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EU unemployment and global value chains

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Abstract
This paper examines the relationship between globalization and unemployment in the EU from 1990–2015, focusing on Global Value Chains (GVCs). We analyze the effects of the composition of the workforce and GVC-type trade on unemployment. Our findings show that GVC participation reduces unemployment in less advanced EU economies but increases it in core countries. Lower labor costs and low-skilled workers enhance the positive impact on reducing unemployment. Some sectors (especially services such as Telecommunications) experience significant employment gains. We recommend policies to remove regulatory barriers and support technological advancement to ensure equitable benefits from GVC integration across the EU.

Keywords Global value chains · EU · Local projections · Unemployment

JEL Classifcation F14 · F15 · F62 · C32

1 Motivation

Over the past decades, the world has witnessed an upsurge in production fragmentation across borders, largely driven by the emergence of global value chains (GVCs). Globalization motivates companies to restructure their operations internationally

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through outsourcing and offshoring activities. Firms try to optimize their production processes by locating the various stages of the value-added chain, such as design, production, marketing, and distribution, at different sites. Moving in lockstep with trade and investment liberalization, product fragmentation has resulted in large increases of trade in intermediates that rendered the gross trade flows measured by trade statistics less informative than in the past (Antràs, 2020; Antràs & Chor, 2022).

Through GVCs, countries not only exchange products but also engage in processes that facilitate the cross-border diffusion of skills and know-how. This is a key distinguishing feature of GVCs that challenges conventional economic wisdom about the consequences of GVC trade for productivity growth, job creation, and living standards. As countries have increased their participation in GVCs, more and more firms have decided to relocate their production, significantly affecting employment patterns within and between countries (Amador & Cabral, 2016). When GVCs are in play, the labor dynamics tied to a nation's conventional trade, which involves final goods and services, become more complex. It is not just about domestic labor in exports and foreign labor in imports anymore. Additional facets come into play, like foreign labor in exports, domestic labor in imports, and labor from third countries embedded in a nation's imports.

According to World-Bank (2020), GVCs are supposed to deliver more and better jobs, as production is more capital intensive. Although this may reduce employment, the overall effect is primarily positive because of the increase in exports. Participation in GVCs can affect employment through job destruction and job creation. Empirical evidence shows that, in general, participation in GVCs has a positive impact on employment, especially in developing countries, since it facilitates either structural transformation or generates new linkages in and around the value chain.

The extant literature on the relationship between GVCs and employment predominantly takes a microeconomic approach and delves into the consequences of firms engaging in value chains, highlighting winners and losers. However, a significant gap exists in understanding their ultimate impact on aggregate unemployment. The literature is non-conclusive, with studies showing varying results influenced by country-specific factors, skill levels of workers, sectoral differences, and measurement indicators (Jiang & Milberg, 2013; ILO, 2015). GVCs present both opportunities and challenges for countries concerning employment dynamics. GVCs allow workers to apply their skills worldwide without moving countries, which affects labor markets: while in the short run, the demand for some skills drops as activities are off-shored, exposing workers to wage reductions or job losses, in the long term, however, offshoring enables firms to reorganize and achieve productivity gains that lead to job creation. Thus, participation in GVCs can reshape the labor market landscape in terms of activities and skill categories. Moreover, the localized impacts of GVC participation across regions vary significantly, complicating the assessment of overall effects on a macro scale. Despite the commonly used term of *"global"* to refer to international value chains, value chains have always had a strong *regional bias*, evolving around three main hubs: North America, Asia, and Europe (Baldwin & Lopez-Gonzalez, 2015).

In this paper, we contribute to the debate on the macroeconomic effects of globalization by analyzing whether involvement in GVCs affects the unemployment

rate across EU countries. We consider this issue empirically by estimating impulse response functions from local projections for the 28 EU Member States over the period 1990–2015.[1] This straightforward methodology, proposed by Jordà (2005), allows us to focus on results rather than the estimation technique. To the best of our knowledge, no previous study has explored the impact of GVC's participation in unemployment for the EU, breaking it down by countries and sectors.

We make several novel contributions to the existing literature. First, we focus on countries belonging to the European Union (EU). An analysis at the European level is interesting since the EU is the region with the most significant degree of participation in GVCs (Baldwin & Lopez-Gonzalez, 2015). Moreover, despite the global GVC's slowdown since 2012, in the EU countries this process has been much less pronounced (ECB, 2019).

Second, we adopt a global and a sectoral approach to value chain participation to provide a richer analysis. Indeed, we analyze not only the sectoral breakdown in manufacturing but also in services. According to Timmer et al. (2013), the revealed comparative advantage of the EU27 is shifting to activities related to non-electrical machinery and transport equipment production. The workers involved in GVCs are increasingly in services rather than manufacturing industries. We also find a strong shift towards activities by high-skilled workers, highlighting the uneven distributional effects of fragmentation. The results show that a GVC perspective is needed to better inform the policy debates on competitiveness. Trade in services has been frequently excluded from GVC studies. However, services have increased in value-added and in sophistication.[2]

Third, we link the GVC unemployment nexus with the workforce composition in terms of skill level and labor costs. This question is highly relevant given that the literature suggests that employment creation has been biased towards more skilled workers, at least in developing countries, which contrasts with the predictions of trade theory. The skill-biased nature of GVC trade is associated with the high complexity of global supply chains and increased use of skill-intensive inputs, notably in business-to-business services. Labor costs can also contribute to the global value chain by their impact on competitiveness and cost differentials vis-à-vis other countries.

Finally, we pay special attention to possible endogeneity issues. Indeed, GVC participation can impact labor market outcomes by shaping the demand for labor and skills. Still, labor market outcomes also strongly shape the scale and nature of GVC participation. Thus, the direction of causality between GVC participation and jobs is often difficult to disentangle. We deal with this issue by relying on local projections and defining the causal effect on the unemployment rate on time $t + h$ of a one-time shock at time $t - 1$. Considering both the shock and all explanatory variables at $t - 1$, our analysis should provide some comfort in addressing endogeneity. However, we also implement an instrumental variable (IV) approach to mitigate such

[1] Although at the moment of writing the paper, the UK is no longer an EU member, it was for the sample period. The sample ends in 2015, the last year available in the sectoral data breakdown.

[2] Therefore, production can also be divided into several stages in different locations. According to the OECD Statistics on International Trade in Services database, the EU leads the trade in services, as the joint exports of this sector amounted to more than one trillion dollars in 2020, and its imports also surpassed 900 billion. The corresponding figures for the US were 700 billion and 460, respectively.

concerns completely. As an instrument, we use the average changes in the participation of the other countries in the sample.

Our results show that value chains affect unemployment in different ways: while they have the potential to reduce the unemployment rate in less advanced EU countries, the impact of this characteristic of the globalization process can be detrimental to labor markets in core economies. In line with this result, we show that countries with low labor costs and skills benefit more from GVC participation. These findings on GVC participation challenge prevailing skepticism about job growth potential for less-skilled workers (Baldwin & Forslid, 2023; Rodrik, 2018). While Reijnders et al. (2021) demonstrated that technical change in GVCs biases against low-educated workers but favors highly educated ones, we reveal that GVC participation can actually reduce unemployment in less advanced EU economies with low labor costs and abundant low-skilled workers, particularly in service sectors.

This nuanced picture reflects a broader debate about globalization's employment effects that has been notably influenced by the "China Shock" narrative popularized by Autor et al. (2016). Their influential work documented how regions more exposed to Chinese import competition experienced worse labor market outcomes, leading many economists and much of the American public to view trade with China as detrimental to US workers. However, this regional analysis fails to capture aggregated effects. Wang et al. (2018) provide crucial context by demonstrating that after accounting for the supply-chain effects of Chinese imports, overall employment and wages actually increased nationwide. Remarkably, they found positive labor market outcomes even in regions that experienced significant manufacturing employment declines through the direct competition channel identified by Autor et al. (2016).

These seemingly contradictory findings parallel our own results and can be reconciled through several important factors:

First, geographic differentiation matters significantly. GVCs reduce unemployment in less advanced economies (both within the EU and globally) while potentially increasing it in advanced economies. This suggests that cost advantages preserve demand for low-skilled labor in developing regions while offshoring eliminates such jobs in developed economies. However, as Wang et al. (2018) demonstrate, even in advanced economies, the aggregated effects may be positive when accounting for both direct competition and broader supply-chain impacts.

Second, sectoral variation plays a crucial role. Automation primarily substitutes labor in manufacturing (Baldwin & Forslid, 2023; Rodrik, 2018), whereas service sectors often benefit from GVC expansion through less-automatable tasks. This helps explain why regions heavily dependent on specific manufacturing sectors might experience concentrated job losses, while the broader economy gains employment through growth in other sectors.

Third, time horizons significantly affect outcome assessments. Short-term disruptions from trade shocks can cause substantial localized displacement, creating highly visible costs, while benefits from lower prices, expanded market opportunities, and productivity enhancements diffuse more gradually throughout the economy.

Our research, alongside studies like Wang et al. (2018), suggests that assessments of globalization's impact require analytical frameworks that account for these com-

plex dynamics rather than focusing exclusively on immediate, localized effects that may not reflect the aggregated economic reality.

