN* matrix $\mathbf{M}_f^{tier1} = \mathbf{D} \circ \left(\mathbf{A\bar{f}}\right)$, where $\circ$ refers to element-wise multiplication (the Hadamard product operation). An element equal to 500 mln dollar-kilometers could, for example, relate to a flow worth of 10 mln dollars with a distance of 50 km between supplier and final producer, or a value of 1 mln dollar with a distance of 500 km between them.
Production by the first-tier suppliers in turn requires intermediate inputs from second-tier suppliers, given by $\mathbf{A}(\overline{\mathbf{Af}})$. The dollar-kilometers between second-tier suppliers and first-tier suppliers in the GVC for final product (*s,i*) are then obtained as $\mathbf{M}_f^{tier2} = \mathbf{D} \circ \left(\mathbf{A}(\overline{\mathbf{Af}})\right)$. Note that this includes purchases by country *s*, but can also include purchases by other countries hosting first-tier suppliers. Continuing this line of reasoning for higher-tier suppliers, we can write $\mathbf{M}_f^{tot}$, the (*CN*x*CN*) matrix with dollar-kilometers needed for one unit of final output of *(s,i)* as an infinite series $\mathbf{M}_f^{tier1} + \mathbf{M}_f^{tier2} + \mathbf{M}_f^{tier3} + \cdots$. Using the expressions above, we can write

$$(1)\qquad \mathbf{M}_f^{tot} = \mathbf{D} \circ \left(\mathbf{A}\bar{\mathbf{f}}\right) + \mathbf{D} \circ \left(\mathbf{A}\overline{\mathbf{A}\mathbf{f}}\right) + \mathbf{D} \circ \left(\mathbf{A}\left(\overline{\mathbf{A}^2\mathbf{f}}\right)\right) + \mathbf{D} \circ \left(\mathbf{A}\left(\overline{\mathbf{A}^3\mathbf{f}}\right)\right) + \cdots \quad ,$$

and using the Taylor-series expansion of the Leontief inverse

$$(2)\qquad \mathbf{M}_f^{tot} = \mathbf{D} \circ \{\mathbf{A}\,[\overline{(\mathbf{I}-\mathbf{A})^{-1}\mathbf{f}}]\}$$

$\mathbf{M}_f^{tot}$ is the (*CNxCN*) matrix with the typical element $m_f^{tot}(t,j)(u,k)$ representing the value of flows of intermediate inputs from country-industry (*t,j)* to country-industry (*u,k),* required for the production of a unit of final product by (*s,i*), multiplied by their distance. The distance (*s,i*)'s GVC is given by the aggregate of dollar-kilometers travelled by intermediate products in the supply chain, over all elements of this matrix:

$$(3)\qquad \theta_f = \mathbf{1}'\,\mathbf{M}_f^{tot}\mathbf{1}$$

In this expression, **1** is a (*CN*x1) summation vector consisting of ones and a prime indicates matrix transposition.
We introduce a subscript to indicate year *t* in order to track changes in θ over time. Let $\mathbf{A}_t$ be the nominal matrix of intermediate input requirements stated in current (year *t*) prices. And let $\mathbf{A}_{t+1}^{PYP}$ be the matrix for year *t+1* at year *t* prices (also known as previous year prices, PYP). Using (2) we can now define the current price intermediate import matrix

$$(4)\qquad \mathbf{M}_{f,t}^{tot} = \mathbf{T} \circ \{\mathbf{A}_t\,[\overline{(\mathbf{I}-\mathbf{A}_t)^{-1}\mathbf{f}}]\}$$

And the intermediate import matrix of year *t+1* in year *t* prices

$$(5)\qquad \mathbf{M}_{f,t+1}^{tot,PYP} = \mathbf{D} \circ \{\mathbf{A}_{t+1}^{PYP}\,[\overline{(\mathbf{I}-\mathbf{A}_{t+1}^{PYP})^{-1}\mathbf{f}}]\}$$

This implies that the change in the GVC distance between *t* and *t*+1 can be written as

$$(6)\qquad \theta_{f,t+1}^{PYP} - \theta_{f,t} = \mathbf{1}'\,\mathbf{M}_{f,t+1}^{tot,PYP}\mathbf{1} - \mathbf{1}'\mathbf{M}_{f,t}^{tot}\mathbf{1}$$

For trends covering longer periods, the indicator is therefore be chained to account for annual changes in the **M** matrix. For example, the change in the SCF ratio over the period $[t, t+2]$ is given by $\left(\theta_{f,t+2}^{PYP} - \theta_{f,t+1}\right) + \left(\theta_{f,t+1}^{PYP} - \theta_{f,t}\right)$.

