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ORIGINAL PAPER

The labour share along global value chains: perspectives and evidence from sectoral interdependence

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Abstract

This article proposes a novel framework to investigate how globalisation affects workers' share of value added. We explore functional income distribution by looking at industrial interdependence and thus identifying Global Value Chains (GVCs) as the unit of analysis; we then track inputs' composition and their labour share evolution along the value chains. First, we find widespread heterogeneous patterns across value chains' components, accounting for the direct, domestic and foreign requirements of the chains, inside an overall declining trend in the vertical labour share. Second, through a shift-share analysis, we investigate what drives such decline in the vertical labour share: albeit country-industry idiosyncratic factors accounted by the within-input component contribute the most, between-input reallocation—GVCs restructuring—matters, particularly highlighting the role played by foreign contributions. Finally, through a parsimonious regression estimation, we confirm the main results found in the shift-share analysis highlighting the role played by countries' development level and structural change towards services. In essence, we provide evidence of the recombination of inputs toward emerging economies and service-based activities. Such recombination negatively affects GVCs labour share dynamics. Overall, our methodology contributes to linking the processes of fragmentation of production and the changing international division of labour with the ensuing implications for functional income distribution.

Keywords Structural change · Global Value Chains · Labour share

JEL Classification F14 · J31 · O14

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1 Introduction

A constant functional income distribution has been considered one of the characteristics of advanced capitalist economies, enough to be listed as the first Kaldor (1957)'s stylised fact on growth. Yet, since the '70s, a consistent drop in the labour share has been documented across major economies (Karabarbounis & Neiman, 2014; Bivens & Mishel, 2015; Dosi & Virgillito, 2019). In the same period, there has been a surge, first, in international trade and then, in Global Value Chains (GVCs) participation to such an extent that has altered both where and how production takes place (Pahl and Timmer, 2019). Among other well-established determinants, the literature has begun to investigate the complex relations between international trade, and in particular GVC participation, and functional income distribution finding however contrasting results. In this article, we aim to assess this nexus highlighting the heterogeneous role of GVC participation across industries and development levels.

The emergence of GVCs has promoted the fragmentation of production, accelerating the reshaping of the international division of labour (Baldwin, 2011; Kaplinsky, 2000). Indeed, such fragmentation might impair labour income under several dimensions. First, GVC participation amplifies specialisation patterns both at the sectoral (e.g., service vs manufacturing) and at the occupational level (pre- vs post-production activities) (Los et al., 2015; Timmer et al., 2019). These specialisations, in turn, affect the distribution of value between capital and labour (Dao et al., 2019; Dimova, 2019; Pavlínek, 2020). Second, the possibility to buy/produce inputs abroad increases the opportunity for capital to gain greater profits, shifting the origin of intermediaries toward low-wage countries. GVCs, favouring the segmentation of the production process, ease the entrance of developing countries into international markets, boosting the competition between workers in advanced and developing countries. Finally, via GVCs, the adoption of more advanced capital inputs requires less labour content, putting downward pressure on wages of low-skill workers, who constitute the bulk of developing countries' labour force (Leitner et al., 2023).

In this article, we examine the nexus between GVC participation and functional income distribution proposing the novel concept of GVC labour share. Leveraging on international Input-Output tables, we construct the average labour share of the backward linkages employed in each value chain. More specifically, we define the GVC labour share of, say, the automotive sector in Germany as the average share of value-added remunerating labour in each stage of the production process. Thus, we are able to account for all domestic and foreign inputs used (e.g., wheels from Poland, textile materials from Italy, business services from the U.K., engines from Germany itself, and so forth). Moving beyond the 'horizontal' (sectoral) or country-level analysis allows us to simultaneously detect the direct (i.e., on the final production stage) and the indirect (i.e., on the backward linkages) impacts of GVC integration on labour share dynamics. Evaluating these complementary effects in an integrated framework renders a richer picture of the complex interrelation between production fragmentation and functional income

distribution. Further, our approach is suitable to track the gains of capital vis-à-vis labour in the production process of each given chain, encompassing both domestic and foreign-sourced inputs; in addition, it allows us to assess the relative worker gains, comparing the remuneration of labour inputs located in different countries but contributing to the same final production.[1] Finally, although our units of aggregation are industries, such an integrated vertical approach is consistent with firm-level decision processes of input requirements, externalisation choices and location abroad of specific production stages. In that, our methodology offers a worthy lens to investigate outsourcing and offshoring and their influences on the labour share.

The vertical approach is fruitful in eliciting the role of globalisation, and more specifically of GVC participation, on functional income distribution. In contrast to the within-country/within-sector analysis of functional income inequality, what we label the horizontal approach, moving from sector/country to GVCs as the unit of observation allows us to capture the impact of both domestic and foreign intermediate inputs on the composition of final output, and how value is distributed among production stages. The composition and remuneration of these inputs significantly shape the overall income distribution within a given chain. The method's flexibility enables us to isolate the chain segment directly affected by GVC participation, such as foreign traded intermediaries, and those potentially influenced indirectly, possibly due to increased competition from abroad, as in the case of domestic intermediaries. By distinguishing between these segments, we can closely examine various dynamics in functional income distribution, stemming from the remuneration of inputs with different origins.

Vis-à-vis the 'Slicing Value Chain approach' proposed in the seminal contribution by Timmer et al. (2014), we address a different set of questions. Timmer et al. (2014) disentangle the very existence, through a longitudinal macro-analysis, of the process of international fragmentation of production in the majority of products, and the implication for the patterns of country specialisation strategies when facing increasing fragmentation. Our contribution, acknowledging the results in Timmer et al. (2014), is meant to capture the distributive implications of such fragmentation of production. Therefore, while Timmer et al. (2014) ask "How pervasive is the process of international production fragmentation for a wider set of products? How does the factor content of these production chains change over time when fragmentation deepens? And how do specialisation patterns differ between high-income and emerging economies that participate in these chains?" (p. 99-100), we ask a series of questions related to the distributional implications of GVC participation, assessing the origin and remuneration of the labour inputs composing each production chain.

[1] Note that a declining labour share does not necessarily imply a reduction in the purchasing power of workers since the latter depends on country-specific price dynamics. Indeed, productivity growth is generally linked to a decrease in prices, therefore in well-functioning specialising economies, productivity increases might map into price declines and real wage growth. However, the net effect is *a priori* undetermined: the dynamics of the general price index, and therefore of workers' purchasing power, is intimately affected by internal macroeconomic conditions of the country plus their external positions, e.g., in terms of import penetration of goods.

Our research questions read as follows: how has functional income distribution changed along GVCs? Is the within- or rather the between-input dynamics driving such pattern? Does increasing GVC participation of developing countries affect the vertical labour share dynamics? What is the role of servitisation of the chains? In short, which segment and which factor of production is gaining/losing from GVC participation?

This paper adresses such questions by analysing the geographical and industry evolution of the *vertical labour share* by leveraging on two distinct streams of research, namely the one documenting the labour share decline and the one documenting the GVC rise. Overcoming the horizontal level perspective, we propose the novel concept of vertical labour share to measure functional income distribution, and therefore the ensuing labour remuneration along the international production structure. The latter structure is mapped by the World Input-Output tables (WIOT), reporting information for the period 2000–2014, covering 43 countries (plus one Rest of the World) and 56 2-digit industries, including information from the Socio-Economic Account (SEA). This framework enables us to track the evolution of the labour share across the inputs of production of each given international value chain. According to our results, first, the vertical labour share when compared to its horizontal counterpart presents distinct patterns, thus motivating the relevance of looking at its specific dynamics; second, by means of a shift-share analysis, we provide evidence that the *between* component, namely structural change across productive inputs, is crucial in determining the labour share variation. Recombinations of productive inputs toward cheaper labour requirements coming from abroad are visible, in line with an overall decline in the vertical labour share. Heterogeneous patterns emerge between domestic and foreign inputs, with domestic intermediaries leading to the vertical labour share decline both in manufacturing and in services in advanced countries, and with foreign inputs mainly gaining in service activities in developing non-EU countries. Finally, through a parsimonious regression setting, we confirm the main results found in the shift-share analysis, highlighting the role played by development levels and sectoral attributes (manufacturing vs services) in affecting labour share dynamics.

Given our results, it is important to define the boundaries of our investigation. GVCs have changed the internal architecture of production and re-articulated the network of relations among actors. The very existence of GVCs has weakened labour market institutions, particularly trade unions, in their capacity to negotiate wage increases (Greer, 2008), but their existence also makes it possible to perform wage dumping and threaten relocation, to this place the automotive industry has been an exemplary case (Banyuls & Haipeter, 2010). In this paper, we focus on GVCs as one of the drivers of the labour share decline. Whenever possible, we encompass potential concurrent drivers in explaining the observed patterns and introduce them in the analysis, particularly with reference to the role exerted by technologies and labour market institutions. However, whereas we closely examine the role played by the servitisation of the chains (i.e., the increase in service inputs as a share of total inputs) and the entrance of developing countries, we gloss over occupational specialisation. Yet, the proposed approach is suitable to include functional and occupational specialisation (Riccio et al., 2024) in future extensions.

The structure of the paper reads as follows: Sect. 2 presents the literature review on the labour share decline and the rise in GVCs. After describing the data and methodology, Sect. 3 presents some descriptive statistics on the dynamics of the vertical labour share compared with the horizontal counterpart. Section 4 proposes a shift-share analysis that distinguishes within- and between-input components by their geographical and industrial origin. Section 5 discusses the results of a parsimonius regression specification accounting for the role of structural change and servitisation of the chains. Section 6 concludes.

2 Labour share decline and GVC rise

In this section, we provide an overview of the existing literature that examines the factors behind the labour share decline. The scope is to highlight the most relevant mechanisms for our empirical inquiry, which include labour market institutions, technological change, structural transformations, and globalisation.[2] While the primary focus of this article centers on globalisation and, more specifically, on the strategy of GVC integration, it is important to consider other concurrent factors that could potentially magnify the effects of GVC participation. Similarly, the role of GVC participation can serve as both an amplifier and enabler of the impacts of other deeper institutional and structural determinants.

For example, discerning the influence of technological progress from that of GVC participation represents a complex conundrum, as GVC integration has been enabled by technological progress in itself, such as the ICT revolution and advancements in transportation technology. Simultaneously, GVC participation exerts an influence on the adoption of new technologies, which subsequently affect the distribution of value. As is often the case in evolutionary processes, our perspective aligns with the notion of cumulative causation where determinants are likely to interact and mutually reinforce each other. Granted these premises, mechanisms enhancing the decline in the horizontal labour share might contribute to those influencing the vertical labour share decline.

2.1 Labour share: trends and determinants

During the last decades, there has been a growing empirical evidence showing the steady decline in the labour share, recorded across both developing and developed countries (Atkinson, 2009; Dao et al., 2019; Dimova, 2019). Notably, Karabarbounis and Neiman (2014) report a declining trend in corporate labour share starting in the ’70s, in 42 out of 59 countries analysed in the period 1975-2012, encompassing both service and manufacturing activities. Such trends intensified during the ’90s. The evidence is mixed for developing countries due to the lack of reliable data. Yet, Rodriguez and Jayadev (2010), Reinbold and Restrepo-Echavarria (2018) and van Treeck (2020) find similar declining trends to those witnessed by advanced

[2] A full revision of the literature is beyond the scope of this paper, but an exhaustive summary can be found in Dao et al. (2019).

countries. Investigating trends in the labour share along development stages, Maarek and Orgiazzi (2020) find evidence of a U-shaped pattern, focusing on the manufacturing sector via the UNIDO dataset, mainly covering developing countries from 1960 to 2000. Especially in developing countries, measurement problems might confound the results. Indeed, in countries where informal labour markets play an important role actual wages might be lower than those recorded in formal labour markets. In addition, self-employed workers constitute an increasing share of the overall employment, not only in developing countries. The lack of accounting for self-employed income can indeed underestimate the actual labour share (Gollin, 2002).