The remainder of the paper is organized as follows. Section 2 relates the present research with previous theoretical and empirical literature. In Sect. 3 we describe the data. The methodology employed is presented in Sect. 4. In Sect. 5, we present the results. Section 6 shows the impact of the workforce composition on the GVC-unemployment link. Section 7 concludes.

2 Related literature

The participation of firms and sectors in GVCs creates cross-country linkages via trade in intermediate inputs with potentially significant macroeconomic consequences. First, employment, productivity, and growth are interlinked, both cyclically and in the long term, with distinctive characteristics in each case (Antràs, 2020).[3] Second, from a socio-political point of view, the development of GVCs has been considered one of the causes of the increase in inequality in developed countries (López-Gonzalez et al.., 2015). Finally, the new wave of re-shoring after the pandemic may also have consequences in the labor markets, something to be considered from an economic policy point of view (Szymczak & Wolszczak-Derlacz, 2022).

GVC expansion delivers substantial welfare benefits primarily through price reductions rather than wage increases. Recent research by Jaravel and Sager (2024) documents large falls in domestic prices, with product categories serving low-income consumers experiencing the most significant declines. At the same time, Waugh (2023) heterogeneous agent model confirms that gains from trade are pro-poor. Unlike employment effects, which can be uneven across regions and skill levels, these price benefits create a rare economic scenario where aggregate and distributional impacts align positively. Everyone benefits, with disproportionate gains for lower-income households.

However, Florio et al. (2025) demonstrate that GVC participation flattens the Phillips Curve in EU economies, weakening the unemployment-inflation relationship. This creates a paradox where employment gains in less advanced economies do not generate proportional wage increases due to strategic price complementarities among global firms, enhanced corporate market power, and weakened worker bargaining positions. Consequently, GVC benefits in developing regions manifest primarily through expanded employment rather than wage growth, while real wage gains (through lower prices) may exceed nominal wage improvements.

This dynamics helps explain divergent perceptions of globalization: losses through job displacement are concentrated and immediately visible, while price benefits accumulate gradually and diffusely. Effective policy responses should combine enhanced safety nets, workforce development investments, strengthened labor mar-

[3] For example, Taglioni and Winkler (2016) argue that GVCs can benefit labor markets through three channels: first, a demand effect, as multinationals (and other GVC participants) have a high demand for skilled labor; second, a training effect, as local firms participating in GVCs may receive training from either multinationals or their foreign buyers; third, a labor turnover effect, as knowledge embodied in the workforce of participating firms moves to other local companies.

ket institutions in developing economies, and monetary approaches that account for altered inflation dynamics to maximize GVC benefits while addressing distributional concerns.

In what follows, this section focuses on the review of the theoretical and empirical literature analyzing the effects of GVCs on the labor market.

2.1 GVCs and unemployment

The organization of GVCs involves restructuring activities and locations of economic activity, with fundamental implications for employment and labor conditions.

Theoretically, the relationship between GVC participation and employment (or unemployment) is a complex and controversial issue. Some authors, like Feenstra and Hanson (1996) or Helpman and Itskhoki (2010), provide arguments for a positive link. Yet, others, like Mitra and Ranjan (2010), Heid and Larch (2016); Farole et al. (2018) or World-Bank (2020) show that globalization reduces unemployment. Finally, others, like Moore and Ranjan (2005); Şener (2001), or more recently, Szymczak and Wolszczak-Derlacz (2022) and Szymczak (2024) provide a discussion leading to an uncertain relationship.

There seems to be no consensus either in the empirical literature regarding the effects of GVCs on employment, notably due to the heterogeneity of factors that influence the net effect (Hummels et al., 2018). The literature lacks consensus on the expected direction of the effects due to the complexity inherent to its study that, in addition to the classic analysis of domestic employment included in exports and foreign employment included in imports, encompasses the study of the labor market in imports from third countries (Crinó, 2009). This framework acquires additional complexity because of the difficulty of isolating the net effects of GVCs from the role of trade policies in changing consumer demand or technological innovations. Furthermore, GVCs affect not only the demand and supply of employment but also other dimensions of the labor market, especially wages.

While the Hecksher-Ohlin theory offers a fundamental analysis of the effects of international trade on the labor market, the “new" theories of international trade based on the heterogeneity of firms present a distinct theoretical framework. According to Melitz (2003), trade liberalization leads to a reallocation of resources in favor of the export sector, where skilled labor predominates, leading to higher demand for this type of worker. Bernard et al. (2007) find that trade liberalization results in the reallocation of factors, not only at the industry level but also across industries, which implies a sectoral approach for any reliable empirical study.

Despite the undoubted relevance of these models, the analysis of the impacts of GVCs necessarily entails greater complexity than the simple study of the effects of international trade on the labor market. The focus of the analysis shifts from the comparative advantage in producing final goods to intermediate goods or specific tasks in the value chain (Jiang & Milberg, 2013). Analyzing the impact on total labor demand in this framework is less straightforward due to the contradictory results generated through different channels. In fact, Farole et al. (2018) identifies three simultaneous effects that should be considered when analyzing the impact of GVCs on employment. First, a “substitution effect" between the production activities trans-

ferred abroad, that is, domestic labor is replaced by foreign labor. Second, an "scale effect" as outsourcing certain stages of the value chain reduces the cost of production, leading to lower prices and higher demand for goods and/or services, which in turn increases the demand for workers in the domestic market. Finally, a "productivity effect", coming from a higher degree of specialization of the economies through outsourcing and a reduction in the demand for labor for each unit of output.[4] In a similar vein, Carrère et al. (2020) have recently proposed a trade model about the effects of trade openness on employment. In this context, trade affects unemployment through two channels: *expansion and reallocation*. The "expansion effect" occurs when a trade reform results in efficiency gains. These gains imply more jobs, higher welfare, and less unemployment. The "reallocation effect" results from different degrees of friction across labor market sub-sectors. Thus, individual effects are heterogeneous, and there are winners and losers in employment. Trade changes displace workers, and adjustment takes time.

Finally, Bamber et al. (2014) also point to three factors that should be considered to analyze the effects of GVC on employment: 1) the type of value chain concerned (backward or forward), 2) the institutional and business environment, and 3) the ability of the economy to participate in higher value-added production stages within the GVC framework. As for the first element, Shepherd and Stone (2012) show that economies that participate concurrently in the incorporation of foreign intermediate inputs into exports (backward integration) and the export of goods or services subsequently integrated into third-country exports (forward integration) exhibit higher increases in the demand for workers than countries with less intense participation in GVCs.[5]

Some contributions have detected several " benefits" to increase participation in GVCs. In particular, it is suggested that GVC trends have important implications for productivity, with potential gains through firms and countries specializing in their most productive tasks and utilizing new varieties and higher quality foreign goods, services, and intangible inputs (Kummritz, 2016). Moreover, the positive view on GVCs suggests that those productivity gains coincide with or even cause scale effects that further allow for fast job growth, at least in less developed countries (OECD, 2013). From an empirical point of view, some of the few examples of research in this area that stand out are Shingal (2015), Reijnders and de Vries (2018), Pan (2020), and Szymczak and Wolszczak-Derlacz (2022). GVC participation has the potential to engender domestic job reallocation across occupations, thereby reshaping the comparative advantage of nations in terms of tasks rather than industries (Grossman & Rossi-Hansberg, 2008). Consequently, adhering to the conventional Heckscher-

[4] According to Taglioni and Winkler (2016), the positive impact on productivity is directly related to a knowledge spillover effect by multinationals.

[5] GVCs are anticipated to facilitate employment expansion within forward GVCs, the ones characterized by exports of raw materials and intermediate inputs for further processing and export by other countries. However, this dynamics may precipitate a reduction in labor demand within nations typically engaged in backward GVCs, that use imported inputs to produce and then export (Bamber et al., 2014) However, Shepherd (2013) posits that employment can offset the job losses in the latter depending on export activities and foreign affiliates.

Ohlin model, GVCs are expected to instigate a transition in the labor composition of exports from low-skilled to higher-skilled labor content (OECD, 2016).

On the other hand, there is a growing belief that rising production fragmentation can lead to unemployment (Dutt et al., 2009). Indeed, one of the main motivations for fragmenting the production process is the ability to procure inputs at a lower cost from abroad than at home. Moreover, it is also argued that GVC participation is associated with reduced job growth because GVC trade increases productivity and fewer workers are needed per production unit (Rodrik, 2021).

Recent empirical literature is surveyed in Lu et al. (2024), Szymczak (2024) and the meta-analysis by Carneiro et al. (2024). Using the workhorse Ricardian trade model of Eaton and Kortum (2002), Caliendo and Parro (2015) provide a solid base to incorporate the role of GVCs and international linkages through a formulation in the form of a gravity equation. However, they do not account for unemployment. Dix-Carneiro et al. (2021), starting from Caliendo and Parro (2015) approach, extend the model to study the effects on unemployment. From an empirical point of view, most of the studies use panel data or systems of equations to consider simultaneously various variables related to the labor market (employment, wages,..) estimated by adopting three-stage least squares (3SLS), VAR, or seemingly unrelated equations. Recently, Camarero et al. (2021) propose a flexible and simple fresh alternative approach to analyze how GVC participation affects macroeconomic variables using local projections.