Computation of GVC Unit Labor Costs

In line with the common definition of unit labor costs (ULC) for industries (see, for example, McKenzie and Brackfield, 2008), we define unit labor costs of a GVC as the nominal labor compensation paid to all employers and employees contributing to the GVC, required per real unit of final output of that GVC. This implies that not only labor compensation in the industry that performs the final stages of production should be considered, but also labor compensation in supplying industries (which can be located in the same country as the final producer, but also elsewhere.

We again define the vector **f** as a *CN*x1 vector with a value 1 for country-industry (*s*,*i*) and a *CN*x1 vector $\mathbf{w}_t$ as the vector with labor compensation per unit of gross output for each of the *CN* industries in year *t*, which can be obtained from the variable LAB in the Socioeconomic Satellite Accounts, the Exchange Rates data in WIOD and the last row in the World Input-Output Tables. $\mathbf{A}_t$ again stands for the CNxCN matrix of intermediate input coefficients. Nominal labor compensation in the GVC can then be derived using straightforward application of input-output techniques as $l_t = \mathbf{w}_t{}'(\mathbf{I} - \mathbf{A}_t)\mathbf{f}$. In order to ensure that the unit of output in the denominator is not affected by price changes, we multiply l_t by $\mathbf{F}_{t+1}\mathbf{1}/\mathbf{F}_{t+1}^{PYP}\mathbf{1}$. The label PYP again denotes values expressed in the prices of the previous year. **F** is a matrix of final demand in which all elements are set to zero, except for those representing sales of final output by country-industry (*s*,*i*). In order to obtain time series, chaining is applied.

Regressions

The basic regression equation relates the GVC Unit Labor Costs for manufactured final products to GVC Distances in a panel setting. Data are available for 18 GVCs in each of 43 countries, for 15 years. After cleaning the data, close to 11,500 observations are available. In the preferred specification, GVC fixed effects and year fixed effects are included. The GVC distance variable is included in log form.

Appendix F: GVCs' reorganization and regional disparities in Europe

a. The operationalization of regional nearshoring

The definition of Home and Host nearshoring regions is translated into operational terms to categorise EU regions into these two groups. In order to identify the nearshoring regions, we use the Multiregional Input-Output (MRIO) Trade in Value Added Tables with regional (NUTS2) disaggregation available for 2000-2010, also known as EUREGIO database (Thissen et al., 2018). We subdivide the timespan into two subperiods, 2000-2008 and 2008-2010, to link nearshoring to the 2008 crisis period.
To EUREGIO matrices, we apply the Leontief decomposition rooted in the traditional logic of input-output trade analysis (Blair & Miller, 2009; Isard, 1951; Leontief, 1936; Rose & Miernyk, 1989). More specifically, through this decomposition, it is possible to define the origin of value added as in (1):

$$Origin\ of\ value\ added\ = fvax_{r,i}^{s,j} \tag{1}$$

where $fvax_{r,i}^{s,j}$ denotes the value added embodied in exports of sector i in region r (using region) originated from sector j in region s (source region).[3] By summing over source regions (*s*) and sectors (*j*), it is possible to calculate for each using region (*r*) the share of what the manufacturing sector (*man*) buys from all other sectors located in EU regions with respect to the world total value bought by the region:

$$Share\ of\ EU-sourced\ VA\ for\ manufacturing\ = \frac{\sum_{j=1}^{N}\sum_{s\in EU} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N}\sum_{s=1}^{M} fvax_{r,man}^{s,j}} \tag{2}$$

A declining trend in this indicator signifies an offshoring process, whereas its growth indicates a nearshoring one. By the same token, by summing over using regions (*r*) and sectors (*j*), for each source region (*s*) we can calculate the share of value added sold to the manufacturing sector of an EU region with respect to the world total value sold by the region, as:

$$Share\ of\ EU-used\ VA\ by\ manufacturing\ = \frac{\sum_{j=1}^{N}\sum_{r\in EU} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N}\sum_{r=1}^{M} fvax_{r,man}^{s,j}} \tag{3}$$

A positive time trend of the shares signals an increase in the production of that region sold to the manufacturing sectors of other EU regions.
These GVCs-related measures between regions and sectors allow to operationalise our conceptual definitions of Home and Host nearshoring regions, as presented in *Table* . It pairs with **Erreur ! Source du renvoi introuvable.**, detailing the indicators behind the conceptual conditions of both types of nearshoring regions.