Beyond measurement problems, such declining tendency, from a classical political economy perspective (Smith, 1776; Ricardo, 1819), is the reflection of the struggle between the relative (bargaining) power between capital and labour, to such an extent that Ricardo himself enlists the declining labour share as one of the scopes of his entire work:

> It has been one of the objects of this work to shew, that with every fall in the real value of necessaries, the wages of labour would fall, and that the profits of stock would rise—in other words, that of any given annual value a less portion would be paid to the labouring class, and a larger portion to those whose funds employed this class.
> [Ricardo 1817, p. 132]

With the marginalist revolution, factor income shares have been postulated to be constant and no more space for investigating their dynamics was left in the neoclassical perspective. Differently from the postulated behaviour, however, with the end of the *Glorious Thirties*, the contrasting empirical evidence is calling for some explanations. The literature investigating the determinants of the labour share dynamics is vast and growing, however, a clear consensus is still lacking. In the following, we shall briefly consider those determinants affecting both the relative power of capital and labour and their potential interaction, with a focus on international trade and GVC participation.

2.1.1 Labour market institutions

Weakened labour market institutions and declining labour power in the negotiation process are the most direct determinants that might have eroded labour income remuneration. While labour market institutions as inequality-reducing mechanisms start to be acknowledged even over the long run (Farber et al., 2021), new evidence shows that the decline in the unionisation rate has increased top income shares by reducing the bargaining power of average wage earners (Jaumotte & Osorio Buitron, 2019). Different labour market institutions have been studied: Stockhammer (2017) and Guschanski and Onaran (2023) find positive effects of unionisation rate in influencing the labour share; the European Commission (2007) attributes a significant role to minimum wage legislations; Kristal (2010) finds positive effects of striking activities on the labour share dynamics. In the context of international fragmentation of production, Bognetti and Santoni

(2010) show that firms are less likely to offshore the higher the union bargaining power in the negotiation process. On the same line, we also expect that firms base their offshoring decisions on the actual labour market institutions of the sourcing countries.

2.1.2 Technical change

Another determinant frequently analysed in the literature is technical change. Karabarbounis and Neiman (2014) find that the declining relative price of investment goods has given strong incentives to automate routine tasks, explaining more than half of the decline in the overall labour share. However, their results crucially rely on an elasticity of substitution greater than one, an assumption quite disputed in the empirical literature (Stockhammer, 2017; Cette et al., 2019; Guschanski & Onaran, 2022) and in more comprehensive meta-analyses (Knoblach & Stöckl, 2020). Beyond the relative price channel, other studies highlight the direction of technical change as being biased toward capital-augmenting techniques squeezing the labour share (Bassanini & Manfredi, 2014; Dao et al., 2019). In contrast, Tytell and Jaumotte (2007) find no significant impact of technological progress on the labour share. More broadly, the most recent literature has addressed the impact of technical change, and in particular computerisation and automation, on wage polarisation and relative wages, revealing a significant relationship (Autor & Dorn, 2013; Acemoglu & Restrepo, 2019). However, these studies mainly address the impact on the wage distribution, rather than on functional income inequality.

A related consideration concerns the potential heterogeneous impacts of technology across different sectors and development levels. Traditional trade models, such as the Heckscher-Ohlin-Stolper-Samuelson (HOSS) framework, predict that international trade of goods reduces the labour share in capital-abundant developed countries, specialising in capital-intensive production, while increases it in labour-intensive developing ones, specialising in labour-abundant goods. However, the implications of the theorem clearly derive from its assumptions. If we relax the HOSS assumptions of homogeneous production functions and identical technologies, and allow for international diffusion of technologies, then we may expect a progressive adaptation of labour demand patterns in the periphery of the world, requiring more skill-intensive technologies originating from the centre (Feenstra & Hanson, 1996; Vivarelli, 2014; Rodrik, 2018). This process, which has been labelled in the literature as 'skill-enhancing trade hypothesis' (Robbins, 1996; Robbins & Gindling, 1999), can also explain widening wage and income disparities in developing countries. In addition, even supposing that specialisation patterns only depend on factor abundance and relative costs, but we include other determinants of specialisations, as capability accumulations, the predictions of the model become progressively weaker: China is the examplary case to the point, experiencing a strong catching-up phase but accompanied by increasing functional income inequality (Xie and Zhou, 2014). Finally, and crucially, the model relies on perfect wage adjustments, particularly upward, a hypothesis hardly compatible with the evidence on wage rigidity (Ehrlich & Montes, 2024).

2.1.3 Structural change

Less investigated but closer to our work is the role of structural change. The intersectoral reallocation of resources typical of the development process (de Serres et al., 2002; Ngai & Pissarides, 2007; Dosi et al., 2021) pushes the workforce first from labour-intensive traditional sectors to modern activities, and then to services. Notably, deindustrialisation might play a major role in the labour share dynamics, as manufacturing industries have always been characterised both by higher remuneration of workers and unionisation rates compared to services (Dao et al., 2019). Shifts in the occupational/skill structure constitute an additional dimension of structural change, which in turn affects the labour share dynamics (Dimova, 2019). While the wage-productivity pass-through is still at work for professional occupations, the declining remunerations of elementary workers have contributed to the overall labour share decline (Guschanski & Onaran, 2023; Reshef & Santoni, 2023). The evidence on workforce polarisation, although usually interpreted as the result of routine-biased technical change, points in the same direction, highlighting the decline in routine tasks and in their remuneration and, more in general, the hollowing out of the occupational distribution in advanced countries, which might be indeed the result of structural change (Bárány & Siegel, 2018). Post-Keynesian authors have focused on a different type of structural change, namely financialisation. Guschanski and Onaran (2022) show that moving resources from the real to the financial sector increases the side option for capital, in that way reducing the bargaining power of labour. Regarding the connection between structural change and GVC participation, there is a growing body of evidence supporting the notion that GVCs can significantly expedite structural transformation (Stöllinger, 2016; Timmer et al., 2019; Rohit, 2023). The strategy of GVC integration can lead countries to specialise in high-value-added activities or, conversely, relegate them to more basic and less valuable tasks. Similarly, countries may leverage GVCs to bolster their manufacturing activities, as exemplified by China and Eastern Europe. Conversely, they can accelerate their deindustrialisation patterns through unwise offshoring decisions of strategic sectors (Cresti et al., 2023; Rohit, 2023).

2.1.4 Globalisation

Globalisation influences the labour share via several channels. For instance, according to Rodríguez and Rodrik (2000) international integration makes firing threats more credible, reducing offshoring costs. The authors present a simple model to examine the effects of capital mobility on labour, concluding that labour can experience adverse consequences from greater economic openness, even if the government can raise taxes on capital to offset the negative impact on labour. In line, Jayadev (2007) finds that increasing capital account openness depresses the labour share in advanced countries; Harrison (2005) shows that rising trade penetration and exchange rate crises reduce the labour share, while capital controls and expansionary fiscal policies have the opposite effect. In addition, as mentioned above, the enlargement of international markets towards low-wage labour-abundant economies increases import competition in labour-intensive sectors, potentially pushing

advanced countries for a reallocation toward more capital-intensive industries (Dao et al., 2019).

2.1.5 GVC participation

With the 'globalisation's second unbundling' (Baldwin, 2013), the fragmentation of production has been steadily increasing across borders and international trade went beyond final goods, encompassing intermediate production stages. GVC penetration reshaped the geography of production and how goods are produced (Johnson & Noguera, 2012; Baldwin & Lopez-Gonzalez, 2015).[3] Such fragmentation has amplified the impact of globalisation on the labour share dynamics both in developing and developed countries (Dao et al., 2019). The emergence of GVCs has also led to a global reallocation of jobs and a new international division of labour, with labour-intensive manufacturing jobs and business services increasingly outsourced from advanced economies to low-wage developing countries, especially in China (Amiti & Wei, 2009; Elsby et al., 2013). Although the interaction of GVC participation and labour share dynamics is gaining attention, the evidence is still not conclusive (Guschanski & Onaran, 2023). Indeed, it is the strategy of GVC participation that ultimately shapes the resulting distributive outcomes, creating both winners and losers.

2.1.6 Productivity upgrading along GVCs

In principle, both developed and emerging economies could benefit from GVC participation and increase their productivity. Advanced countries can reduce costs by specialising in technologically rich segments of production and offshoring labour-intensive tasks to developing countries (Grossman & Rossi-Hansberg, 2008; Antràs & de Gortari, 2020). Emerging economies can catch up along the development ladder, overcoming the 'industrialisation gap' and importing complex intermediaries that they are not able to produce. Beyond that, international cooperation within GVCs enhances technological spillovers, allowing some emerging markets to catch up with the frontier and improve workforce's skills and wages (Koren & Csillag, 2011). Finally, it is easier for developing countries to enter an already existent foreign GVC rather than building up new domestic capabilities (Rodrik, 2018). However, some recent literature has focused on the adverse effects of GVC participation on income distribution, recognising that trade integration fosters lock-in effects in sub-optimal industry/task specialisations, favouring both within and between countries wage inequality (Antràs et al., 2006; Goldberg & Pavcnik, 2007; Grossman & Rossi-Hansberg, 2008).

[3] This process of international integration started around the 70s (Pahl & Timmer, 2019b) and steadily continued till the 2008 financial crisis when it consistently slowed down and, up to now, it has not fully recovered the previous pace.

2.1.7 The 'smile curve' along GVCs

In a similar vein, the *smile curve* literature has highlighted a novel perspective on intra- and inter-country inequality stemming from specialisation patterns along GVCs (Shin et al., 2012; Mudambi, 2008; Meng et al., 2020; Stöllinger, 2021). Such an approach allows tracking the content of value added along the entire production process, although at a relatively high-level of aggregation, and shows evidence that high-value added activities, such as R&D and commercialisation, are usually executed in advanced economies. On the opposite side, developing countries enter supply chains in standardised manufacturing stages of production, characterised by low wages and low value added contributions. Such division of labour accelerates deindustrialisation in rich countries, while at the same time segregates developing countries in the low value added (and low-technological) space of production, creating dependence on advanced countries' high-tech activities. According to Engel and Taglioni (2017), looking at the cases of GVC upgrading in developing countries, just a handful of them, already engaged in industrial development, are ripping the benefits of integration. While GVC participation can be beneficial for middle-income countries, a certain level of industrial development is a necessary condition to gain from GVC participation. The majority of middle-income countries lack the institutional and production requirements to prosper within GVCs. Closing technological gaps and abating market and Intellectual Property Rights (IPRs) barriers become increasingly difficult for developing countries, hampering the possibility for escaping the middle-income trap by entering, and then upgrading within GVCs. Indeed, technological upgrades require increasingly more complex capabilities and institutional settings (Rodrik, 2018; Taglioni & Winkler, 2016).

2.1.8 Employment upgrading within GVCs

An increasing amount of studies have started to investigate the consequences of GVC participation for workers and working conditions, a dimension sometimes referred to as social upgrading, showing that the link between social upgrading and greater integration in GVCs is even weaker than economic upgrading (Flanagan, 2006; Milberg & Winkler, 2011; Rossi, 2011; Barrientos et al., 2011). More recently, employment upgrading (Reinbold & Restrepo-Echavarria, 2018; Bontadini et al., 2020) and functional specialisation (Timmer et al., 2019) have started to be investigated. Timmer et al. (2019) show little sign of convergence in the occupational structure through GVC participation, documenting that advanced countries are increasing their relative employment share in managerial and R&D occupations while developing countries are specialising in low value added jobs. Such results of specialisation patterns are particularly worrisome since relative specialisation in fabrication tasks is found to hold back wage growth (Leitner et al., 2023). Similarly, Foster-McGregor et al. (2013) highlight that offshoring has negatively affected all skill types, with the largest impacts upon medium-skilled workers. Finally, Reinbold and Restrepo-Echavarria (2018) find that the interplay between technological diffusion (i.e., robotisation) and offshoring decisions has led to a fall in the employment share of routine manual jobs in advanced countries.