In sum, even if firms with the strongest international linkages, i.e., firms that participate in a GVC, create jobs, the relationship between GVC integration and unemployment is not necessarily positive at the aggregate level. Evidence and intuition suggest that GVC participation will have distributional implications concerning where jobs go, the types of jobs, and who gets them. Of course, at the national level, the crucial question is whether there are spillovers that operate through labor markets, leading to less unemployment at the aggregate level, and if they are changing over time.

2.2 GVCs and unemployment in the EU

This paper focuses on EU countries for several reasons related to the region's particularities. Indeed, three interconnected production hubs have been established around the world: North America (centered in the United States), Asia (with China playing a dominant role), and Europe (with Germany as the core). Overall, the participation of Europe in GVCs is significantly higher than the other two, and it has steadily increased with the creation of the Single Market and the launching of the euro (Huidrom et al., 2019). Therefore, value chain participation has significant economic implications for the euro area's economies (ECB, 2019).

In addition, within the EU, the distribution of economic activities presents a core-periphery pattern, with the bulk of investments concentrated in core countries. Nonetheless, peripheral countries have gained prominence with the acceleration of the economic integration process in the EU. Since tariffs and non-tariff barriers were already eliminated in the 1990s, the Central Eastern European Countries (CEECs) accession into the EU in 2004 provides a quasi-natural experimental setting that can

be used to investigate the importance of behind-the-border barriers across integrated markets.

Most of the literature has been pessimistic, arguing that increased competition in an integrated area would force firms to trim their workforce and shift towards more capital-intensive "advanced" technology, thereby restricting employment expansion and a marked trend towards the informalization of the workforce (Mundle, 1993). More recently, the problem has been formulated as the seemingly paradoxical "pair of concerns": more advanced countries worry about the potential loss of manufacturing jobs going to lower-cost countries, whereas the countries that host the new production worry about receiving the wrong type of jobs (as formulated by Baldwin and Ito 2022). Motivated by these developments, it is increasingly important to understand the implications for labor markets that result from GVCs.

As multiple channels explain how GVCs may affect labor markets, the implications of participation in GVCs for employment remain fully misunderstood and can be diverse. Recent literature shows the relevance of not just the intensity of GVC involvement but also of the position within the GVC (The World Trade Organization, 2019). The effect of greater production fragmentation may differ depending on how far the country sector is from the final or initial production stage. Moreover, according to ECB (2019), participation in GVCs can change the composition of the labor force. Low-skilled jobs would be affected, with downward pressure on wages. While recent studies show that import competition from low-cost countries such as China has led to a fall in employment, especially in the manufacturing sector (Autor et al., 2015), competition from low-cost countries is only one aspect of GVCs. OECD countries import intermediates from high-tech manufacturing industries and business services and export these products to other countries, creating new employment opportunities.

Evidence for Europe also shows that employment shares of both high-skilled and low-skilled workers are increasing at the expense of medium-skilled workers. According to Shepherd (2013), the available empirical evidence suggests that GVC participants' activities influence labor market outcomes. Similarly, Fritsch and Matthes (2020) analyze the derived labor demand generated by the export of intermediate goods to other EU countries. Their findings indicate that Eastern European countries exhibit significantly higher proportions of employment attributable to these networks compared to major Western European economies. This disparity suggests a greater dependency of labor markets in Eastern Europe on the interconnected industrial activities within the broader European production system hub. In the same vein, ECB (2019) suggests that participation in GVCs may be essential for labor market outcomes, and the impact of GVCs on labor market dynamics should be further analyzed not only from a geographical perspective but from a sectoral one. This is the aim of the present paper.

Our results align with standard trade and labor market theories in several respects. In particular, the mechanisms that cause participation in GVCs to have differentiated effects on employment are surveyed in Szymczak (2024):

1. Comparative Advantage and Specialization: Less advanced EU economies have a comparative advantage in low-cost, labor-intensive production. Instead, core EU

economies specialize in high-value-added, skill-intensive production (Stöllinger, 2019; European Parliament, 2023).

2. Labor Cost Differences and Offshoring Dynamics: Low wages in less advanced EU countries make labor-intensive tasks more competitive, leading multinational firms to relocate production stages there. This job creation effect counteracts the skill bias of GVCs, at least temporarily. In contrast, in core EU economies, low-skilled labor costs are high, making automation or offshoring to lower-wage EU members (or non-EU countries) more attractive, leading to job losses (Lian, 2019);
3. Sectoral Differences and Non-Automatable Jobs. Service sectors may experience significant employment gains. Unlike manufacturing, many service jobs require human input and are harder to automate or offshore. Less advanced EU economies may specialize in GVC service components that benefit from globalization without suffering heavy automation-related job losses (Josten & Lordan, 2019);
4. GVC-Driven Demand Effects: GVC participation increases trade and investment, leading to higher demand for locally produced inputs and services. In less advanced economies, this demand translates into employment growth because firms hire more workers for both low-skilled manufacturing and supporting services. In core economies, however, demand shifts toward high-skilled labor, leading to polarization, where high-skilled jobs increase but middle- and low-skilled jobs disappear (Ignatenko et al., 2019; Timmer et al., 2013).
5. Institutional and Policy Differences. Some less advanced EU countries may have more flexible labor markets or lower labor protection, making them more attractive for firms seeking low-cost workers. Core EU economies often have stronger labor regulations and unions, which can make job losses more persistent when firms relocate or automate tasks (Stöllinger, 2019).

The previous mechanisms support exploring the relationship between GVC participation and unemployment.

3 Data and descriptive statistics

3.1 Data and definitions

We have collected data for the 28 EU members from 1990–2015. We use the UNCTAD-Eora GVC database (2019) to obtain our measures of GVCs, given its geographical coverage and relatively recent input–output data. Measuring GVCs is far from simple due to the fragmentation of production across several countries. While trade data have been widely used to measure GVCs, this raises important concerns.[6] The most obvious drawback is that trade data are expressed in gross terms, meaning that the value of intermediate inputs traded along the supply chain is accounted for several times, distorting the measure. Key progress in GVC measurement has come

[6] See, for instance, Feenstra and Hanson (1996), as well as Amador and Cabral (2016) and Haltmaier (2015) for a survey.

from constructing multi-country input–output tables that link national input–output tables using bilateral trade flows (De Backer et al., 2018). Those tables allow quantifying the contributions of each production stage within the global supply chain to the value of the final product. The Eora global supply chain database (UNCTAD) is particularly well suited for this purpose, as it consists of a multi-region input–output table and is currently the most commonly used in the literature.

Based on these data and following Koopman et al. (2014), country i's backward participation in GVC is defined as:

$$Backward_i = \frac{FVA_i}{VAX_i} \tag{1}$$

where FVA_i stands for foreign value added in country i; and VAX_i is country i's value added exports. Thus, backward participation looks upward at the value chain at the imports used in producing exports, such as raw materials or intangibles involved at the beginning of the production process (e.g., research, design). $Backward_i$ then captures the "import to export" dimension and indicates that a country is positioned at a higher stage of the production process. Backward participation is supposed to be linked to better economic performance through productivity gains due to the increasing access to the highest-quality inputs to the production process. Note, however, that taken to the extreme, backward integration may crowd out local production and limit domestic value addition (Farole, 2016).

Forward participation captures the domestic value added contained in inputs sent to third economies for further processing and export through supply chains. More specifically, it measures the domestic value added that is embodied in foreign exports.

$$Forward_i = \frac{DVX_i}{VAX_i} \tag{2}$$

where DVX_i denotes domestic value added in country i. Typically, forward participation can be expressed as well as an index (if multiplied by 100). Forward linkages imply producing and exporting intermediates, to which importing countries will add further value and export as finished products or intermediates to other production stages. Productivity spillovers from forward linkages in value chains are expected to come from the requirements to meet demanding standards and technical regulations imposed by buyers, with subsequent demands diffusing down through the domestic value chain (Farole, 2016).

Based on backward and forward participation, overall participation in GVCs is defined as follows:

$$GVC_i = \frac{DVX_i + FVA_i}{VAX_i} \tag{3}$$

We break down GVC participation for each country into eight sub-sectors in manufacturing and services. As for manufactures, we can distinguish between the following subsectors: (i) Food and beverages, (ii) Textiles and wearing apparel, (iii) Wood

and paper, (iv) Petroleum, chemicals, and non-metallic mineral products, (v) Metal products, (vi) Electrical and machinery, (vii) Transport equipment, and (viii) Other Manufacturing. Similarly, we divide services into (i) Maintenance and repair, (ii) Wholesale trade, (iii) Retail trade, (iv) Transport, (v) Post and communication, (vi) Financial intermediation, (vii) Public administration, and (viii) Education, health, and other services.

We also include a measure of the relative upstream position in the GVC captured by the ratio between forward and backward participation scores. A relatively higher share of foreign value added from upstream input providers would indicate a downstream position, leading to a value of the index lower than 1. Conversely, a higher share of value added in re-exported intermediate products traveling further down the value chain would be an indication of an upstream position and, in this case, the GVC position index would be higher than 1.