[3] *FVAX* is a common notation to denote the Leontief decomposition (cf. Quast & Kummritz, 2015; Timmer et al., 2015).

Table F.1: Empirical conditions to measure Home and Host nearshoring regions

Home nearshoring regions	Host nearshoring regions
• $\Delta^{00-08} \frac{\sum_{j=1}^{N} \sum_{s \in EU} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N} \sum_{s=1}^{M} fvax_{r,man}^{s,j}} < 0$ • $\Delta^{08-10} \frac{\sum_{j=1}^{N} \sum_{s \in EU} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N} \sum_{s=1}^{M} fvax_{r,man}^{s,j}} > 0$ • $LQ_{r,2000,man} > 1$ • $1 - \frac{\sum_{j=1}^{N} \sum_{s \in EU} fvax_{r,man,2010}^{s,j}}{\sum_{j=1}^{N} \sum_{s=1}^{M} fvax_{r,man,2010}^{s,j}} < 75th\ pctile$	• $\Delta^{00-08} \frac{\sum_{j=1}^{N} \sum_{r \in EU} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N} \sum_{r=1}^{M} fvax_{r,man}^{s,j}} > 0$ • $\Delta^{08-10} \frac{\sum_{j=1}^{N} \sum_{r \in Home} fvax_{r,man}^{s,j}}{\sum_{j=1}^{N} \sum_{r \in EU} fvax_{r,man}^{s,j}} > 0$ • $\Delta^{08-10} \frac{DVA_{s}^{interm}}{Exports_{s}} > 0$

b. Empirical model and regression results

In order to measure the effects of nearshoring on growth and, consequently, on regional disparities, we estimate the growth effects of nearshoring, so to be able to simulate regional inequalities in presence or absence of such income source.

The effect of nearshoring on regional economic growth is estimated through a multivariate OLS regression, controlling for various regional economic determinants. Specifically, the econometric model is outlined in equation (4):

$$\Delta GDP_r = \beta Host_r + \gamma X_r + \varepsilon_r \tag{4}$$

The dependent variable (ΔGDP_r) is the 2013-2019 compound growth rate of regional GDP. The primary variable of interest is the Host dummy, which takes a value of 1 if the region is a Host nearshoring region and 0 otherwise. This dummy is then broken down into three additional non-mutually exclusive binary variables to capture the effect of nearshoring under different efficiency conditions (quality, low labour cost, automation), as in Table . This allows for measuring the impact of nearshoring on growth following various efficiency logics.

Control variables, on the other hand, include, as suggested by the literature:

- the region's wealth level to capture the convergence/divergence effect (GDP per capita) (Barro & Sala-i-Martin, 2004);
- the share of employment in manufacturing to control for the sectoral specialization of the region;
- urbanization economies, measured through the population density of the area (Perloff et al., 1960);
- regional innovativeness level, captured by patent density (patents per capita, in logarithm) (Capello & Lenzi, 2013; Rodríguez-Pose & Crescenzi, 2008);
- education level, measured through the proportion of individuals with tertiary education (Crescenzi, 2005; Sterlacchini, 2008), and
- the East dummy controls for different development levels between Eastern and Western countries. All control variables are measured at the beginning of the growth period.

The estimation of the model presented in equation (4) relies on cross-sectional data. This choice is driven by the need to use two distinct time periods to accurately identify nearshoring in host regions. Furthermore, aside from the dummy variable for Eastern countries, the model does not incorporate any other fixed effects (e.g., country fixed effects). This choice is due to the fact that, since the nearshoring phenomenon does not impact all countries uniformly, the inclusion of such fixed effects would result in collinearity with the Host dummy, compromising the interpretability of the analysis. A complete list of variables with some descriptive statistics is reported in Table .

Table F.2: list of variables and descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max	Source
CAGR of regional GDP	249	0.0318	0.0167	-0.0465	0.0999	Eurostat
Dummy Home nearshoring region	249	0.1727	0.3787	0.0000	1.0000	EUREGIO
Dummy Host nearshoring region	249	0.2892	0.4543	0.0000	1.0000	EUREGIO
Dummy Host nearshoring region - Quality	249	0.1767	0.3822	0.0000	1.0000	EUREGIO
Dummy Host nearshoring region - Low Labour Cost	249	0.1044	0.3064	0.0000	1.0000	EUREGIO
Dummy Host nearshoring region - Automation	249	0.1727	0.3787	0.0000	1.0000	EUREGIO
GDP per capita (ln)	249	-3.7501	0.4972	-5.0649	-2.3923	Eurostat
Manufacturing employment (%)	249	0.1365	0.0680	0.0037	0.3402	Eurostat
Population density	249	0.4162	1.0486	0.0029	10.3883	Eurostat
Patents per employee (ln)	249	0.1720	0.1664	0.0000	0.8603	OECD RegPat
Population with tertiary education (%)	249	0.2836	0.0893	0.1190	0.6330	Eurostat
Dummy Eastern EU country	249	0.1566	0.3642	0.0000	1.0000	Eurostat