Given the extant literature, in this article taking a 'vertical' perspective, we investigate how the changing value chains' input structure is associated with the evolution of functional income distribution. Following this strategy, we isolate the contribution of country-industry idiosyncratic labour share dynamics from those due to shifts in input composition. Companion attempts have been put forward in the literature. For instance, Timmer et al. (2013) and Timmer et al. (2019) track labour income in a GVC setting, investigating respectively time dynamics and occupational heterogeneity. Yet, they do not tackle the interplay of wage and productivity. The first attempt in this direction has been proposed by de Vries et al. (2012), who investigate the labour income share of traded gross output at the country level. Chen et al. (2017), instead, outline a sectoral level measure of labour income in GVCs; however, the focus of their investigation then diverts to intangible income share. Thus, an exhaustive examination of the remaining components is still missing. Finally, in the spirit of this article, Grodzicki and Skrzypek (2020) and Marczak and Beissinger (2018) have independently proposed two measures of 'embodied unit labour costs' and 'vertically-integrated labour costs' which track the average unitary labour costs in the GVC context. As in this paper, the authors adopt the framework of vertically integrated sectors (Pasinetti, 1973). Interestingly, Grodzicki and Skrzypek (2020) find that cost-reduction strategies are among the most significant drivers of GVC integration in the automotive chains. The primary distinction from our work is that their focus is on the supply side, as they examine cost dynamics in the production process. In contrast, our focus is on the distributive outcome stemming from GVC integration.

3 Data, methodology and selected evidence

3.1 Data

We employ the industry-by-industry Input-Output database from the World Input-Output Tables (WIOT) (Timmer et al., 2015) also including the Socio and Economic Account (SEA) dataset, providing variables at the 2-digit level of aggregation (NACE Rev. 2 classification) as employment, value added, gross fixed capital formation, labour compensation, matched with I-O tables. The WIOT (2016 Release) is available for the period 2000–2014, for 43 countries (plus one Rest of the World) and 56 sectors.[4] As common in labour share studies, we exclude from the analyses industries that heavily rely on natural resources inputs, such as Agriculture (A), Electricity (E), Mining activities (B), and non-market service activities, namely Public Administration (O), Education (P), Health activities (Q) and extra-territorial activities (U). The reason is that they are personal (non-business) services and wage determination in these industries is detached from the typical competitive market

[4] See http://www.wiod.org/home for further details on the country coverage and data availability.

dynamics. Similarly, we exclude the Real Estate sector (L68) since its value-added largely constitutes imputed rents.[5]

We use 'Labour compensation' and 'Value added' to construct our variable of interest, the vertical labour share defined as *ls*. Final demand *d* is directly provided by the WIOT database and computed by summing up five categories: final consumption expenditure by households, non-profit organisations, government, gross fixed capital formation and changes in inventories and valuables. Gross output *x* is provided from WIOT as well. All values are in US dollars at 2010 prices, using the exchange rates provided on the WIOT website and the price indexes contained in the SEA (2016) dataset for deflation. WIOT are provided in current prices, therefore we adopt a specific deflation method to transform them into constant prices (2010 base year) to rule out price dynamics. Appendix A describes in detail the deflation procedure.

3.2 Construction of the vertical labour share

To construct the vertical labour share we rely on Leontief (1951)'s Input-Output analysis and on the identification of vertically integrated sectors proposed by Momigliano and Siniscalco (1982) and Siniscalco (1982) developing the theoretical underpinnings of Pasinetti (1973). Such methodology is nowadays largely employed in the GVC literature using global Input-Output (I-O) tables (Feenstra & Hanson, 1996; Timmer et al., 2013, 2014; Johnson, 2018), and recently adopted also by the European Commission's reports on trade in employment and in value added (Arto et al., 2020a, b).

We start with the construction of the matrix of embodied value added in intersectoral trade flows. Such matrix allows decomposing the value added embodied in each final good according to the industry and country of origin of the inputs required. In order to obtain such matrix, few algebraic transformations of the raw data are performed. First, we compute the Leontief Inverse matrix, allowing the quantification of the sequential effects in each production stage of one-unit increase in the demand of a final good, thus enabling to account for both *direct* (deriving from the same sector of activity) and *indirect* contributions (deriving from the other sectors of activity) (Pasinetti, 1977; Miller & Blair, 2009).[6] Given the input-output matrix $\boldsymbol{Z}$ of intermediate flows and the diagonal matrix of sectoral output $\hat{x}$, the matrix $\boldsymbol{A}$ of direct inter-industry coefficients is derived by the dot product of $\boldsymbol{Z}$ by the inverse of the diagonal matrix $\hat{x}^{-1}$[7]:

[5] The exclusion involves both rows and columns meaning that we do not consider neither the GVCs of Agricultural activities, for instance, nor the inputs that such industry gives to others. We also exclude inputs coming from the Rest of the World before the construction of the value added matrix *V* as the SEA dataset does not contain information for it. Eventually, we accounted for more than 90% of the value added generated in the chains under consideration.

[6] Available Input-Output tables measure trade flows in monetary terms, usually in million of US$. As a result, in the Leontief Inverse framework, one-unit of final demand stands for one million of US dollars.

[7] The hat over variables stands for the transformation from a vector to a diagonalised matrix.

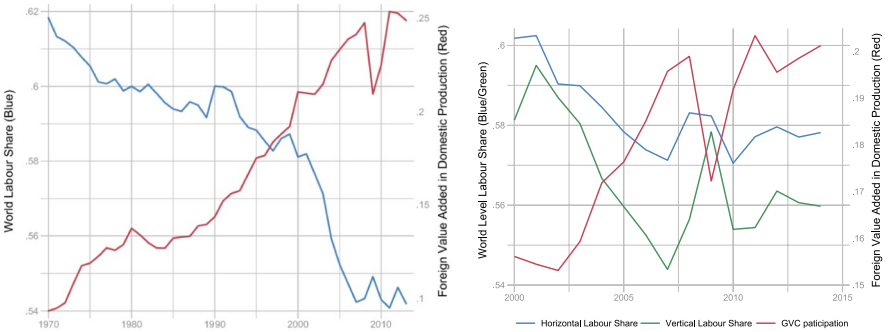

Fig. 1 Left Panel: Comparison between worldwide labour share (blue) and foreign value added in manufacturing domestic production (red). Labour share data comes from PWT 9.1 while the foreign value added ratio is computed using Pahl and Timmer (2019a) data and methodology. Right panel: Comparison between worldwide horizontal labour share (blue) vs vertical labour share (green) and GVC participation (red). Labour share and GVC participation are computed using WIOT and SEA. The sample restriction is described in the data section

$$\boldsymbol{A} = \boldsymbol{Z}\hat{x}^{-1} \tag{1}$$

The matrix $\boldsymbol{A}$ allows solving the accounting equation according to which the gross output of each industry (in each country) (x), is given by the sum of intermediate demand ($\boldsymbol{A}x$), from other industries, and final demand (d) (Leontief, 1951; Pasinetti, 1977; Miller & Blair, 2009). In matrix notation:

$$x = \boldsymbol{A}x + d \tag{2}$$

Solving by x, where $\boldsymbol{I}$ is the identity matrix and assuming the existence of the inverse of $(\boldsymbol{I} - \boldsymbol{A})$, it yields:

$$(\boldsymbol{I} - \boldsymbol{A})x = d \tag{3}$$

$$x = (\boldsymbol{I} - \boldsymbol{A})^{-1}d \tag{4}$$

The so-called *Leontief Inverse matrix*, or 'total requirements matrix', is given by:

$$\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \tag{5}$$

Considering the international flows accounted for by the World Input-Output Tables (WIOT), every element $l_{ic,jk}$ of the Leontief matrix captures the direct and indirect requirements in output of industry i in country c to produce one additional unit of final good in industry j in country k. By adopting the framework of vertically integrated sectors (Momigliano & Siniscalco, 1982), in accordance with the methodology employed in de Vries et al. (2012), we then construct the matrix of direct and indirect contributions in terms of value added of each industry to produce the goods in the economy activated by final demand. Given the diagonal matrix of the final demand $\hat{d}$, of value added $\hat{va}$ and of gross output $\hat{x}$, we get matrix V, accounting for value added in trade requirements of final demand:

Table 1 Descriptive statistics on country-level and sectoral-level Labour Share

	Code	Vertical labour share				Horizontal labour share				GVC integration	
		Mean	SD	$\Delta_{00\text{-}07}$	$\Delta_{08\text{-}14}$	Mean	SD	$\Delta_{00\text{-}07}$	$\Delta_{08\text{-}14}$	Foreign VA share	$\Delta_{00\text{-}14}$
Country evidence											
Germany	DEU	0.614	0.069	−0.057	0.016	0.675	0.129	−0.062	0.010	0.143	0.025
Japan	JPN	0.604	0.105	−0.040	0.005	0.631	0.217	0.001	0.009	0.070	0.047
China	CHN	0.500	0.090	−0.017	0.089	0.513	0.144	−0.016	0.101	0.070	−0.011
Poland	POL	0.495	0.066	−0.061	−0.014	0.471	0.111	−0.075	−0.050	0.231	0.089
Mexico	MEX	0.368	0.121	−0.033	−0.030	0.305	0.167	−0.046	−0.035	0.274	0.042
United States	USA	0.547	0.081	−0.028	−0.025	0.597	0.138	−0.021	−0.038	0.061	0.022
Sectoral evidence											
Textile	C13-15	0.549	0.095	−0.013	0.032	0.629	0.152	0.024	0.045	0.110	−0.013
Pharmaceutical	C21	0.408	0.066	−0.031	0.010	0.341	0.115	−0.032	0.026	0.170	0.063
Automotive	C29	0.534	0.092	−0.030	−0.006	0.443	0.161	−0.006	−0.002	0.213	0.040
Transportation	H	0.552	0.109	−0.029	0.017	0.586	0.090	−0.045	0.083	0.165	0.032
Financial Service	K	0.536	0.079	−0.020	−0.020	0.395	0.121	−0.028	0.005	0.060	0.012
Scientific Activities	M	0.607	0.057	−0.010	0.016	0.576	0.251	0.058	0.054	0.110	0.037

Vertical and Horizontal Labour shares refer to 2014. Changes refer to the period 2000–2014. Appendix B presents the whole tables with country and sectoral evidence. We exclude from the computation non-market services (P, Q and U), Construction (F), natural resources based activities (A, B, C19 and D) and Real Estate (L). GVC participation is measured as the percentage of Value Added produced in foreign countries

$$\boldsymbol{V} = \hat{va}\,\hat{x}^{-1}\,\boldsymbol{L}\,\hat{d} \tag{6}$$

Each element $v_{ic,jk}$ stands for the amount of value added activated in industry i for country c by the effective component of final production for subsystem j for country k. Given n total number of industries (for rows) and subsystems (for columns) and m total number of countries, $\boldsymbol{V}$ can be represented as an nm x nm matrix:

$$\boldsymbol{V}_{nm,nm} = \begin{bmatrix} v_{11,11} & \cdots & v_{11,jk} & & \\ \vdots & \ddots & & & \\ v_{ic,11} & & v_{ic,jk} & & \\ & & & \ddots & \\ & & & & v_{nm,nm} \end{bmatrix}$$

The columns of this matrix are defined as international production subsystems, or vertically integrated sectors (Pasinetti, 1973; Momigliano & Siniscalco, 1982) and represent the value added incorporated in intermediate production stages induced by the production of final goods. The main diagonal represents the amount of value added embodied in inputs generated internally within the same industry. The sum of the elements of column (j, k) represents the entire value added generated by the subsystem j in country k required to satisfy the final demand for the goods it produces.

Given the construction of the matrix $\boldsymbol{V}$, it is possible to calculate vertically integrated (or subsystems) industry labour shares. Using the elements of the value added matrix as weights ($v_{i,c}$), we can derive the labour share LS of subsystem j in country k as follows:

$$LS_{j,k} = \sum_{(i,c)\in(j,k)} \frac{v_{i,c}}{\sum_{(i,c)\in(j,k)} v_{i,c}} ls_{i,c} = \sum_{(i,c)\in(j,k)} vash_{i,c} ls_{i,c} \tag{7}$$

where the element (i, c) represents the input from industry i in country c contributing to the value chain of subsystem j in country k. Therefore, $LS_{j,k}$ - the labour share of the subsystem (j, k) - is computed as the weighted sum, in terms of valued added $v_{i,c}$, of the labour shares across industries inside the vertically integrated sector ($(i, c) \in (j, k)$).