The rest of the variables that we use in the empirical models are: (i) The harmonized unemployment rate (source: Eurostat); (ii) The employment protection legislation or EPL (source: OECD); (iii) A measure of factor proportion, proxied by the capital intensity ratio or capital abundancy, i.e., ratio of net fixed assets per employed person (source: Bighelli et al. (2023)); (iv) A market concentration index. This indicator measures the dispersion of trade value across an exporter's partners. A country with a preponderance of trade value concentrated in very few markets will have an index value close to 1. Thus, it is an indicator of the exporter's dependency on its trading partners. Measured over time, a fall in the index may be an indication of diversification in the exporter's trading partnerships (source: WIITS, by the Worldbank); (v) GDP growth (source: IFS, IMF) and (vi) Labor productivity growth (source: Eurostat).

3.2 Descriptive statistics and some stylized facts

In this section, we describe the participation of the EU countries in GVCs as defined above. In addition, we also present the three groups (core, periphery, and CEE countries) of EU members that we will analyze later.

Table 1 describes the evolution of GVC participation at the beginning of the sample (1990) and the end (2015). Some patterns can be inferred from them. First, the smaller EU countries need to source a more significant share of inputs from abroad, so their participation in GVCs is higher than that of the bigger economies. Second, Cyprus and Greece may have obtained their positions due to their specific domestic export structure; both countries specialize in the tourism sector, are located at the end of the supply chain, and are relatively less vertically fragmented. Also an exporter of services, but on the opposite extreme, Luxembourg appears to be involved in much supply chain trade, most probably due to its strong financial services sector that provides inputs to many other firms. Third, a couple of smaller economies, Denmark and Lithuania, specialize in production stages at the end of the supply chain compared to other larger countries such as Italy, Spain, and the UK. Finally, Germany, having the largest market size in the EU and taking up a central position in Europe's supply chains, exhibits a middle level of participation (between 50% and 60%).

Table 1 Global value chain participation, 1990 and 2015

Country	GVC participation			GVC postion	EPL	Capital abundancy	Market concentrartion	Unemp rate
	1990	2015	Average					
Austria	0.59	0.72	0.69	0.77	2.48	NA	0.12	4.98
Belgium	0.71	0.79	0.77	0.44	1.70	0.45	0.08	8.07
Bulgaria	0.40	0.60	0.57	1.20	NA	NA	0.06	11.84
Croatia	0.51	0.63	0.60	0.93	2.48	NA	0.13	14.54
Cyprus	0.42	0.51	0.51	0.52	NA	NA	0.10	5.58
Czech	0.53	0.74	0.70	1.07	3.52	0.8	0.15	6.41
Denmark	0.56	0.68	0.64	0.60	1.49	NA	0.09	6.07
Estonia	0.67	0.75	0.74	0.47	2.04	NA	0.08	8.84
Finland	0.54	0.67	0.65	1.01	2.21	0.73	0.06	9.69
France	0.53	0.62	0.60	1.00	2.56	0.20	0.06	9.24
Germany	0.51	0.60	0.59	0.80	2.58	0.62	0.05	8.42
Greece	0.49	0.60	0.57	0.77	3.01	NA	0.08	12.62
Hungary	0.57	0.79	0.75	0.48	1.96	NA	0.13	8.51
Ireland	0.61	0.71	0.70	0.29	1.23	NA	0.11	9.90
Italy	0.41	0.54	0.51	1.01	3.01	0.13	0.05	9.43
Latvia	0.60	0.64	0.63	0.89	3.02	NA	0.07	11.02
Lithuania	0.69	0.70	0.68	0.40	2.63	0.54	0.06	10.20
Luxembourg	0.79	0.85	0.85	0.50	2.14	NA	0.10	3.71
Netherlands	0.67	0.78	0.75	0.48	3.30	0.78	0.11	5.56
Poland	0.49	0.71	0.67	1.48	2.33	0.16	0.12	12.82
Portugal	0.53	0.60	0.59	0.85	4.33	0.36	0.12	8.44
Romania	0.49	0.68	0.63	0.91	NA	0.40	0.10	7.33
Slovakia	0.74	0.81	0.79	0.46	2.93	2.5	0.12	14.42
Slovenia	0.62	0.75	0.70	0.72	21.49	NA	0.10	8.18
Spain	0.48	0.59	0.57	0.86	2.53	0.56	0.09	16.54
Sweden	0.54	0.67	0.65	0.91	2.51	0.57	0.05	6.82
UK	0.52	0.62	0.61	1.14	1.43	NA	0.06	5.90
Mean EU-28	0.56	0.68	0.65	0.77	2.49	0.63	0.09	9.04

Source: Own calculations, using UNCTAD Eora data, OECD, WITTS and Bighelli et al. (2023)

The picture that emerges from the data is that the EU countries are active participants in value chains, reflecting the high level of openness and economic integration of the EU economies. Moreover, participation in the backward and forward stages of production is relatively balanced. However, the relative position of the countries depends on their size and specialization.[7]

[7] The relative position of the countries is not homogeneous: smaller countries are placed more downstream (these are the cases of Belgium, Estonia, Ireland, Luxembourg, or Slovakia) than larger EU countries, which tend to lie more upstream. According to ECB (2019), compared with the world average, EU countries are placed relatively downstream, signaling that the foreign content of their production is larger compared to the inputs that EU countries supply to other countries. The United States is positioned more upstream than the EU mainly due to its specialization in natural resources, research and development, and financial services, all serving as intermediate inputs to other sectors. Within the EU, there are also pan-European production chains, where the larger countries produce intermediate goods and services, while the assembling process takes place in the smaller or CEE countries.

Table 2 shows sectoral GVC participation between 1990 and 2015. In all cases, GVC participation has increased by around 20% on average during the period, the increase being stronger in agriculture and the service sector. Regarding manufacturing, the highest levels of participation are found in sectors strongly linked to raw materials (chemicals, petroleum, metal products), which are located upstream and provide primary inputs. In services (some in upstream locations, others downstream), wholesale and transport are the sub-sectors with the highest participation. This ranking has changed little over time.

4 Empirical strategy

Following Frankel and Romer (1999), the methodology relies on a production function and its decomposition. Our starting point is a standard translog production function, which extends the Cobb-Douglas production function to allow for substitution elasticity between inputs.[8] We assume that output (Y) in a country/sector depends on labor (L), capital (K), and GVC participation (GVC):

[8] See, for instance, Ignatenko et al. (2019), page 12.

Table 2 Global value chain participation by sectors, 1990 and 2015

Sector	1990	2015	% Change
Agriculture, forestry and fishing	36.25	46.03	27.0
Mining and quarrying	52.85	62.45	18.2
Manufacturing	51.03	59.69	17.0
Food and beverages	31.73	40.84	28.7
Textiles and wearing apparel	45.29	54.24	19.8
Wood and paper	51.00	60.65	18.9
Petroleum, chemicals, and nonmetallic mineral products	57.19	66.22	15.8
Metal products	61.94	71.56	15.5
Electrical and machinery	48.84	57.17	17.1
Transport equipment	54.43	60.94	12.0
Other Manufacturing	37.97	45.04	18.6
Services	35.34	43.07	22.0
Maintenance and repair	37.89	45.47	20.0
Wholesale trade	46.08	58.21	26.3
Retail trade	20.89	28.30	35.5
Transport	40.83	48.98	20.0
Post and communication	34.56	43.19	25.0
Financial intermediation	34.10	41.44	21.5
Public administration	16.53	20.28	22.7
Education, health and and other services	20.76	25.68	23.7

Source: Own calculations, using UNCTAD Eora data

$$\ln Y_t = \beta_0 + \beta_L \ln L_t + \beta_K \ln K_t + \beta_G \ln GVC_t + \frac{1}{2}\left(\sum_i \sum_j \beta_{ij} \ln X_i \ln X_j\right) \quad (4)$$

where Y_t is output, L_t is labor, K_t is capital and GVC_t measures global value chain participation. X_i, $X_j \in \{L, K, GVC\}$ and β_i, β_j capture interaction effects among inputs.[9]

From Eq.(4), we derive labor demand as:

$$\ln L = \alpha_0 + \alpha_Y \ln Y + \alpha_W \ln W + \alpha_G GVC + \text{ other terms} \quad (5)$$

where W is the wage level, and α_G captures the direct effect of the participation in GVC on the labor demand. Using a labor market equilibrium condition linking labor demand and unemployment, we get the following expression:

$$U = f(W, L, GVC, X) \quad (6)$$

where U is the unemployment rate, and X includes control variables. Based on this framework, to quantify the effects of GVC participation on the labor market, our empirical approach is based on the local projection (LP henceforth) method proposed by Jordà (2005).

Local projections is a popular tool for estimating impulse response (IR) functions in macroeconometric analysis. According to Jordà and Taylor (2025), after a shock (a policy intervention), LPs are "a sequence of regressions where the outcome is regressed on the intervention conditional on a set of controls (including lags of both the outcome and the intervention, as well as other exogenous or predetermined variables." Unlike traditional vector autoregression (VAR) models, LPs offer a flexible approach that is particularly useful under nonlinearities and structural changes and when dealing with short time series. According to Montiel Olea et al. (2025), an LP estimates the impulse response with respect to a shock that is defined as the residual of projecting the impulse variable on the control variables. In our case, we believe it can be a superior econometric methodology to document the dynamic response of unemployment to GVC participation. LPs have become increasingly popular because of their flexibility (they easily allow for the inclusion of control variables) and robustness to misspecification. Compared to VARs or autoregressive-ditributed lags (ARDL) specifications, LPs do not impose the dynamic restrictions embedded in those models.