Results of the estimation are presented in Table , where the distinction among specifications (columns) lies in the type of host nearshoring regions being considered. In column (1), the Dummy Host nearshoring region encompasses all regions falling within the category as per the definition. Columns (2), (3), and (4), on the other hand, include all Host nearshoring regions that also fall under the classification of quality, low labour cost, and automation regions, respectively.

Finally, the Theil Index is used as the measure of interregional inequalities (Theil, 1967). This measure quantifies the entropic gap between the current income distribution across regions and an ideal scenario where each region possesses an identical per capita income. A higher value indicates a substantial departure from an equal distribution, reflecting heightened inequality. The Theil Index is calculated as:

$$T = \frac{1}{N}\sum_r \frac{Y_r/pop_r}{Y_{EU}/pop_{EU}} \ln\left(\frac{Y_r/pop_r}{Y_{EU}/pop_{EU}}\right)$$

$$= \frac{1}{N}\sum_r \frac{Y_r/pop_r}{Y_{EU}/pop_{EU}} \ln\left(\frac{Y_r/pop_r}{Y_c/pop_c}\right) + \frac{1}{N}\sum_r \frac{Y_r/pop_r}{Y_{EU}/pop_{EU}} \ln\left(\frac{Y_c/pop_c}{Y_{EU}/pop_{EU}}\right) \quad (5)$$

Table F.3: estimation results of the regional growth model

Dep. variable: CAGR of regional GDP 2013-2019	(1) All	(2) Quality	(3) Low labour cost	(4) Automation adoption
Dummy Host nearshoring region	0.0046***			
	(0.001)			
Dummy Host nearshoring region - Quality		0.0035**		
		(0.002)		
Dummy Host nearshoring region - Low Labour Cost			0.0053***	
			(0.002)	
Dummy Host nearshoring region - Automation				0.0038**
				(0.002)
Dummy Home nearshoring region	0.0010	0.0011	0.0015	0.0010
	(0.002)	(0.002)	(0.002)	(0.002)
GDP per capita (ln)	-0.0045	-0.0049	-0.0051	-0.0053
	(0.004)	(0.004)	(0.004)	(0.004)
Manufacturing employment (%)	0.0388**	0.0438***	0.0422**	0.0414**
	(0.017)	(0.017)	(0.017)	(0.017)
Population density	0.0026***	0.0027***	0.0031***	0.0028***
	(0.001)	(0.001)	(0.001)	(0.001)
Patents per employee (ln)	0.0125*	0.0124	0.0157**	0.0125*
	(0.007)	(0.008)	(0.007)	(0.007)
Population with tertiary education (%)	0.0441***	0.0449***	0.0454***	0.0475***
	(0.011)	(0.011)	(0.011)	(0.011)
Dummy Eastern EU country	0.0230***	0.0229***	0.0219***	0.0231***
	(0.004)	(0.004)	(0.004)	(0.004)
Constant	-0.0114	-0.0131	-0.0140	-0.0148
	(0.016)	(0.016)	(0.016)	(0.016)
Observations	249	249	249	249
R-squared	0.435	0.426	0.429	0.426

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

where Y is the GDP in PPS and pop is the population, measured for the European Union (EU), for a generic country c, and for a generic NUTS2 region r belonging to c. Upper horizontal bars denote the mean of the variable. In the formula, the Total Theil Index can be decomposed into a 'within-country' (first element) and a 'between-country' component (second element).

c. List of Host nearshoring regions

Table F.4: list of host nearshoring regions

NUTS 2 Code	Quality	Low Labour Cost	Automation
BE10	X		X
BE21	X		X
BE22	X		X
BE24	X		X
BE25	X		X
BE32			X
BE33	X		X
BE34	X		X
BE35	X		X
DE11	X		X
DE12	X		X
DE13	X		X
DE14	X		X
DE22			X
DE24	X		X
DE27	X		X
DE30	X		X
DE40		X	X
DE50	X		X
DE60	X		X
DE72	X		X
DE73			X
DE80		X	X
DE91			X
DE92	X		X
DE93	X	X	X
DE94		X	X
DEA1	X		X
DEA2	X		X
DEA3	X		X
DEA4	X		X
DEB1	X		X
DEB2		X	X
DEB3	X		X
DED2		X	X
DED5	X	X	X
DEE0		X	X
DEF0	X		X
DEG0		X	X
FRF1	X		
FRF3		X	X