Borrowing from the employment multipliers approach (Bivens, 2003, 2019) we distinguish three components of $LS_{j,k}$. We define as *direct* contributions the production inputs that the element (i, c) produces for itself, while *indirect* contributions are the inputs coming from other industries. The indirect component can in addition be distinguished in *domestic indirect*, corresponding to inputs coming from other domestic industries (i.e. $i \neq j$ and $c = k$), and in *foreign*, corresponding to inputs coming from abroad industries ($c \neq k$). In the following, we shall distinguish in terms of broad countries (e.g., advanced vs. developing) and broad sectors (e.g., manufacturing vs. service), to further disentangle heterogeneity.

3.3 Vertical labour share: preliminary trends

Accounting for the 'vertical dimension' of the labour share means examining how value added is distributed among capital and labour along the mix of inputs from different countries and industries participating in GVCs. Thus, for instance, the labour share of the German automotive industry takes into account the wage received by, let's say, German workers producing engines and providing support services, Italian workers manufacturing axle shaft, Chinese workers of the textile industries producing the seat covers. In the following, we link the concurrent rise of GVC participation to the worldwide fall in the labour share and contribute to the literature investigating the labour share dynamics in backward linkages. Our approach allows us to take into account the increasing fragmentation of production processes and goes beyond the standard sector-specific (i.e., horizontal) analysis which undervalues the role of widespread interdependences characterising modern production processes. By looking at the foreign backward linkages, we can uncover the underlying different dynamics of income remuneration in the domestic vis-a'-vis foreign inputs labour share. Thus, we embrace a vertical perspective tracking the changing inputs composition of final productions, and their functional income distribution. In so doing, we mimic, from a meso-level perspective, the actual decisions firms face in terms of combinations of inputs of production.

The left panel of Fig. 1 shows the impressive long-run negative correlation (correlation coefficient − 0.88) between the rise of foreign value added in manufacturing domestic production (red line) and the fall in aggregate labour share (blue line) in the period 1970-2010. Notably, even if the boom in intermediate inputs started in the 90s, the initial phase of GVC expansion in manufacturing industries had already started in the 70s (Pahl & Timmer, 2019a). Although our period of I-O investigation starts in 2000, using a different data source we show that the concurrent fall in the labour share and the rise in GVC participation, in terms of opposing patterns, was already starting well before. Therefore, while the declining pattern in the pre-1990 era cannot be exclusively due to GVCs rise, over time it could be ascribed to GVCs progressive expansion. In addition, although the nineties are commonly understood as the phase of initial rise in GVCs, this is also the result of a lack of data availability in the long run, until very recent developments, in terms of I-O data. As documented by other sources (Fouquin & Hugot, 2016, World Development Report, 2009), not using I-O tables, but for example CEPII data, intermediate trade has been markedly rising since the sixties. For the sake of comparison, the right panel of Fig. 1 distinguishes between the accustomed horizontal and the vertical labour share, the latter being the average labour share of all intermediaries contributing to final output. We use the WIOT (2016 version) matched with the Socio-Economic Account, as described in the following data section. While we confirm the decline in the horizontal dimension, using two distinct data sources (PWT vs WIOT), we are able to identify a dynamics of the vertical labour share neatly distinguished by its horizontal counterpart. The difference between the two is due the evolution of GVC participation, measured as the share of foreign inputs in domestic production, plotted in the right axis of Fig. 1 and further discussed with reference to specific country-industry in Table 1. Not only the average vertical labour share is substantially lower than

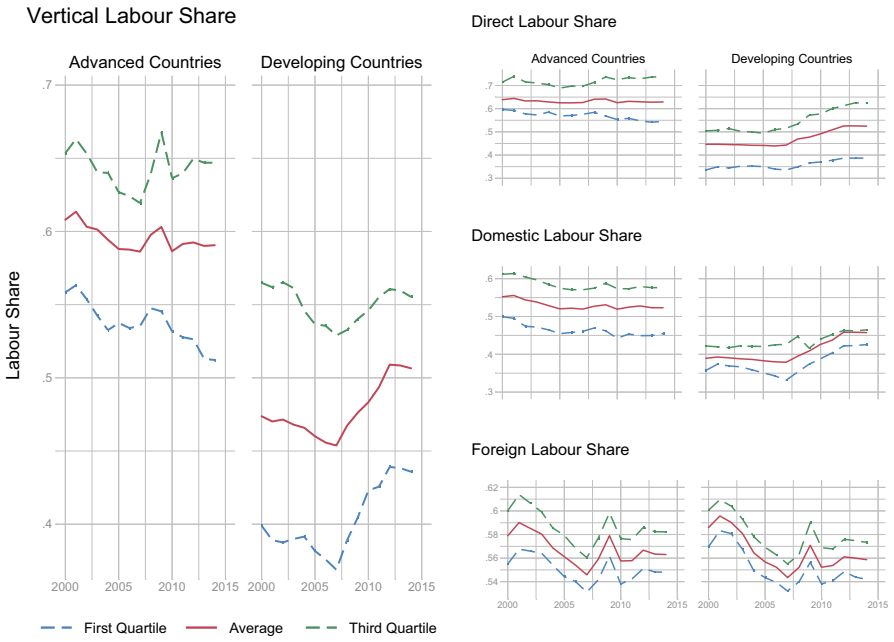

Fig. 2 Labour share trends in advanced and developing countries. Labour share distribution is weighted by real value added

its horizontal counterpart, but it also presents a higher degree of volatility, both in abrupt downswings (trade collapse in 2008) and upswings (post-crisis recovery).

On this line, in Table 1 we present some preliminary evidence on the country- and sector-level labour shares at the scope of specifically disaggregating the novel measure we propose, and assessing the difference with the existing one. The sector/country in the first columns are the identifiers of the chains and represent the sector/country where the final stage of production occurs (destination). Vertical labour share columns refer to the average labour share, standard deviation and growth of all intermediaries composing the final output. Those inputs may come from the sector/country itself (i.e., direct contribution) but also from countries with different development levels and institutional settings, as well as from both manufacturing and service industries having different labour-capital ratios. As a comparison, the horizontal labour share columns report the corresponding statistics of that specific sector/country. The difference between the vertical and horizontal labour shares arises due to the role of indirect intermediaries, both domestic and foreign ones, necessary for producing the final output. In fact, in the last two columns GVC penetration is shown, representing the overall share of value added originating from abroad. In essence, if a country or sector produces its final output solely relying on direct inputs, the values in the horizontal and vertical labour share columns would be the same. Therefore, the higher the fragmentation of the production process, the higher the difference in the horizontal vs the vertical labour shares.

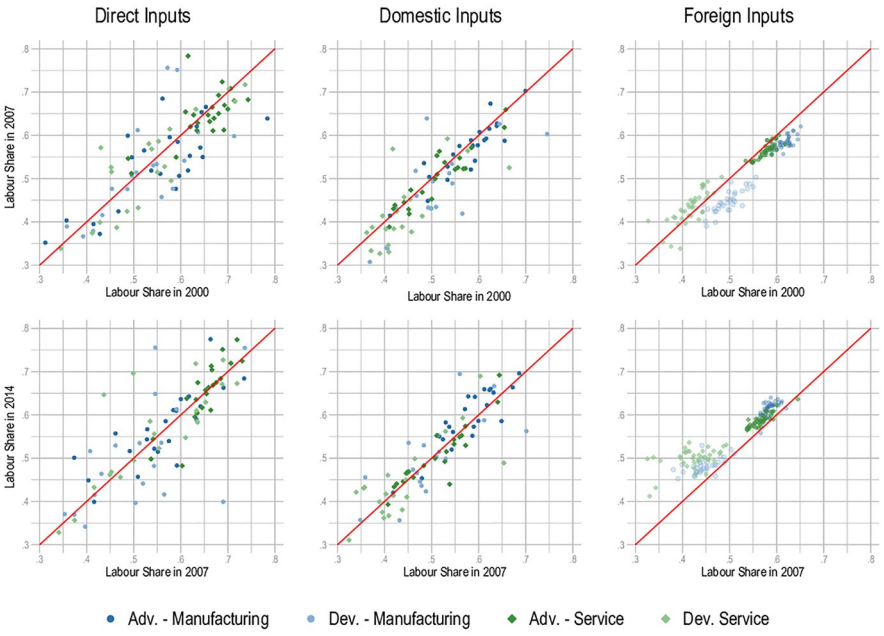

Fig. 3 Vertical labour share shift in the pre- and post-crisis periods by macro-sector, country development level and GVCs' components. Direct input refers to final stage contributions, domestic to inputs coming from domestic sectors, and foreign from abroad. Chains are aggregated into two broad sectors, namely manufacturing and service. Domestic and foreign inputs are split between inputs from developing and advanced countries and between manufacturing and service sector industries

The top panel of Table 1[8] compares country-level vertical and horizontal labour shares for selected countries and sectors (mean, standard deviation, changes pre- and post-crisis), while the last two columns display the average dependence on indirect foreign inputs (and its change). First, dependence on indirect inputs is growing almost across all countries, both developing and developed ones, with China being an exception. As a consequence, the value added originating from the direct contribution of a sector to its final production is progressively decreasing. Thus, as time goes by, the horizontal and vertical labour shares diverge. On average, developing countries' vertical labour share is higher than their horizontal counterpart, while the opposite holds for advanced economies. This is in line with the different roles countries exert on the international division of labour. Finally, within-country dispersion is greater in horizontal sectors rather than in vertical GVCs.

As a counterpart, the bottom panel in Table 1 presents the sectoral-level descriptive statistics. The differences between the vertical and horizontal dimensions are now stark. The automotive and pharmaceutical industries are more reliant on foreign inputs than services, and thus the vertical and horizontal dimensions diverge significantly. Similarly, within-sector vertical labour shares are less volatile than horizontal

[8] Appendices 5 and 6 present the correspondent tables covering all sectors.

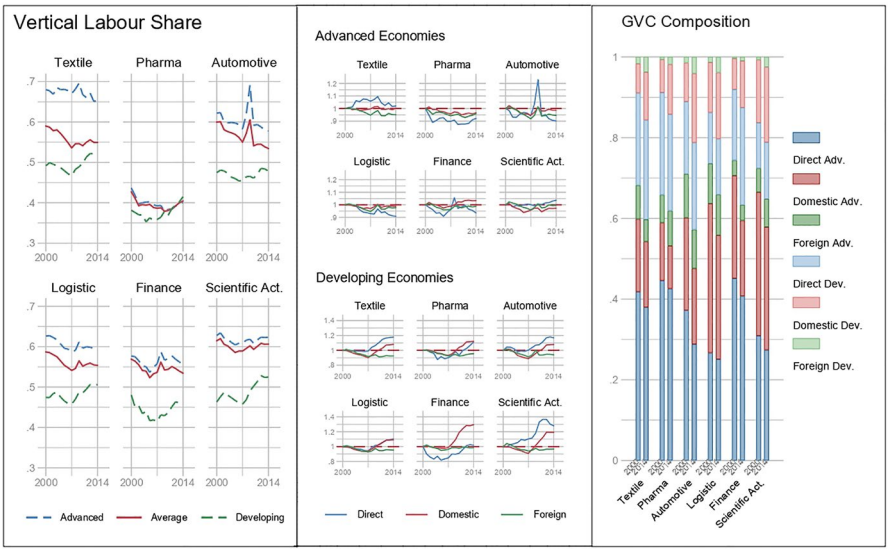

Fig. 4 Left Panel: aggregate labour share trends in six selected industries. The figure displays weighted averages across advanced, developing countries and the whole sample vertical labour share. Central panel: evolution of direct, domestic and foreign contributions' labour share (2000=1). Right panel: sectoral GVCs value added composition. All variables are aggregated using value added as weight

ones, especially services. Finally, while labour share drops virtually in all vertical sectors, the horizontal picture is more nuanced.