Our framework is intentionally empirical and agnostic to specific structural assumptions, allowing the data to reveal dynamic patterns that might be constrained within a more structured theoretical model. This flexibility is particularly valuable given the heterogeneous effects of GVC participation we observe across different economies, sectors, and time horizons. The LP methodology enables us to capture

[9] Note that we omit intermediate inputs from Eq.(4) since GVC is measured as the foreign value-added share in gross exports. As such, it implicitly captures the use of imported intermediate inputs.

nonlinear responses and interaction effects that might be difficult to specify ex-ante in a more structured network model.

Since their introduction by Jordà (2005),[10] LPs have been extensively compared to VARs in the literature (Plagborg-Møller & Wolf, 2021; Montiel Olea et al., 2024; Montiel Olea et al., 2025). These comparative studies consistently highlight several advantages of the LP approach over traditional VAR methods. First, the LP method generates estimates less vulnerable to misspecification of the data-generating process because each horizon's impulse response is estimated separately. Since LPs do not rely on the correct specification of a multivariate dynamic system, they are less prone to errors due to misspecification than VAR models. This can be particularly beneficial when dealing with short time series or small sample sizes. Second, it allows controlling for a relatively large set of variables, which would be impractical in a standard VAR setting. LP allows for the straightforward inclusion of control variables that may change over time, enabling a more precise estimation of the effects of interest. Third, it allows for inference directly from the estimated impulse responses. Fourth, VARs extrapolate, and for that reason, they have low variance but potentially high bias. In contrast, LPs have more variability but a very small or nonexistent bias. For this reason, LPs have very good coverage; that is, they have a very high probability that their intervals contain the true impulse response. Fifth, they can easily accommodate non-linear specifications, which we use to uncover patterns more naturally than traditional VARs. Researchers can capture more complex dynamics by including interaction terms or regime-specific parameters. In sum, quoting the title of a recent paper by Plagborg-Møller and Wolf (2021) "local projections and VARs estimate the same impulse responses": the only requirement to obtain this result is an unrestricted lag structure. The latter represents a critical element, as it supports using LPs as a suitable method for many empirical applications, with all the advantages enumerated above. Finally, LPs can be specified in panel data and maintain the single equation properties enumerated above.

As mentioned above, the LP technique generates new estimates for each forecast horizon $h = 0, 1, ..., H$, regressing the dependent variable at $t + h$ on the available information set at time *t*. Then, the impulse response functions (IRFs) are obtained as a subset of the estimated slope coefficients of the projections. LPs can be formulated both in levels and in first differences. In levels, they should be interpreted as the cumulative response in differences, and both are asymptotically equivalent. Piger and Stockwell (2023) recommend using the formulation in differences, as the small sample bias is largely suppressed and provides consistent estimates. Based on Eq. (6), the baseline specification for the panel model, in differences, is the following:

$$\Delta U_{i,t+h} = \alpha_i + \gamma_t + \beta_h \Delta GVC_{i,t-1} + \nu X_{i,t-1} + \epsilon_{i,t+h} \tag{7}$$

where $U_{i,t}$ is the outcome variable of interest (the unemployment rate) for country *i* at time *t*, α_i are country-fixed effects to control for unobserved cross-country heterogeneity, γ_t are time-fixed effects to control for global shocks, $\Delta GVC_{i,t}$ is the change

[10] See Jordà and Taylor (2025) for an updated survey and many practical recommendations.

in the GVC participation, that is the "shock" or "policy variable"[11], ν is a vector of nuisance coefficients, $X_{i,t-1}$ is a vector of potentially endogenous controls lagged for one period as a first solution to address endogeneity concerns arising from reverse causality.[12] This vector includes: a) changes in the dependent variable; b) changes in the GVC participation score; c) labor costs, and d) GDP and productivity growth. Finally, the error term is $\epsilon_{i,t}$.

For robustness purposes and inspired by earlier studies in the empirical trade literature, we also address endogeneity concerns related to GVC participation by implementing an instrumental variable (IV) approach. As an instrument, we use the change in participation in the other countries of the group– core, peripheral, or EEC– over the same period. This instrument is meant to capture the variation in the participation driven by changes in conditions in foreign but similar countries that are not driven by domestic industry-specific shocks, which might be endogenous to GVCs.[13]

The coefficients on the variations of participation, β_h, trace out the effect of an increase in participation at time t on labor market outcomes at time $t+h$, i.e., the impulse response of the outcome variable. Given that GVC is measured as a fraction of gross exports, GDP in logarithms, and productivity in changes, the estimated coefficients on GVC quantify the percentage change in the outcome variable at time $t+h$ in response to a one percentage point change in participation at time t.[14]

5 Results

5.1 Benchmark results

We aim to study whether participation in value chains has an aggregate impact on the economy via the unemployment rate. This question is not trivial, given the evidence, mainly micro-oriented, of the drastic effects of this type of trade on workers of different categories.

An additional advantage of LPs versus VARs is that they are straightforward to implement and interpret. Each horizon-specific regression provides a direct estimate of the impact of a shock at that horizon without the need to iterate through a system of equations.

Interpreting the graph of an Impulse Response Function (IRF) using local projections involves understanding several key elements depicted on the graph. In what follows, we show how to interpret the graph step-by-step: the x-axis typically represents the time horizon over which the response of the dependent variable to a shock is measured. Each point on the x-axis corresponds to a different period (e.g., years

[11] When implementing local projections, if the theory suggests focusing on changes rather than levels, then first differences should be used in the specification. This is typical in studies analyzing short-run dynamics or responses to shocks (Jordá 2005; Kilian and Lütkepohl,2017). As mentioned above and according to Piger and Stockwell (2023), it also reduces the small sample bias.

[12] Another potential source of endogeneity is the correlation between the lags of the dependent variable and the unobserved country effect in the error term, which we control for using country fixed effects.

[13] See, among others, Autor et al. (2013); Dauth et al. (2014); Hummels et al. (2014); Bloom et al. (2016).

[14] $(t-1)$ in our case.

in our case) following the shock. The y-axis shows the magnitude of the response of the dependent variable (unemployment rate) to the shock. Positive values indicate a positive response, while negative values indicate a negative response. The solid line on the graph represents the average estimated response of the dependent variable to the shock over time. This line is the main focus of the IRF as it shows how the variable of interest reacts to the initial shock at different time horizons. The shaded area or the dashed lines surrounding the solid line represent the 90% confidence interval, computed using Driscoll-Kraay standard errors. This interval indicates the uncertainty around the estimated response. These robust standard errors account for potential autocorrelation and cross-sectional dependence in the residuals, common in panel data. Using Driscoll-Kraay standard errors helps ensure the confidence intervals are reliable even when these issues are present. At each point, the true response is expected to lie within this interval 90% of the time if the experiment were repeated multiple times. Narrower intervals indicate more precise estimates, while wider intervals suggest greater uncertainty.

In our case, to know the initial impact, we look at the response at time 0 to see the immediate effect of the shock. The shock initially reduces the unemployment rate if the solid line starts below zero. Later, to analyze the dynamic response, we follow the solid line across the time horizon to see how the unemployment rate evolves. If the line initially dips and then rises, it suggests that unemployment initially falls but recovers over time. To assess the significance of our results, we scrutinize whether the confidence interval includes zero at each time point. If the entire shaded area is above zero at specific horizons, the response is significantly positive at those times. The response is not statistically significant at the 90% confidence level if it includes zero. Finally, the graph allows us to evaluate the magnitude of the response and how long it persists (duration). A prolonged response that remains significant for many periods indicates a lasting effect of the shock. Bearing these tips in mind, in the next paragraphs, we present the results.

The aggregated results of both the benchmark and the IV equations are presented in Fig. 1. The shock consists of a one-standard-deviation rise in participation, corresponding to an increase of about 1.66 percentage points, well within the standard range of the data. In all our LP results, we present the cumulative response after a

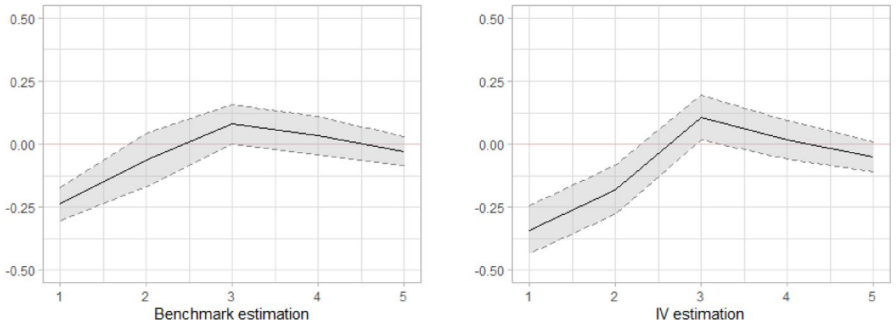

Fig. 1 The effect of GVC participation's shocks on aggregated unemployment. Notes: Time is portrayed on the x-axes; the solid lines represent the average estimated cumulative response. We include its 90 percent confidence interval (computed using Driscoll-Kraay standard errors)

shock with a time horizon of 5 periods. As shown in Fig. 1, the response of the unemployment rate is significant in both specifications. In particular, the first two periods show a negative response, signaling the macroeconomic relevance of changes in GVC participation.