NUTS 2 Code	Quality	Low Labour Cost	Automation
FRI1	X	X	X
FRI3			X
FRL0	X		X
HU10		X	
HU21		X	
HU22		X	
HU23		X	
HU31		X	
HU32		X	
HU33		X	
SK01	X	X	
SK02		X	
SK03		X	
SK04		X	
UKC1			
UKD1			
UKD3	X		
UKE3	X		
UKE4	X		
UKF1	X		
UKG2			
UKG3	X		
UKH1	X		
UKH3	X		
UKI1	X		
UKJ2	X		
UKK2	X	X	
UKK3		X	
UKK4	X	X	
UKM2	X		
UKN0		X	

Appendix G: Machinery production networks that bridge East Asia and Europe

<Quantitative analysis of the change in import sources for EU bilateral imports from the pre- to post-pandemic at the product (HS 6-digit) level>
Analytical period: change from 2019 to 2023 (change from 2017 to 2023 and change from 2019-2022 for robustness tests)

Our equation:

$$
\begin{aligned}
Share_{ijp2023} - Share_{ijp2019} &= \beta_1 RTA_{ij2023} + \beta_2 Agree_{ij2022} + \beta_3 \ln Dist_{ij} + \beta_4 Lang_{ij} + \beta_5 Colony_{ij} + \mathbf{R'}_i \boldsymbol{\beta} \\
&\quad + \mathrm{u}_{jp} + \epsilon_{ijp},
\end{aligned}
$$

where

$$
Share_{ijpt} \equiv 100 \cdot \left(\frac{Imports_{ijpt}}{\sum_k Imports_{ikpt}} \right)
$$

$Imports_{ijpt}$: imports of product *p* (defined at an HS six-digit level) from country *i* in EU country *j* in year *t*. Exporting countries include all countries in the world.

A vector of **R**: four region dummy variables, i.e., ASEAN, China (including Hong Kong), Japan-Korea-Taiwan (JKT), and the rest of the world (ROW). The baseline is intra-EU imports.

RTA_{ij} and $Agree_{ijt}$: economic and political friend-shoring. RTA_{ij} takes a value of one if countries *i* and *j* belong to the same RTA . We regard the increase in imports from RTA partners as economic friend-shoring. $Agree_{ijt}$ is the voting similarity index, which indicates the similarity of state preferences inferred from voting behavior in the United Nations General Assembly. We regard the increase in imports from politically similar countries as political friend-shoring.

$Dist_{ij}$: geographical distance to examine near-shoring.

$Lang_{ij}$ and $Colony_{ij}$: the language-commonality dummy and the colonial relation dummy to examine cultural linkage.

We control for exporter-product fixed effects. ϵ_{ijp} is a disturbance term.
We estimate this equation for each of 4 machinery industries (general machinery, electrical machinery, transport equipment, and precision machinery) and for the total industry including machinery and non-machinery industries by using OLS method. We also conduct analyses for machinery parts and components as well as machinery final products separately.

Although our main interests are machinery industries, we conduct analyses for each non-machinery industry for comparison as well, including industries with CRMs.

<Quantitative analysis of the change in EU countries' outward FDI from 2017 to 2021>
We examine the share of sales by foreign affiliates of EU firms in manufacturing industries. The share for the dependent variable is replaced with the following in the equation above.

$$Share_{ijst} \equiv 100 \cdot \left(\frac{Sales_{ijst}}{\sum_k Imports_{kjst}} \right).$$

$Sales_{ijst}$: sales of EU country *i*'s affiliates in industry *s* in host country *j* in year *t*.