Figure 2 introduces some descriptive evidence splitting the sample between advanced and developing countries. The left panel presents the trends of the whole GVC labour share comparing the two sets of countries. The unit of analysis is the single value chain (e.g., the automotive vertical sector in Italy), then aggregated in broad geographical areas using real value added as weights. The vertical labour share encompasses both domestic and GVCs inputs. The right panel instead splits the labour share dynamic into three components, namely direct (i.e., final stage), domestic (i.e., national inputs) and foreign (i.e., GVCs) contributions. Looking at the left panel, we observe that, first, advanced countries' labour shares are greater than developing countries' ones. Second, two divergent time trends emerge, a pre-crisis declining trend until 2007, when most chains show a consistent drop, and a post-crisis period in which several developing countries, and especially China, witness a labour share boom, while advanced countries stagnate. Interestingly enough, while the first and third quartiles of the distribution of the labour share of developing countries follow similar trends, advanced countries show contrasting tendencies, with the top quartile showing a growing/stagnating labour share in the final period while the bottom one keeps declining. These diverging trends illustrate a widening of the underlying labour share distribution in advanced countries and they hint at potential different sectoral trends, as well as at country-specific dynamics. Looking at the right panel, direct contributions constitute the lion's share of the total inputs, and therefore,

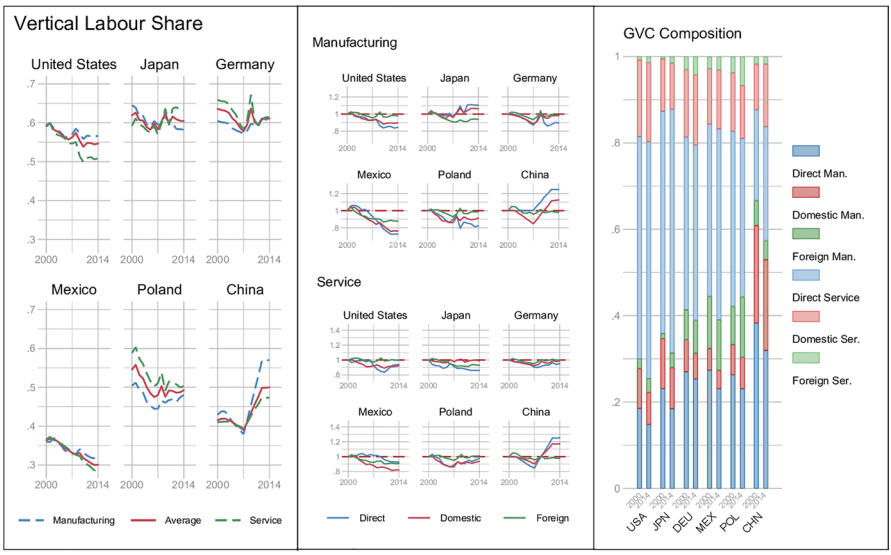

Fig. 5 Left Panel: aggregate labour share trends in six selected countries. The figure displays weighted averages across manufacturing industries, service activities and the whole economy vertical labour share. Central panel: evolution of direct, domestic and foreign contributions' labour share (2000=1). Right panel: country-level GVCs value added composition. All variables are aggregated using value added as weight

their dynamics closely mimic the whole chain. Advanced countries' domestic contribution falls on average by almost 5% in the period under scrutiny. Again, contrasting tendencies emerge among the third stable quartile and the declining first one. Developing countries' domestic inputs are stable in the pre-crisis period while their labour share has increased steadily in the last seven years. Finally, foreign inputs labour share declined steadily in the whole period, with 2008 as the only exception. Notably, the differences between developing and advanced countries shrink in the foreign component, and the distributions have narrower supports. Furthermore, the dynamics in the domestic and foreign components are increasingly relevant in explaining the whole pattern since increasing GVC integration maps into higher weights of the vertical value added.

Figure 3 offers a more disaggregated picture tracking GVCs' changes in the pre- and post-crisis periods, 2000–2007 in the top plots, and 2007–2014 in the bottom ones, and distinguishing by macro-sector, country development level and GVCs' components. First, both advanced and developing countries' service value chains have a higher direct component of the labour share. This evidence reverses in the domestic and foreign segments, meaning that manufacturing productions activate domestic labour inputs characterised by a higher labour share than those of service industries. Second, a typical pattern in all categories is a greater incidence of a declining labour share along value chains in the pre-crisis period, both in advanced and developing countries, particularly in the foreign component. This trend is similar across macro sectors. The most striking evidence

concerns foreign manufacturing input contributions that show a pervasive drop in the pre-crisis period and a partial recovery in the post-crisis ones. Such a remarkable drop in conjunction with the crisis year is consistent with the evidence of the trade collapse (Levchenko et al., 2010), characterised by the strong reduction in intermediate input trade flows. Contrarily, service industries' foreign inputs see a minor drop in the pre-crisis period while they witness a sustained rebound in the latter period. This rebound is particularly evident at the very bottom of the distribution, thus accounting for a partial catching up in labour share levels.

3.4 Sectoral and country dynamics: selected evidence

We now propose some illustrative evidence on specific sectors and countries to pinpoint insights on the vertical labour share dynamics. Figure 4 shows the dynamics of six chains characterised by distinct technological attributes, employment structures and market conditions. The left panel presents the evolution in three manufacturing (textile, pharmaceutical, automotive) and three service value chains (logistics, finance, scientific activities), distinguishing between developing and advanced countries.

The textile sector goes through a widespread and steady decline up to the financial crisis, especially in developing economies. In the post-crisis period, advanced and developing countries have opposite dynamics resulting in an overall stagnation of the average labour share. The central panel shows that the direct contributions sustain the labour share while the domestic component stagnates and foreign contributions fall. Jointly evaluating the temporal dynamics and the textile value chain composition, in the initial and final years of the period (2000 and 2014), in the right panel we detect a concurrent expansion in relative production by developing countries in all GVCs' segments.

The pharmaceutical chain displays a relatively lower vertical labour share in advanced and developing countries. This evidence is in line with Chen et al. (2018) showing that intangible capitals (i.e., trademarks and patents) have an increasingly important role in pharmaceutical industries. This points to the rise of intangibles as a concurrent determinant of the labour share drop. Interestingly, advanced and developing countries' labour shares converge to a similar level due to the opposite dynamics in the post-crisis period. The right panel of Fig. 4 shows, however, that the restructuring of the value chain composition is due to a change in the weights of the three components rather than to an expansion of developing countries' markets.

Automotive value chains are the most reactive to the financial crisis, with a positive jump in advanced countries just afterwards. However, the decline in the labour share keeps going immediately after the crisis. Developing countries show a constant labour share with a slightly positive trend in the final years. Looking at the dynamics of GVCs' components in the central panel, advanced countries experienced ubiquitous negative trends, while developing countries only in the foreign component (driven mainly by imports from advanced countries). Finally, the right panel in Fig. 4 documents a broad expansion of developing countries in the

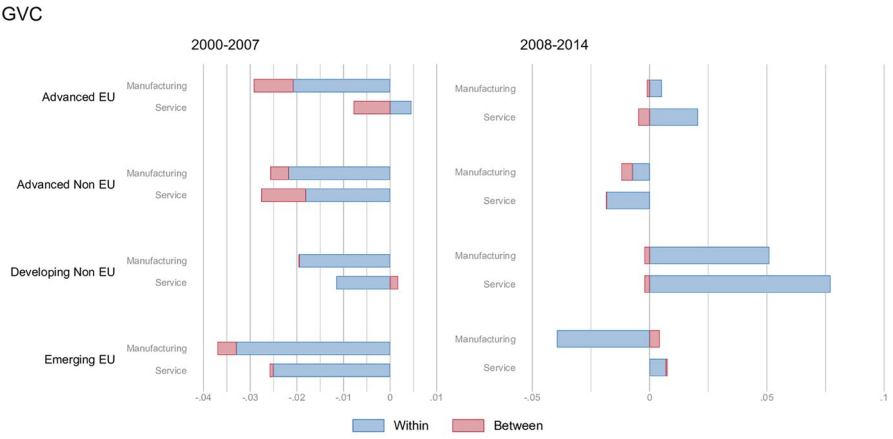

Fig. 6 Shift-share analysis by vertically integrated sectors on whole GVC labour share. Results are computed at the GVC-level and then averaged across sectors weighting by real value added

automotive sector, in all segments of production. The bottom panel displays service sector dynamics. Advanced countries' labour shares, after an initial fall, largely stagnate in the post-crisis period, while developing countries witness an upsurge ending with a greater share than the initial one (all but financial services). Interestingly, similarities across service activities are more remarkable than among manufacturing industries. Focusing on the dynamics of GVCs' components (central panel), the most striking evidence is that foreign inputs labour shares decline in all sectors and countries, however in contrast with the growing role played by the value added generated in all sectors.

The bottom line of this sectoral overview is that advanced countries are witnessing a decline in the vertical labour share, particularly in manufacturing sectors, while the opposite holds for developing countries. More precisely, advanced and developing labour share dynamics appear similar and fall in the pre-crisis period, while they diverge afterwards. Finally, service sectors' labour share dynamics appear to be more homogenous (within the same development status) than manufacturing industries.

Moving to selected countries' evidence, the left panel of Fig. 5 distinguishes between average productions in service and manufacturing activities, showing that country-specific characteristics are critical in explaining the labour share decline. The United States and Mexico led the fall in manufacturing and services with an overall drop greater than 5%. In both manufacturing and service, Japan and Germany's labour shares fall in the pre-crisis period, while in the post-crisis period, divergent dynamics emerge. Japan's manufacturing industries keep falling, and service sectors slightly grow, while the opposite holds for Germany. China has the most astonishing labour share performance with a considerable jump in the post-crisis period in both manufacturing and service sectors. On the opposite side, Poland and Mexico declined in the whole period. We can interpret contrasting developing countries' experiences as a hint of different competitive strategies: Poland and Mexico

rely more on productivity upgrading, compressing wages to gain market shares, while China focuses on both quality upgrading, to increase overall competitiveness, and extensive margins.

In the central panel, GVCs contributions are displayed. The ubiquitous decline in foreign components' labour share emerges. Domestic and direct components largely follow similar dynamics. The main evidence is that China's manufacturing sectors are the only ones witnessing increasing vertical labour share among the selected countries, while, on average, all the others fall. Looking at the right panel of Fig. 5 we acknowledge a progressive and widespread servitisation of the economy with expanding direct and domestic components in terms of value added composition of the GVCs. On the other hand, manufacturing still accounts for the lion's share of foreign inputs value added.

To sum up, countries' characteristics are more relevant than sectoral attributes in understanding the vertical labour share dynamics, as shown by narrower labour share distributions in the latter case. Furthermore, manufacturing sectors witnessed a ubiquitous fall in the labour share, especially in advanced countries in the pre-crisis period. Finally, developing countries' labour share follows idiosyncratic paths, with China standing out in the post-crisis period with an impressive upsurge in vertical labour shares.

4 Shift-share analysis

This section develops a shift-share analysis to investigate how inputs from different origins (e.g., country development levels, sectoral macro-aggregates) are responsible for changes in the vertical labour share of a given GVC. We move, therefore, from a comparative static framework to a dynamic one in which we look at input changes from 2000 to 2014. In practice, variations in the vertical labour share might arise either from a change in the labour share of the inputs used, keeping constant their composition, or from the reshuffling of inputs' composition, presuming a stable functional income distribution. Thus, we decompose the vertical labour share in a *within-inputs component*, capturing the evolution of the functional income distribution keeping constant the input requirements, and a *between-inputs component*, capturing how the change in the bundle of input requirements, e.g., toward cheaper labour from another sector/country, might affect the dynamics of the vertical labour share in a given chain. Thus, we can interpret the within component as informative about the distribution of the gains of productivity to wages along the chain, and the between component as informative of the change in the firm decisions to perform outsourcing and/or offshoring of labour requirements.