5.2 Heterogeneity across country characteristics

Our findings so far provide a general understanding of how participation impacts the unemployment rate in EU countries. However, they do not provide information on the heterogeneity across countries. In this Section we present the IV results, our preferred specification, for several country groups.

Our initial classification follows the widely used 'core-periphery' framework in the literature. We define Core the group formed by Austria, Belgium, Denmark, Finland, Germany, France, Luxembourg, the Netherlands, Sweden, and the UK. The Periphery includes Cyprus, Greece, Ireland, Italy, Malta, Portugal, and Spain. Finally, the Central and Eastern European Countries (CEECs) comprise Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia.

Since the previous regional grouping may not accurately reflect labor market characteristics, we further classify countries based on the following factors, which may be relevant to labor markets: (a) factor proportions, specifically capital abundance; (b) market concentration; and (c) labor market regulation, as measured by the EPL index. Table 1 presents the mean value of each indicator by country over the period. In each case, we define two groups based on whether they fall below or above the EU mean.[15]

Finally, we pay special attention to the position in the value chain by exploiting the backward and forward participation and the relative proportion of these two components of gross exports. This is important since participation measures are based on gross trade figures and do not account for the key GVC characteristic: only a part of the value is added by the exporter; the rest comes from other GVC participants often located abroad. Typically, a relatively higher share of foreign value-added from foreign input providers– backward participation as defined before– can indicate a higher exposure to foreign supply shocks affecting vendors of raw materials and intermediates. Conversely, a higher reliance of exports of a given country on demand from foreign countries– forward participation– can mean higher exposure to demand shocks coming from final consumers or distributive services abroad. Then, other than the overall participation score, we provide a deeper analysis by using the two measures of the position of the countries in the value chain and constructing the relative 'upstreamness' of an economy, i.e., a higher share of domestic content that returns to a country after processing abroad within GVCs. Upstreamness is usually associated with technologically enhanced products and, thus, more beneficial engagement in GVCs than 'downstreamness', i.e., participation through assembly stages of the

[15] All variables have been defined in Sect. 3.

production chain. Again, we defined two groups relative to the mean in the EU (see Table 1).[16]

Figure 2 presents the local projection based on our previously defined groups. The results highlight that the most notable differences among countries stem from the Core-Periphery distinction. Specifically, Peripheral and CEEC countries exhibit a significant and persistent negative response, which is particularly pronounced in CEECs. Interestingly, there is also a notable increase in unemployment in core EU countries two years after the shock, i.e., an increase in GVC participation. The figures indicate no significant differences among country groups for the remaining characteristics. For instance, in both upstream and downstream countries, higher GVC participation leads to a decrease in the unemployment rate. The only exception is

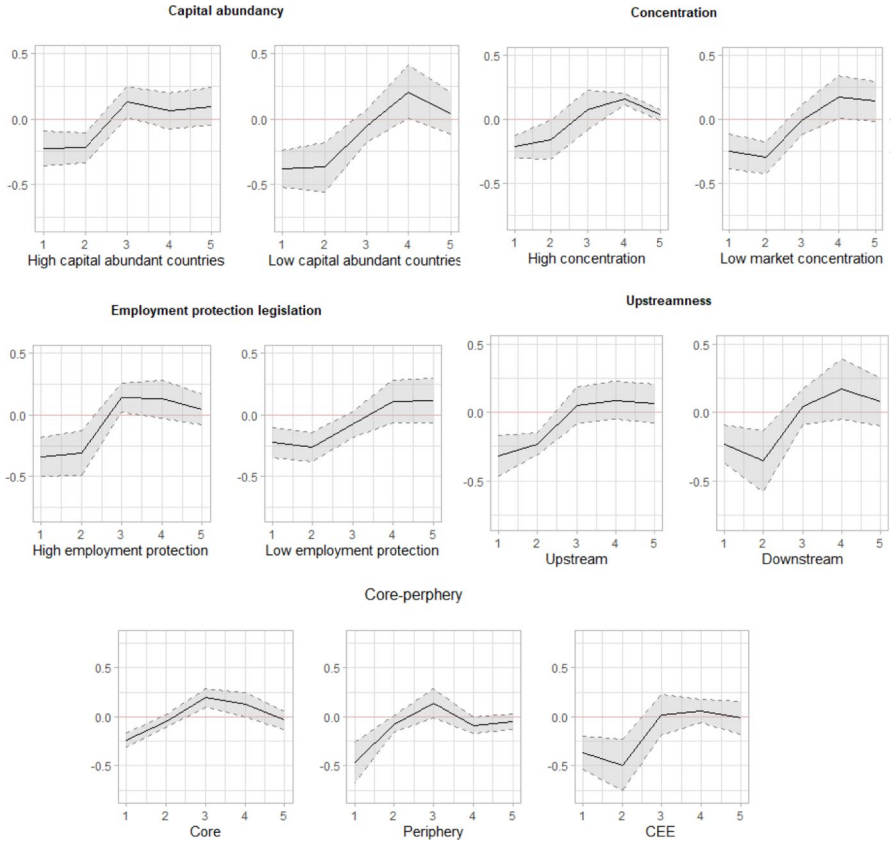

Fig. 2 The effect of GVC participation's shocks on unemployment according to country groups classifications. Notes: Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90% percent confidence interval (computed using Driscoll-Kraay standard errors). The results correspond to the LP obtained with instrumental variables

[16] Purely upstream positions would imply values above 1, but here we compare the position within the EU. As the EU mean is 0.77, the EU countries occupy intermediate positions and only a few are above 1 (see the fourth column of Table 1).

the degree of concentration: when concentration is above average, unemployment increases again after 4 years.

The previous result can be interpreted in light of the sectoral reallocation mechanisms triggered by deeper GVC integration. As countries like the CEECs and other peripheral economies become more embedded in regional value chains, they tend to specialize in labor-intensive segments of production, consistent with their relative abundance of labor. This process can lead to employment gains in those countries, particularly in export-oriented sectors. In contrast, richer core economies may experience job losses in specific manufacturing sectors as production is relocated. This pattern aligns with part of the "concern" highlighted by Baldwin and Ito (2022), namely, that GVC participation can shift labor-intensive processes toward lower-income economies within regional production networks, with asymmetric employment effects across countries.

5.3 Heterogeneity across economic sectors

A logical step forward regarding heterogeneity is the sectoral breakdown analysis. This point is essential since, due to the characteristics of the production process, some sectors are closer to the final stages. Therefore, we can gain a richer analysis by distinguishing (i) Agriculture, forestry, and fishing, (ii) Mining and quarrying, (iii) Manufacturing, and (iv) Services. Moreover, our breakdown includes eight subsectors in manufacturing and services that represent the main economic activities.

The previous sectoral decomposition can be linked to the factor intensity of industries, regardless of the statistical nomenclature, at least for agriculture, mining, and manufacturing. According to the classification for revealed factor intensity (RFI) indices, the manufacturing sectors, which include machinery and transport, manufactured products and the chemical sectors, are characterized by high revealed physical capital intensity (RCI) and revealed human capital intensity (RHCI), and not too high revealed land intensity (RLI). At the opposite end are the food and agricultural sectors, with relatively low levels of RCI and RHCI while high RLI. The position of the mineral fuel sector suggests that the sector is relatively high in RCI and RLI but not in RHCI.[17]

Several questions about the role of sectoral GVC participation and unemployment can be explored. The first is whether the response to increased participation differs depending on which sector is affected. In Fig. 3, we present the response to increased GVC participation in the four larger sectors (Agriculture, Mining, Manufacturing, and Services). The answer to our question is negative: the response is relatively homogeneous, regardless of the factor intensity of industries. However, services are the sector whose integration in GVC affects the EU country's macro-unemployment rate and shows more persistence. We should remember that even if the EU constitutes the most prominent trade bloc globally, the present leadership is more in services than manufacturing. As some services are provided upstream, but others are closer to

[17] The RFI indicators are based upon three factor endowments: (i) physical capital stock per worker; (ii) human capital stock; and (iii) arable land per worker. This classification, however, does not include services. See Shirotori et al. (2010) and Mclaren et al. (2018) for further details.