TWIN SEEDS

Appendix H: Disentangling regional spillovers from GVCs

Table H.1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Source
patent	10890	15.86	40.411	0	669.831	Patstat
ExtNet	10890	7.598	26.68	0	500	Orbis
IntraMNE network	10890	32.002	75.248	0	738.941	Orbis
IntraDom Network	10890	14.663	49.845	0	458	Orbis
Specialization	10890	1926.701	4434.934	0	77523.26	Istat
r&d	10890	1.146	.408	.4	2.2	Istat
Openness	10890	42291.764	81170.619	0	1771893.4	Istat
Human capital	10890	15.755	2.767	10.4	24.9	Istat
LUR	10890	5.527	3.743	.7	15.8	Istat

Table H.2: Baseline results

VARIABLES	(1)	(2)	(3)	(4)	(5)
ExtNet	7.736***	7.149***	7.718***	7.238***	7.047***
	(2.328)	(.379)	(2.331)	(2.369)	(2.313)
IntraMNE network			2.168**	2.122**	2.350*
			(1.084)	(1.061)	(1.292)
IntraDom Network				1.899	1.977*
				(1.424)	(1.033)
Specialization	9.976***	7.798***	9.853***	9.835***	9.717***
	(2.959)	(.453)	(2.873)	(2.800)	(2.687)
Openness	3.804**	2.675***	3.751**	3.715**	3.757**
	(1.696)	(.292)	(1.698)	(1.681)	(1.684)
Human capital	2.529**	2.111*	2.452**	2.349**	2.321**
	(0.996)	(1.091)	(1.012)	(0.994)	(0.985)
LUR	-2.466***	-2.719**	-2.883***	-2.853***	-2.806***
	(0.903)	(.962)	(0.902)	(0.927)	(0.918)
r&d	1.474	1.84	1.542	1.674	1.686
	(1.954)	(1.368)	(1.954)	(1.983)	(1.976)
ExtNet		.885			
Spatial lag of th dependent variable		.412***			
Spatial lag of the error term		.225***			
Observations	10,890	10,890	10,890	10,890	10,890
Model	FE	SDEM	FE	FE	FE
R-squared	0.529		0.531	0.532	0.529
NUTS3	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES
SECTOR	YES	YES	YES	YES	YES
SECTOR/YEAR	YES	YES	YES	YES	NO

Robust standard errors in parentheses, clustered at province (NUTS3) level. *** p<0.01, ** p<0.05, * p<0.1

Table H3: Intra- and inter-sectoral knowledge spillover within and between regions

VARIABLES	Science-based	Specialized producers	Scale-intensive sectors	Dominated suppliers
Direct impact (ExtNet)				
Science-based	2.175***	1.451*	0.043	0.165
	(0.580)	(0.763)	(0.695)	(0.466)
Specialized producers	0.406	1.702***	0.394	-0.041
	(0.644)	(0.383)	(0.373)	(0.354)
Scale-intensive sectors	-0.811	-0.206	0.689***	0.353
	(0.513)	(0.430)	(0.241)	(0.412)
Dominated suppliers	0.033	-0.211	-0.470	0.495
	(0.440)	(0.377)	(0.361)	(0.455)
Intra-MNE domestic network				
Science-based	0.630***	0.031	0.290*	0.231
	(0.117)	(0.333)	(0.157)	(0.162)
Specialized producers	0.035	0.461*	0.071	-0.318
	(0.100)	(0.271)	(0.203)	(0.291)
Scale-intensive sectors	-0.293	0.060	0.102	-0.003
	(0.321)	(0.095)	(0.159)	(0.115)
Dominated suppliers	-0.277	-0.085	-0.226	0.325
	(0.243)	(0.167)	(0.280)	(0.273)
Intra-domestic firm national network				
Science-based	0.286***	0.092	0.196***	0.096
	(0.050)	(0.233)	(0.021)	(0.080)
Specialized producers	0.470	0.134	0.371	0.128
	(1.959)	(0.192)	(0.253)	(0.189)
Scale-intensive sectors	-0.844	-0.143	0.217	-0.087
	(3.947)	(0.136)	(0.167)	(0.243)
Dominated suppliers	0.589	0.281	0.128	-0.020
	(1.964)	(0.204)	(0.142)	(0.196)
Observations	1,210	1,210	1,210	1,210
R2	0.859	0.889	0.848	0.851
NUTS3	YES	YES	YES	YES
YEAR	YES	YES	YES	YES

Coefficients in the upper panel refer to the impact of the external networks created by local MNEs (*ExtNet*) on patent activity in their regions of origin. Coefficients in the intermediate and bottom panel of the Table refer to the impact on innovative activity of the intra-MNE (*IntraMNE*) and intra-Domestic firm (*IntraDom*) national networks, respectively. All specifications also include all control variables included in eq. (4) and Table (A.1). Robust standard errors in parentheses, clustered at the province (NUTS3) level.

*** p<0.01, ** p<0.05, * p<0.1