The shift-share analysis reads as follows:

$$\Delta LS^{GVC}_{(j,k),t} = \overbrace{\sum_{(i,c)\in(j,k)} (\Delta ls_{(i,c),t} * \tilde{v}_{(i,c),t})}^{Within\text{-}Inputs} + \overbrace{\sum_{(i,c)\in(j,k)} (\Delta v_{(i,c),t} * \tilde{ls}_{(i,c),t})}^{Between\text{-}Inputs} \tag{8}$$

Table 2 Shift-share analysis by vertically integrated sectors on whole GVC labour share following Eq. 9

		2000–2007							2008–2014						
		Direct		Domestic		Foreign		Tot.	Direct		Domestic		Foreign		Tot.
		w	*b*	*w*	*b*	*w*	*b*		*w*	*b*	*w*	*b*	*w*	*b*	
Advanced EU	*Manufacturing*	−0.014	−0.016	−0.002	0.002	−0.005	0.005	−0.029	−0.005	0.007	0.006	−0.018	0.004	0.009	0.004
	Service	0.004	0.002	0.002	−0.006	−0.001	−0.003	−0.003	0.015	−0.003	0.004	−0.006	0.001	0.004	0.016
Advanced non-EU	*Manufacturing*	−0.013	−0.016	−0.007	0.001	−0.002	0.011	−0.026	−0.009	0.001	−0.001	−0.009	0.003	0.003	−0.012
	Service	−0.014	−0.006	−0.004	−0.006	0.000	0.003	−0.028	−0.017	0.004	−0.001	−0.007	0.001	0.002	−0.019
Developing non-EU	*Manufacturing*	−0.005	−0.022	−0.012	0.007	−0.003	0.015	−0.020	0.026	−0.004	0.024	0.015	0.002	−0.013	0.049
	Service	−0.009	0.010	−0.002	−0.004	−0.001	−0.004	−0.010	0.056	0.004	0.020	0.000	0.001	−0.006	0.075
Emerging EU	*Manufacturing*	−0.016	−0.025	−0.008	−0.001	−0.009	0.022	−0.037	−0.043	−0.009	−0.002	−0.008	0.006	0.021	−0.035
	Service	−0.014	0.008	−0.008	−0.008	−0.003	−0.001	−0.026	0.006	−0.003	−0.002	−0.004	0.003	0.008	0.008

Results are computed at the GVC-level and then averaged across macro-sectors and country groups weighting by value added

Fig. 7 Shift-share analysis on domestic and foreign components following Eq. 9. Results are computed at the GVC-level and then averaged across industries and country groups using value added as weights. The analyses highlight the sectoral origin of inputs along the value chains

where (j, k) identifies the subsystem j ending in country k; (i, c) the inputs from industry i in country c, and t the year. Δ represents the variation in the variable of interest from the beginning to the end of the period, while $\tilde{ls}$ and $\tilde{v}$ are respectively the average labour and value added shares in the initial and final year of that period.

Notably, the components of the analysis are also an indirect measurement of some of the drivers discussed in Sect. 2. In particular, while the within component can be considered a proxy of the concurrent institutional and technological dynamics occurring inside the boundaries of each country and producing wage compression, the between component is an indirect proxy of the offshoring channel, creating access to new global production arrangements, possibly leading to restructuring processes negatively affecting labour vis-à-vis capital remuneration.

Figure 6 shows the results of the shift-share decomposition splitting the analysis into two sub-periods: 2000–2007 (left) and 2008–2014 (right). The two periods are distinct because of the evidence suggesting a breaking behaviour of the labour share during the crisis. The bars report the average within- and between-input components across country groups and macro-sectors, weighted by value chains' value added. While macro-sectors still refer to the manufacturing-service category, country aggregates are further disentangled into four groups: advanced EU, advanced non-EU, developing non-EU and emerging EU. This distinction was adopted to allow for emergence of different integration strategies occurring worldwide, particularly the integration of the Visegrad Group in 2004.

First, the within-input dynamics is the most relevant in explaining overall changes in both periods, while the between components, in general, exert a negative contribution to the change, signalling that input re-composition occurs at the cost of the labour share. The pre-crisis period (2000–2007) is marked by a ubiquitous and robust decline in the vertical labour share both in advanced and developing countries, mainly driven by the within component. This drop encompasses both manufacturing and service activities with a greater impact on the former.

Fig. 8 Shift-share analysis on foreign components following Eq. 9. Results are computed at the GVC-level and then averaged across industries and country groups weighting by value added. Top panel accounts for inputs from advanced countries while the bottom panel from developing countries

Notably, the negative between-input components in manufacturing and services in both advanced EU and non-EU countries might reflect strategies of labour cost reductions through production fragmentation operated by advanced economies.

In the post-crisis period, the only group of countries recording a substantial rebound in the labour share are developing non-EU countries, driven by China. The negative change experienced by emerging EU countries is evident, particularly in the within component of the manufacturing activities. Coupled with the negative between-input component of the manufacturing sector in the 2000–2007 period experienced by advanced EU countries, the negative within-labour share in EU emerging countries is another confirmation of wage compression strategies put forward by processes of international fragmentation, operated even by backward countries that should have in principle benefited from participation in GVCs. However, the distinct dynamics between emerging EU and developing non-EU countries is quite interesting, the latter instead recording a positive within dynamics.

While the within-input components appear to play a major role in the change of the vertical labour share, disentangling the effects across GVCs' segments unveils a more variegated/complex interplay. Indeed, the shift-share decomposition allows for the disentangling of *within-input* and *between-input* changes in value chains' contributions (s), namely direct inputs (i.e., $dir : (j,k) = (i,c)$), domestic indirect contributions (i.e., $dom : j \neq i$ and $k = c$), and foreign indirect contributions (i.e., $for : k \neq c$). Thus, adapting Eq. 8, changes in $\Delta LS^{Dir,Dom,For}_{(j,k),t}$ can be further decomposed in:

$$\Delta LS^{GVC}_{(j,k),t} = \frac{\tilde{va}^{dir}_{(j,k),t}}{va^{gvc}_{(j,k),t}} \Delta LS^{dir}_{(j,k),t} + \frac{\tilde{va}^{dom}_{(j,k),t}}{va^{gvc}_{(j,k),t}} \Delta LS^{dom}_{(j,k),t} + \frac{\tilde{va}^{for}_{(j,k),t}}{va^{gvc}_{(j,k),t}} \Delta LS^{for}_{(j,k),t} =$$

$$= \sum_{s \in (Dir,Dom,For)} \tilde{v}^{s}_{(j,k),t} \Bigg[\underbrace{\sum_{(i,c)\in s} (\Delta ls_{(i,c),t} * \tilde{v}_{(i,c),t})}_{Within\text{-}Inputs} + \underbrace{\sum_{(i,c)\in s} (\Delta v_{(i,c),t} * \tilde{ls}_{(i,c),t})}_{Between\text{-}Inputs} \Bigg] \tag{9}$$

where s stands for the three components of GVCs (i.e., direct, domestic and foreign contributions respectively) and $\tilde{v}^{s}_{(j,k),t}$ for the value added shares of each chain contribution averaged across the period. Thus, following the decomposition of Eq. 9, we replicate the analysis now accounting for the three components and show results in Table 2. Direct components largely outweigh the other two, in line with the higher role of direct value added. In the pre-crisis period, all three within-input components are negative, almost in all chains signalling capital shares gaining against labour ones.

On the contrary, the between components have heterogeneous dynamics. Looking at manufacturing chains, the between components are negative in all direct contributions, while positive in indirect domestic and foreign ones, also in line with the increasing indirect labour share patterns documented so far. This evidence shows that the fragmentation of production upsurged in the years under consideration, increasing the share of value added indirectly produced domestically and, even more, abroad. On the other hand, these patterns are less evident in the service chains. Direct contributions between components are largely positive, while domestic and foreign ones are negative. However, all service sectors between components are relatively smaller than their manufacturing counterparts. Given the overall negative values of within components and contrasting signs in between contributions, the net effect in Fig. 6 shows the prevalence of the within-component. Moving to the post-crisis panel, direct within components are negative in all chains except developing non-European countries. In contrast, foreign and domestic within-contributions are either positive or close to zero. Across advanced economies, as a result of the counter-cyclical impact of the 2008 crisis and the reduction in inter-industries trade with the great collapse, both within and between components are smaller in absolute values than in the previous periods. Looking at developing countries, two patterns emerge: non-European developing countries, driven by the direct and domestic components, more than recover the fall of the previous periods ending with a positive change in the labour share; on the opposite, European emerging manufacturing sectors record negative changes in the direct and domestic components, while service ones stagnate. These divergent patterns across developing countries recall the sign of different integration strategies, one prevalently based on internal wage compression (the eastern European strategy), and another largely based on employment expansion and technological upgrading, mainly driven by China (Dosi et al., 2020).

We finally zoom in on the indirect components (i.e., domestic and foreign contributions) to understand which sources, whether outsourcing or offshoring, drive our results. First, we investigate the sectoral origin of the input requirements,

distinguishing manufacturing and service contributions. Then, focusing on foreign components, we investigate the labour share dynamics of inputs from advanced *versus* developing countries. In Fig. 7 we decompose domestic and foreign inputs separately (i.e., value added shares sum to one in each segment).

Notably, in both periods, most of the positive contributions are due to service inputs. More precisely, between-input components are greater in the pre-crisis, while within-input components prevail in the post-crisis. These positive contributions hold both in domestic and foreign inputs, confirming a progressive servitisation of the chains, but also the increased tradability of services (Baldwin & Freeman, 2022).

Contrarily, manufacturing inputs are characterised by negative within and between components, especially in the pre-crisis period. In the post-crisis period, a small rebound signals some gains for the within-manufacturing component in developing non-EU countries. Overall, notwithstanding the positive contribution of service inputs, the rise of service labour share is not sufficient to compensate for the drop in manufacturing industries' inputs labour share, neither in domestic nor in foreign components.

To conclude, Fig. 8 deals with backward linkages' origin, distinguishing between inputs from advanced and developing countries. Introducing the origin dimension allows us for the detection of new patterns concealed in previous analyses. While foreign inputs from advanced countries record a negative labour share shift, in all components, foreign inputs from developing economies register sustained gains in the labour share, driven by their between-component. This suggests an international restructuring of labour requirements toward developing countries that increased their participation in GVCs. However, the labour share's fall in inputs from advanced countries is greater than the rise in developing countries, resulting in an overall decline in the labour share.

Thanks to the sectoral and geographical origins of the input composition, the shift-share analysis highlights that service inputs' labour share is gaining while manufacturing is falling everywhere. Foreign labour from non-EU emerging economies benefits at the cost of inputs from advanced countries (opposite between-input dynamics). However, such gains already decreased in the second period, also questioning the duration of the benefits for the labour share due to GVC participation.