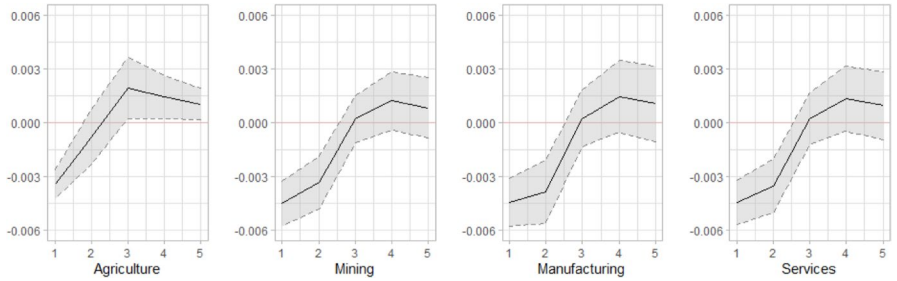

Fig. 3 The effect of GVC participation's shocks on unemployment, by sectors. Notes: Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90% percent confidence interval (computed using Driscoll-Kraay standard errors). The results correspond to the LP obtained with instrumental variables

the consumer, a further breakdown of services into sub-sectors provides additional insights.

At a higher degree of decomposition, we distinguish eight sub-sector breakdowns of manufactures and services. The response to an increase in total GVC participation from the different sub-sectors is shown in Fig. 4. The first two rows of the graph are devoted to manufacturing sub-sectors. Increased GVC participation in *Food and beverages* and *Textiles and apparel* generates a negative and relatively long-lasting response in unemployment. Note that these are sectors characterized by low labor skills and relatively low capital intensity according to the UNCTAD's classification. Later absorbed, a short negative impact is captured for *Wood, Paper, and Chemicals*. The remaining manufactures are mostly unaffected, including those with higher revealed physical capital intensity such as machinery and transport equipment and chemicals.

The response of unemployment to GVC participation in services is depicted in the two lower rows of Fig. 4. As seen, the rise of global services value chains and, particularly, *Maintenance, Wholesale* (placed upstream), *Transport* (in a downstream position), *Communications* (which comprises *Publishing, Audiovisual and Broadcasting Activities, Telecommunications and IT and other Information Services)*, *Public Administration* and *Other services* have a strong impact on unemployment. Only *Financial services* and *Retail* (mostly non-tradable) do not show a significant impact. Taglioni and Winkler (2016) find (for a group of developed and developing countries) that with GVCs, employment has grown more in services than in manufactures, with some exceptions, such as China and Turkey. In particular, in Germany, Italy, and Spain, the increase in GVCs-related service jobs is larger than the loss of jobs in manufacturing and agriculture.

Our results align with those found by Timmer et al. (2013), who stress that a myopic approach to policies focusing on the manufacturing sector only is missing out on this important trend. Producing final manufactures includes activities in the manufacturing sector and supporting industries such as business, transport communication, and finance services by delivering intermediate inputs needed to produce manufacturing goods.

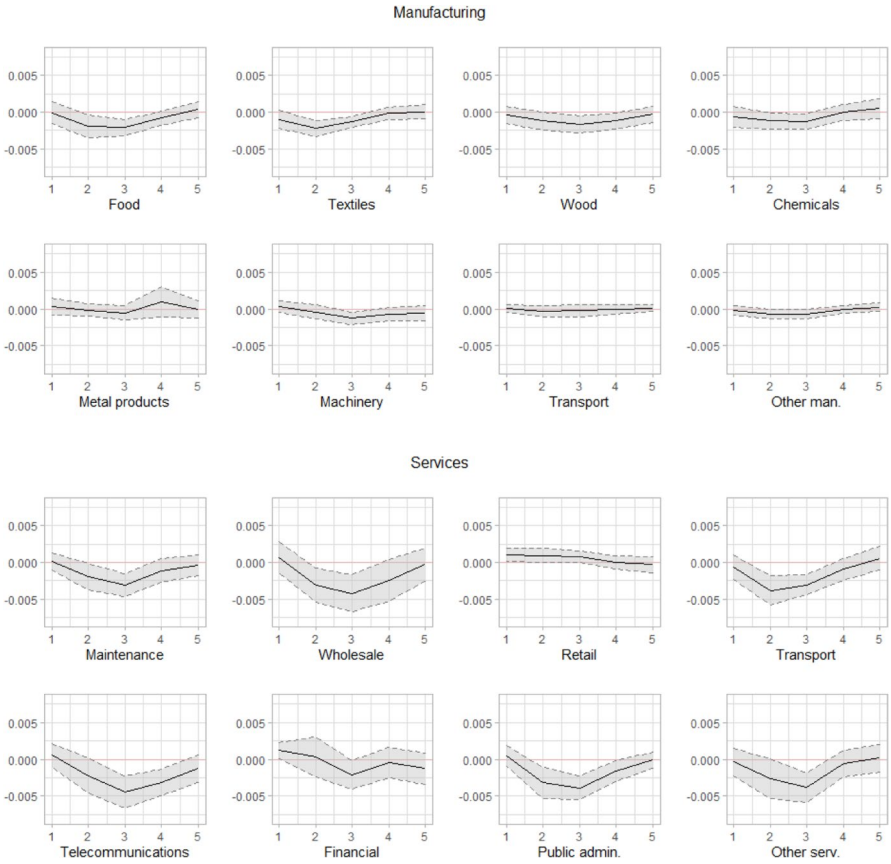

Fig. 4 The effect of GVC participation's shocks on unemployment, by sub-sectors. Notes: Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90% percent confidence interval (computed using Driscoll-Kraay standard errors). Results correspond to the LP obtained with instrumental variables

The former result is relevant as it stresses the relatively modest role of manufacturing subsectors in GVCs for employment. Therefore, neglecting other sectors from the discussion, mainly services, would be a mistake. Indeed, the past few decades have witnessed an unprecedented shift of employment and output shares toward services. Moreover, services increasingly set up their value chains. The "production process" of certain services allows for fragmentation similar to that of goods. *Delivering software*, for instance, involves many discrete steps, most of which can be performed remotely. This fact enables countries to join services GVCs just as they joined goods GVCs (Asian Development Bank, 2021). As a result, more value-added has also shifted from manufactures to services (Baldwin & Ito, 2022).

6 What makes unemployment more sensitive to GVCs?

Our results show a link between GVC participation and unemployment. Moreover, this relationship is characterized by significant heterogeneity, particularly at the country level. A relevant question immediately arises: Which country-level characteristics shape the impact of the GVCs on unemployment?

To answer this question, we focus on two characteristics of the workforce composition as the drivers of the heterogeneity outlined in the previous section: skills and costs. Indeed, our first intuition is that the mix of skilled and unskilled jobs in the economy can affect the link between economic globalization and unemployment. There is a general view that, in developed countries, low-skilled workers have been most affected by increasing unemployment due to competition from developing countries' workers and also as a result of technological progress (see Meng et al. 2020; Szymczak and Wolszczak-Derlacz 2022). However, the workforce in developing countries is becoming better qualified and increasingly engaging in more sophisticated, service-oriented activities. As such, skilled workers in developed countries increasingly feel the competition of their counterparts in developing countries (Farole et al., 2018).

Labor costs might also be a mechanism for amplifying the impact of value chains on the unemployment rate. Indeed, factors that allowed globally "footloose" firms (i.e., firms that are not tied to any particular location or country) to locate in the host economy also will enable them just as easily to shift out to a lower-cost area, and governments may be locked into a "race to the bottom" on costs, which will most likely result in suppression of employment (Shingal, 2015; Farole, 2016).

We aim to draw attention to these interactions' general relevance as complementing factors, designed at the country level, that can magnify the impact of GVCs participation on unemployment. To capture these mechanisms, our specifications are similar to those presented before with the following modifications:

$$\begin{aligned}\Delta y_{i,t+h} = {} & \alpha_i + \gamma_t + \beta_h^{r1}(\Delta GVC_{i,t-k} \times F(z_{i,t-1})) + \beta_h^{r2}(\Delta GVC_{i,t-k} \times (1 - F(z_{i,t-1}))) \\ & + \nu X_{i,t-1} + \epsilon_{i,t+h}\end{aligned} \tag{8}$$

As in Eq. (7), the X vector contains changes in the GVC participation score, GDP, productivity growth, and labor costs. In addition, we include skills and labor costs. In Eq. (8), we also added a logistic function, $F(z_{i,t-1})$, that governs the transition between the high and low regime, $z_{i,t-1}$ being the scalar state variable at time $t-1$. This switching variable represents the workforce composition, i.e., skills and labor costs. As standard, the transition function is the logistic transformation of the original z_t:

$$F(z_t) = \frac{1}{1 + \exp\left(-\theta\left(\frac{z_t - c}{\sigma^2 x}\right)\right)} \tag{9}$$

where the parameter θ determines the smoothness of the transition between regimes (low vs. high regime). Therefore, we obtain two impulse response functions corresponding to two regimes characterized by low and high values of the switching

variables. For instance, if the transition variable captures the skill level of the labor force in (9), an increase in z_t would lead to a decrease in $F(z_t)$. Values close to zero of $F(z_t)$ would thus indicate a regime of high skill level. By interacting this transition function with the participation score in (8), we can obtain the two regimes corresponding to the high and low indicators of the workforce composition.[18]

Our proxy for skills is the labor force with advanced education, defined as the % of the total working-age population with advanced education and extracted from the EU Labor Force Survey.[19] The variable "labor costs" corresponds to unit labor costs,[20] which measure the average cost per unit of output and are calculated as the ratio of total labor costs to real output.

Our interaction terms with skill composition and labor costs provide the theoretical mechanisms explaining these non-linearities. When a country possesses high shares of low-skilled workers and competitive labor costs, GVC participation generates larger initial employment gains by reallocating labor-intensive tasks. As participation deepens, returns diminish as the easily transferable tasks become saturated, requiring workforce upskilling to capture higher-value chain segments.

The results, presented in Fig. 5, indicate the complex interactions between GVC and market composition inshaping aggregate unemployment. The results suggest that the negative effect is magnified in countries with lower-educated workers or cheaper workforce. The LPs show that not only lower costs but also a less skilled workforce are affected by GVC participation (unemployment decreases, and the effect is persistent). Moreover, unemployment increases in higher-skilled workers. Nevertheless, we should bear in mind that all the countries in the sample are EU members, and labor costs and education are relative to the European level. In addition, the EU countries are involved in regional (intra-EU) GVCs and global chains as hubs or participants in some particular stages or tasks. This result, combined with previous evidence about

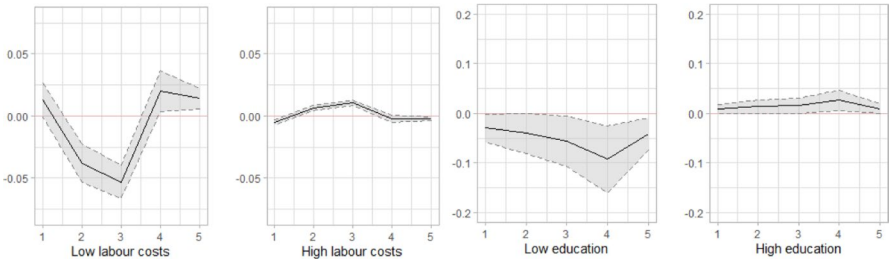

Fig. 5 The effect of GVC participation's shocks on unemployment according to labor costs and skill level. Notes: Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90% percent confidence interval (computed using Driscoll-Kraay standard errors). Education is the labor force with advanced education (% of the total working-age population with advanced education, source: EU Labor Force Survey, Eurostat). Labor costs correspond to the ratio of total labor costs to real output (source: OECD)

[18] These results are obtained using a smoothness parameter, θ, equal to 1.5. For robustness, we present the models when we impose lower and higher values for θ. See Fig. 6 in the "Appendix".

[19] Source: Eurostat.

[20] Source: OECD.

country-group heterogeneity, implies that CEECs and peripheral countries are those where these relatively fewer skill stages are concentrated. At this level of aggregation, and taking into account that around 70% of EU value added is in services, this may be the sector that accumulates most of the activity.

The heterogeneous effects of GVC participation on unemployment across EU countries can be largely explained through functional specialization within value chains, a perspective highlighted in recent literature (Fontagné et al., 2024; Riccio et al., 2024). Core EU economies typically specialize in R&D, design, and high-value services, while less advanced EU economies focus on assembly, routine services, and lower-value manufacturing segments. This division of functions helps explain why GVC participation reduces unemployment in less advanced EU economies, which benefit from labor cost advantages and the relocation of labor-intensive activities, while potentially increasing unemployment in core economies where low and mid-skilled jobs are offshored. Riccio et al. (2024) provide complementary evidence for this interpretation, documenting that production fragmentation has increased GVC participation in emerging economies, with employment growth particularly in services compared to developed countries. However, this may not translate to proportional increases in labor share. Our findings align with Fontagné et al. (2024), where a country's position in the value chain interacts with technological adoption to determine labor market outcomes. The sectoral dimension of our results, showing more substantial employment benefits in services than manufacturing, further supports this functional specialization perspective, as services in less advanced economies often face fewer automation pressures while benefiting from GVC-related employment opportunities. This theoretical lens enhances the interpretation of our empirical results without requiring the imposition of a specific structural model, maintaining the flexibility advantages of our Local Projections approach.

7 Summary and discussion

This paper revisits the nexus between globalization and the unemployment rate by focusing on GVCs, the most prominent characteristic of globalization in recent years. Furthermore, our study provides the first empirical investigation of the impact of interactions between the workforce composition and GVC-type trade on unemployment for the 28 EU Member States from 1990–2015.

We make several contributions to the relatively scarce existing literature. First, we focus on the European Union (EU) countries, a region with the highest participation percentage in GVCs. Second, we allow for heterogeneity in two dimensions: first, by defining groups of countries with similar characteristics (core, periphery, and CEECs) and, second, by decomposing the data into sectors and sub-sectors. Third, we account for a potential nonlinearity related to workforce composition. Finally, since caution is required concerning the direction of causality between trade and labor market outcomes, we rely on impulse response functions obtained from local projections, where we also introduce instrumental variables to overcome any endogeneity issues.

Our results show that the effects of GVC participation on the unemployment rate are not homogeneous: higher participation reduces the unemployment rate in less

advanced EU economies. Still, it slightly increases it in "core" countries. Moreover, the impact on unemployment reduction is reinforced in countries with lower labor costs and a higher proportion of low-skilled workers.

Our finding can be linked to the literature on " offshoring", where firms in advanced economies outsource parts of the value chain (goods production and/or services) to third countries. While many debates remain to be settled in the offshoring literature, what is becoming increasingly clear is that GVC integration for advanced economies has reinforced the effects of skills-biased technical change. That is, offshoring involves the most labor-intensive processes in the value chain. This fact will result in a reduction in employment in the short and medium term for advanced economies. On the contrary, lower-income EU countries that have successfully attracted investment experience a significant increase in formal manufacturing jobs. However, in the long run, technical change in the global production of manufacturing goods has an essential factor bias, which may drive down relative demand for low-educated workers throughout the chain. Increasing efficiency in automation drives the use of robots for production stages brought back in high-income countries. To minimize this possible outcome, peripheral and CEEC countries must upgrade their labor force to meet the requirements of today's global production systems.

We show that GVC participation has a significant negative response impact on aggregate unemployment that varies according to a sectoral breakdown. In particular, the reduction in unemployment in the manufacturing sector tends to focus on *Food and Beverages, Textiles and Apparel*, and *Wood products*. We also show that subsectors with higher GVC participation growth in the manufacturing sector can generate more employment, although the capacity to increase value added is more limited.

A salient feature of our findings is that an even larger response of unemployment is found in services, notably *Wholesale* (placed upstream), *Transport* (in a downstream position), and *Telecommunications* (which comprises publishing, audiovisual and broadcasting activities, telecommunications and IT, and other information services). This result is essential since the past few decades have witnessed an unprecedented shift of employment and output shares toward services, which can increasingly set up their value chains. Moreover, the production of many services allows for fragmentation due to the declining costs of services trade, thanks to digitalization. This fact opens an avenue for the less developed countries in the EU.

Indeed, some economic policy takeovers can be derived from our findings. As services sectors are subject to barriers rooted in regulations, lifting these barriers in the EU Single Market seems paramount to facilitating services-led economic growth. Policies that ensure a fair distribution of benefits across countries, like the EU structural and cohesion funds (education attainment, especially in technology adoption, as computer-aided manufacturing and robotics and R&D policies) or the Recovery and Resilience program, can be crucial to achieving these benefits.

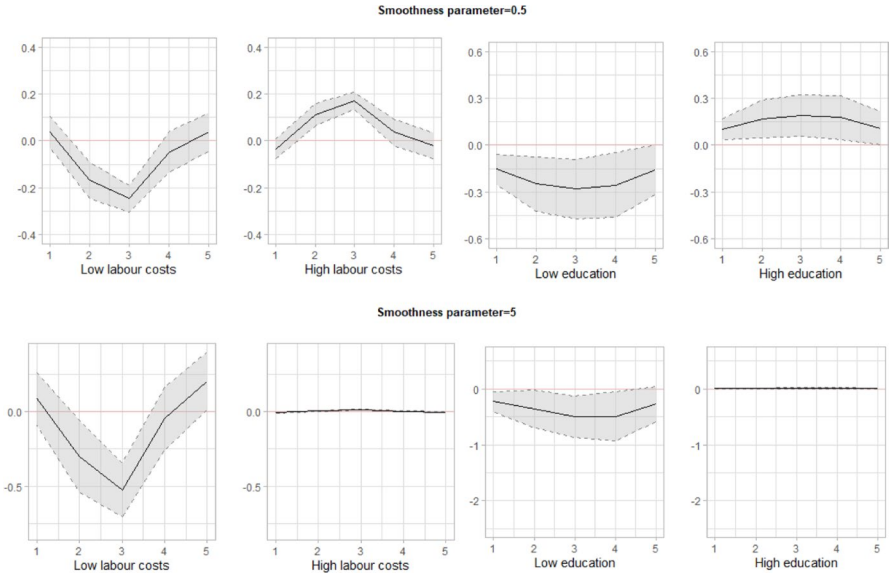

Fig. 6 The effect of GVC participation's shocks on unemployment according to labor costs and skill level according to different transition parameters. Notes: Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90% percent confidence interval (computed using Driscoll-Kraay standard errors). Education is the labor force with advanced education (% of the total working-age population with advanced education, source: EU Labor Force Survey, Eurostat). Labor costs correspond to the ratio of total labor costs to real output (source: OECD)

Appendix

See Fig. 6.

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