5 Econometric analysis

5.1 Empirical setting

In this section, we deeply investigate the factors driving the decline in the labour share through a parsimonious econometric specification. Using the results of the shift-share analysis, we exclusively focus on the labour share of *backward foreign linkages*. Such choice stems from two reasons. Firstly, our descriptive statistics (cf. Fig. 2) and the shift-share analysis (cf. Fig. 7) reveal that this component is the only one presenting a considerable and systematic decline in the labour share

Table 3 Estimates for regression in Eq. 10

	(1) OLS	(2) Fixed effects	(3) LSDV
Labour Share$_{t-1}$	0.905***	0.620***	0.698***
	(0.007)	(0.013)	(0.008)
y	0.000	0.009***	0.006***
	(0.000)	(0.002)	(0.001)
Final Demand	−0.000***	−0.002***	−0.002***
	(0.000)	(0.001)	(0.000)
Capital per Emp.	−0.016***	−0.038***	−0.034***
	(0.001)	(0.005)	(0.002)
Union Density	0.017***	0.030***	0.027***
	(0.001)	(0.004)	(0.002)
GVCsh	0.001***	−0.001	−0.001
	(0.000)	(0.001)	(0.001)
Devshoring	−0.005***	−0.022***	−0.018***
	(0.000)	(0.002)	(0.001)
Manshoring	−0.004***	−0.016***	−0.013***
	(0.000)	(0.003)	(0.002)
Obs.	15,520	15,520	15,520
R^2	0.922	0.770	–
Country-Ind FE	No	Yes	No
Year FE	Yes	Yes	Yes
Number of id	1145	1145	1145

Column one is estimated using Ordinary Least Squared, column two uses Fixed Effect estimation while column three uses the Least Square Dummy Variable. Note that LSDV estimations do not provide R-squared and p-values are obtained by bootstrapping the variance-covariance matrix (100 repetitions). Further, we initialize the estimation using the Arellano-Bond estimator. The regression has been estimated through the STATA command *xtlsdvc*

across advanced and developing economies. Secondly, analysing domestic linkages in isolation would closely resemble the accustomed country-level analysis of horizontal labour share dynamics. In addition, merging the domestic and foreign components would blur the dynamics of foreign inputs, which hold different weights in the overall production. Therefore, to fulfil our research question, to repeat meant to address the role of international fragmentation of production and labour share dynamics along international value chains, we opt to focus exclusively on foreign backward linkages, through which the GVCs dynamics are exerted. Consistently, in the econometric setting our unit of analysis, and thus our dependent variable, will be the average labour share of the intermediate inputs coming from abroad. To comprehensively address unobserved heterogeneity among countries and the persistence of the dependent variable, we employ a dynamic specification. From an interpretative viewpoint, incorporating the lagged value of the dependent variable helps to account

Table 4 Regression results for Eq. 10 on sub-sample of the whole matrix

	(1) Advanced Inputs	(2) Developing Inputs	(3) Service	(4) Manufacturing	(5) Pre-Crisis	(6) Post-Crisis
Labour Share$_{t-1}$	0.685***	0.758***	0.646***	0.727***	0.727***	0.436***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.015)	(0.019)
y	0.012***	0.001	0.012***	0.005***	−0.020***	0.001
	(0.001)	(0.003)	(0.001)	(0.002)	(0.003)	(0.004)
Final Demand	−0.002***	−0.001	−0.002***	−0.002***	−0.002***	−0.003***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Capital per Emp.	−0.058***	0.001	−0.052***	−0.027***	−0.048***	−0.030***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)
Union Density	0.013***	0.046***	0.030***	0.020***	0.015***	0.103***
	(0.005)	(0.002)	(0.002)	(0.003)	(0.005)	(0.005)
GVCsh	−0.001**	0.001	−0.002***	−0.001	−0.006***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Devshoring	−0.003***	0.002	−0.022***	−0.014***	−0.043***	−0.012***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Manshoring	−0.015***	0.006**	0.012***	−0.014***	−0.016***	−0.031***
	(0.001)	(0.003)	(0.001)	(0.002)	(0.003)	(0.003)
Obs.	15,522	15,521	15,520	15,522	7,708	6,681
Country-Ind. FE	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of g	1145	1145	1145	1145	1132	1141

Note that LSDV estimations do not provide R-squared and p-values are obtained by bootstrapping the variance-covariance matrix (100 repetitions). Further, we initialize the estimation using the Arellano-Bond estimator. The regression has been estimated through the STATA command *xtlsdvc*

for path dependency in labour share dynamics. This path dependency is influenced by various structural factors, including institutional contexts and factor endowments, which change slowly over time. Consequently, the empirical specification we propose is as follows:

$$\begin{aligned} Labsh^{for}_{j,k,t} = {} & \beta_0 + \beta_1 Labsh^{for}_{j,k,t-1} + \beta_2 y_{j,t} + \beta_3 FinalDemand_{j,k,t} \\ & + \beta_4 CapitalperEmp^{for}_{j,k,t} + \beta_5 UnionDensity^{for}_{j,k,t} \\ & + \beta_6 GVCsh_{j,k,t} + \beta_7 Devshoring_{j,k,t} + \beta_8 Manshoring_{j,k,t} \\ & + \gamma_t + \epsilon_{j,k,t} \end{aligned} \tag{10}$$

Where j and k stand respectively for country and industry where the final stage takes place and γ_t are year fixed-effects. To address the influence of countries' development levels and potential size effects, we incorporate controls for the GDP per capita in the country of production and the final demand of the value chain. We use capital

per worker as a proxy for technological intensity, measuring the complementarity or substitutability of capital and labour. This technological proxy is constructed by averaging input-level capital per worker, using employment share as a weight. We acknowledge that this approach captures only the intensity of the relative use of the factors, but still it is a measure of the degree of mechanisation of the chain. The importance of capital intensity varies across sectors, and the type of technology introduced (e.g., labour vs. capital augmenting, process vs. product innovation) is likely more influential than its sheer value in shaping distributive outcomes. However, given the specific nature of the variable and the available dataset, this proxy is the best one at our disposal. To consider the role of institutional factors, we create a new variable, the vertical union density, which measures the share of workers who belong to unions among those producing foreign inputs for the value chain. This variable is computed as the weighted average of union density based on the number of workers involved. It is important to note that this variable captures just one aspect of the institutional environment; we do not consider factors such as minimum wage, labour laws, or the nature of the bargaining process. Again, the choice to use this variable is primarily motivated by data availability. We take information on the unionisation level from Visser (2019). We then introduce three indicators to account for the type of GVC integration strategy at the value chain level. First, *GVCsh* that measures the proportion of value added originating from abroad. This serves as a straightforward proxy for the significance of foreign inputs in the production process. Second, *Devshoring* is constructed as the share of foreign inputs from developing countries compared to advanced countries. This variable reflects the overall development level of the input sources, and we expect that higher participation of developing countries in the value chain will exert a downward pressure on the labour share. Third, *Manshoring* is computed as the share of manufacturing inputs over the share of service inputs from foreign sources. This variable is included to account for sectoral-level structural changes, which are relevant in the shift-share analysis' results. Appendix C provides descriptive statistics, cross-correlations, and data sources for all the variables introduced in the regression analysis. To estimate Eq. 10 we employ the biased corrected Least Squares Dummy Variable (LSDV) estimator, a method originally introduced by Kiviet (1995) and extended by Bruno (2005) to unbalanced panels. This method has been put forward as an effective approach for handling dynamic panel data in cases where the sample exhibits moderately large T and N, or an unbalanced panel structure, where GMM cannot be applied efficiently.

5.2 Results

The baseline specification of our regression in Table 3 offers valuable insights into the complex relationships shaping the labour share dynamics along GVCs. First, in line with previous evidence, the country's development level in the final stage proxied by GDP per capita (y) is associated with a higher labour share. Developed countries are still relatively more served by inputs coming from other advanced countries. As illustrative evidence, over the period of analysis, the share of inputs originating from advanced countries is 72% in developing countries as destination,

vis-à-vis 80% in the case of advanced countries, when measured in terms of employment; while 77% vis-à-vis 84% in terms of value added. On the contrary, *final demand*, which controls for chain-specific size effects, has a negative coefficient. We interpret this as the negative impact of international competitive pressure, that is, chains increasing their demand share in international markets tend to exert wage compression strategies, for example, to be consistent with just-in-time dynamics often relying on temporary workers. *Capital per worker* exhibits a negative impact on the labour share. This finding highlights the inverse relationship between capital intensity and the portion of income accruing to labour, or better, the higher the intensity in the use of capital vis-à-vis labour the lower the labour share. However, the latter is a result mediated by the final produced output of the chain and the composition of the demanded intermediate inputs. On the contrary, *union density* influences positively the labour share emphasising the significance of institutional factors in shaping income distribution. Delving into the specifics of GVC participation, our study introduces a noteworthy nuance. While our initial specification of sheer GVC participation (*GVCsh*) demonstrates a significant impact on the labour share, its significance diminishes when additional information on the mode of GVC participation is incorporated. This insight emphasises that the strategy of GVC engagement is crucial in understanding its implications for the labour share. Furthermore, the data sheds light on the consequences of offshoring towards developing countries. In line with the previous shift-share analysis, this process is associated with a reduction in the overall foreign labour share as shown by the sign of the *devshoring* variable. In a similar vein, *manshoring*, which detects the servitisation of global value chains, exerts a similar negative impact on the labour share. As chains increasingly shift toward service-oriented activities, the traditional labour-intensive manufacturing components witness a decline, thereby such shifts contribute to an overall reduction in the labour share.

Table 4 presents a series of disaggregations. A breakdown of the overall foreign labour share, distinguishing between inputs originating from advanced and developing countries is presented in columns 1 and 2, while columns 3 and 4 split these inputs based on their source industries, specifically manufacturing and service sectors. These partitions of the dataset allow us to gauge the heterogeneous impact of the determinants put forward in the econometric analysis along different development levels and sectoral origins. Notably, the size controls —GDP per capita (y) and *final demand*— exhibit consistent magnitude and sign, but have statistical significance exclusively concerning the labour share of inputs from advanced countries. *Capital per worker* keeps its negative impact, albeit solely for advanced countries. Its influence appears more pronounced on the labour share of workers in service industries, highlighting sector-specific dynamics in the relationship between capital intensity and labour allocation. *Union density* consistently maintains a positive impact across all specifications and subsets of the foreign labour share, suggesting its stable relevance in shaping labour market dynamics. Notably, the significance of union density appears even more pronounced in the context of developing countries' labour share dynamics, underlining the crucial role of labour market institutions in emerging economies, whenever present. Shifting focus to GVC participation (*GVCsh*), our findings indicate that increased participation yields a modest negative

impact in advanced countries, primarily driven by inputs from the service sector. This insight highlights the sector-specific implications of GVC engagement on foreign labour share dynamics. The adverse impact of *devshoring* holds across all specifications, except for developing countries, which experience a positive effect stemming from their heightened share in foreign inputs. Additionally, the increase in manufacturing inputs from abroad (*manshoring*) negatively affects the foreign labour share of advanced countries, particularly impacting manufacturing inputs themselves, as a proxy of competition among substitutable labour inputs. In contrast, service sector inputs and developing countries stand to gain from increasing manufacturing offshoring, highlighting the divergent impacts across industries and economies.

6 Concluding remarks

Investigating how globalisation affects functional income distribution is crucial to understand why advanced and developing economies are experiencing a dramatic drop in the labour share. In this work, we focus on a particular type of globalisation, namely the rise in GVCs and the ensuing progressive fragmentation of the production processes, investigating their impact on the share of remuneration accruing to labour. Indeed, there exists the risk that international restructurings of GVCs limit how the gains from globalisation and technological advances are shared between capital and labour. Firms have increasingly greater options in choosing inputs in international markets and can reorient their strategies versus the acquisition of labour inputs less remunerated. Instead of relying on traditionally horizontal sectors as units of analysis, we propose the novel concept of vertical labour share, shifting the focus from country-sector-specific dynamics to GVC integration. Using worldwide I-O tables for the 2000–2014 period and the definition of vertically integrated sectors, we can investigate supply chains' labour share, emerging from the combination of intermediaries entering in the production of the final output. Thus, we do not limit our analysis to standard synthetic indicators of GVC participation, but rather we explore a new broad spectrum of measures able to capture the heterogeneity characterising the supply chains. First, we find that the pre-crisis period is characterised by the drop in labour share in virtually all vertically integrated sectors. While the post-crisis period witnesses heterogeneous dynamics. Among advanced countries, European vertical labour shares stagnate while non-European economies, led by the US, keep falling. Developing countries witness contrasting patterns as well: Eastern European countries increased their international competitiveness at the cost of the labour share. This resulted in an economic upgrading within GVCs that led to greater integration in international production networks. On the opposite, developing non-European countries went through a post-crisis period of labour share growth, mainly led by China, the latter showing strategic participation in GVCs, both increasing integration and remuneration of labour inputs. Second, we split GVCs dynamics into three components, *direct* (i.e., produced in the same sector of activity), *domestic* (i.e., originating from other sectors but in the same country) and *foreign* (i.e., indirect imported inputs) contributions and investigate them separately.

The remuneration of the foreign components records a drop in advanced countries while increases in developing ones.

A shift-share analysis, distinguishing within- and between-input changes, shows that the contribution of the within-component has been mostly responsible for the drop. However, the between-component also played a negative role, with value chains restructuring toward cheaper labour inputs. When accounting for the sector and country of origin, service inputs have experienced a rise in the labour share in contrast with manufacturing inputs. At the same time, advanced economies have embraced restructuring processes, signalled by the negative between-component, directed versus advancing economies. Foreign labour inputs from non-EU advanced countries are among those benefiting the most in terms of remuneration. However, such gains already in the post-crisis period come to a halt. Together with providing a new perspective on GVCs dynamics focusing on labour requirements, their remuneration and functional distribution, this paper also offers a methodological contribution to study production fragmentation, both domestically, looking at outsourcing processes, and internationally, looking at offshoring. Limitations of our results are due to the level of aggregation, being the unit of analysis not the firm taking strategic decisions, but rather the 2-digit sector. However, lacking firm-level datasets of domestic and international flows, we deem our analysis still relevant to advance our understanding of the implication of the rise in GVCs for functional income distribution. The results are confirmed via a parsimonious econometric specification, highlighting the different channels at work. Future extensions include digging inside the labour force and distinguishing across tasks/functions performed along the chains. Indeed, occupational layers differently contribute to the overall labour share and understanding how their concentration affects the division of gains along the chains bears important implications. In addition, linking occupational and functional specialisation would allow us to connect our approach more directly with the stages of production addressed in the smile curve literature. Finally, it will enable to deepening the structural `capability-based theory' of economic development, and the dependency theory as well, to understand the heterogeneous gains countries are accruing from asymmetric participation in GVCs.

Appendices

Appendix A: Deflation procedure

WIOT are provided in current prices and in previous year prices. Building upon the contribution by Dietzenbacher and Hoen (1998) and the recent insights by Los et al. (2014) and Timmer et al. (2021), among others, we implement the so-called RAS-method to deflate WIOT (2016 Release) moving from current to constant price (base year 2010). The RAS-procedure essentially exploits the property that all the margins of the Input-Output table are already known in constant prices (gross output, value

added, final demand), as price deflators for them are largely available. What is missing is the deflation of the so-called *Z* matrix of intermediate deliveries. The procedure consists of a bi-proportional projection method, developed originally to update a given matrix in order to satisfy exogenously row and column sums (which in I-O tables result in the aforementioned 'margins'). The RAS-method proceeds iteratively, i.e., recursively updating a matrix in current prices converging to a matrix in constant prices, given row and column totals in constant prices. As such, the procedure is completed once the sums of the cells in each row and in each column are close to the totals previously exogenously identified. Following Timmer et al. (2021), we actually use the Generalised RAS algorithm (Junius & Oosterhaven, 2003; Lenzen et al., 2007; Temurshoev et al., 2013) because the standard RAS-procedure cannot deal with negative values; moreover the row and column sums over all industries in all countries should be identical, given the I-O accounting identity (worldwide value added should equal worldwide final demand), and this is likely not to be the case given the different sources from which the price deflators originate. More information on GRAS-method can be found in Temurshoev et al. (2013).

We first deflate gross output, value added and final demand (the row and column sums of I-O tables). Price deflators for output and value added are provided by the SEA dataset, while deflators for final demand components (household consumption, government consumption and investment) are taken from United Nations (UN) National Accounts, following Timmer et al. (2021). Deflation is computed row-wise, meaning that we use deflators of the producing country. We use industry gross output deflators also to deflate intermediate consumption. All deflators have been previously converted in US dollars, being the WIOT measured in such units, with exchange rates that can be found on the WIOT-website (http://www.wiod.org/home). Once deflated all the components of the I-O table, we iteratively run the convergence algorithm to get the WIOT in 2010 constant prices. We checked that the magnitudes of intermediaries' flows for our 2010 constant prices table (2010 base year) were equal to the 2010 table in current prices. Then, we did the same iterative check for the 2011 constant prices (2010 base year) table in comparison with the 2011 previous year prices provided by WIOT. Although impossible to obtain identical values given the various sources of deflators and an iteration algorithm at work, magnitudes were largely approximating, hinting to a satisfactory deflation procedure.

Appendix B: Further evidence

See Tables 5, 6, 7 and 8.

Table 5 Descriptive statistics on sectoral Labour Share. Vertical and Horizontal Labour shares refer to 2014

Sector	Code	Vertical labour share				Horizontal labour share				GVC integration	
		Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Foreign Va share	$\Delta_{2000\text{-}2014}$
Food	C10-12	*0.482*	*0.099*	0.003	0.003	0.402	0.114	−0.004	−0.019	0.099	0.020
Textile	C13-15	0.549	0.095	−0.013	0.032	0.629	0.152	0.024	0.045	0.110	−0.013
Wood	C16	0.573	0.108	−0.004	−0.007	0.519	0.136	0.038	0.004	0.118	0.014
Paper	C17	0.550	0.092	0.013	−0.008	0.517	0.101	−0.027	0.049	0.165	0.029
Printing	C18	0.596	0.082	−0.029	−0.012	0.566	0.103	−0.041	0.031	0.123	0.033
Chemicals	C20	0.415	0.110	−0.043	−0.017	0.340	0.146	−0.041	−0.006	0.147	0.016
Pharmaceutical	C21	0.408	0.066	−0.031	0.010	0.341	0.115	−0.032	0.026	0.170	0.063
Rubber & Plastic	C22	0.539	0.092	−0.014	−0.010	0.494	0.143	0.002	0.039	0.171	0.033
Mineral Products	C23	0.554	0.099	−0.046	0.018	0.464	0.129	−0.076	0.033	0.115	0.017
Basic Metals	C24	0.498	0.109	−0.087	0.047	0.386	0.160	−0.115	0.013	0.181	0.011
Fabricated Metals	C25	0.619	0.136	−0.048	0.038	0.469	0.196	−0.069	0.026	0.143	0.025
ICT & Electronics	C26	0.530	0.073	−0.007	0.028	0.478	0.158	−0.042	0.063	0.203	0.057
Electrical Eq.	C27	0.545	0.106	−0.034	0.055	0.449	0.162	−0.083	0.060	0.164	0.022
Machinery	C28	0.586	0.090	−0.053	0.038	0.522	0.135	−0.065	0.029	0.157	0.032
Automotive	C29	0.534	0.092	−0.030	−0.006	0.443	0.161	−0.006	−0.002	0.213	0.040
Oth. Transport	C30	0.591	0.063	−0.047	0.038	0.516	0.191	−0.043	0.033	0.179	0.015
Forniture	C31-32	0.568	0.116	−0.027	0.007	0.485	0.157	−0.007	0.029	0.126	0.018
Reparing	C33	0.712	0.051	−0.016	0.010	0.743	0.187	0.013	0.001	0.142	0.003
Water Collection	E	0.499	0.072	−0.014	0.002	0.525	0.110	−0.010	0.009	0.131	−0.001
Wholesale & Retail	G	0.547	0.083	−0.024	0.001	0.501	0.136	−0.032	0.028	0.072	0.016
Transportation	H	0.552	0.109	−0.029	0.017	0.586	0.090	−0.045	0.083	0.165	0.032
Accommodation	I	0.613	0.087	−0.008	0.022	0.691	0.173	−0.001	0.157	0.042	0.006
Information Services	J	0.519	0.072	−0.035	0.016	0.407	0.108	−0.021	0.049	0.114	0.036
Financial Service	K	0.536	0.079	−0.020	−0.020	0.395	0.121	−0.028	0.005	0.060	0.012

Table 5 (continued)

Sector	Code	Vertical labour share				Horizontal labour share				GVC integration	
		Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Foreign Va share	$\Delta_{2000\text{-}2014}$
Scientific Activities	M	0.607	0.057	−0.010	0.016	0.576	0.251	0.058	0.054	0.110	0.037
Admin. Services	N	0.681	0.143	0.027	0.068	0.550	0.246	0.107	0.051	0.043	−0.000
Other Services	R-S	0.677	0.090	−0.008	0.027	0.665	0.208	−0.067	0.119	0.040	0.008
Service of Household	T	0.964	0.097	0.005	0.004	0.846	0.322	0.072	−0.012	0.005	0.001

Changes refer to the period 2000–2014. We exclude from the computation non-market services (P, Q and U), construction (F), natural resources-based activities (A, B, C19 and E) and real estate (L). GVCs integration is measured as the percentage of real value added produced in foreign countries

Table 6 Descriptive statistics on the Labour Share at the country level

Country	Vertical labour share				Horizontal labour share				GVC integration	
	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Foreign Va share	$\Delta_{2000\text{-}2014}$
AUS	0.619	*0.114*	*−0.021*	0.008	0.637	0.134	−0.027	0.015	0.078	−0.023
AUT	0.575	0.056	−0.043	0.017	0.607	0.128	−0.050	0.023	0.193	0.016
BEL	0.620	0.082	−0.005	0.004	0.695	0.129	−0.003	0.010	0.280	−0.003
BGR	0.575	0.086	−0.102	0.070	0.601	0.148	−0.167	0.056	0.220	−0.013
BRA	0.572	0.115	−0.019	0.048	0.615	0.138	−0.029	0.065	0.091	−0.002
CAN	0.608	0.061	0.010	−0.007	0.653	0.108	0.067	−0.006	0.195	−0.034
CHE	0.624	0.120	−0.055	0.033	0.691	0.133	−0.065	0.033	0.191	−0.005
CHN	0.500	0.090	−0.017	0.089	0.513	0.144	−0.016	0.101	0.070	−0.011
CYP	0.544	0.106	0.010	0.005	0.631	0.174	0.041	0.052	0.151	−0.008
CZE	0.535	0.050	0.007	0.003	0.541	0.112	0.020	−0.004	0.352	0.115
DEU	0.614	0.069	−0.057	0.016	0.675	0.129	−0.062	0.010	0.143	0.025
DNK	0.615	0.109	0.024	−0.027	0.691	0.173	0.051	−0.025	0.229	0.033
ESP	0.600	0.095	−0.020	−0.031	0.645	0.137	−0.019	−0.014	0.120	−0.040
EST	0.564	0.059	−0.004	−0.026	0.620	0.106	0.009	−0.006	0.317	0.082
FIN	0.645	0.095	−0.035	0.050	0.695	0.202	−0.035	0.058	0.201	0.043
FRA	0.654	0.074	0.002	0.041	0.706	0.130	0.019	0.031	0.164	0.019
GBR	0.648	0.071	0.007	−0.011	0.694	0.107	0.036	−0.041	0.117	0.009
GRC	0.477	0.130	0.046	−0.027	0.605	0.219	0.046	0.014	0.081	−0.004
HRV	0.633	0.112	−0.088	−0.013	0.722	0.162	−0.020	0.028	0.164	−0.027
HUN	0.538	0.053	−0.018	−0.024	0.562	0.145	−0.009	−0.057	0.416	0.035
IDN	0.512	0.135	−0.012	0.010	0.470	0.202	0.044	−0.000	0.103	−0.075
IND	0.421	0.070	−0.039	0.008	0.366	0.128	−0.065	0.008	0.099	0.016
IRL	0.475	0.109	−0.022	−0.024	0.570	0.226	−0.014	−0.053	0.376	−0.018
ITA	0.633	0.095	0.021	0.027	0.687	0.109	0.026	0.037	0.128	0.018

Table 6 (continued)

Country	Vertical labour share				Horizontal labour share				GVC integration	
	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Mean	SD	$\Delta_{2000\text{-}2007}$	$\Delta_{2008\text{-}2014}$	Foreign Va share	$\Delta_{2000\text{-}2014}$
JPN	0.604	0.105	−0.040	0.005	0.631	0.217	0.001	0.009	0.070	0.047
KOR	0.618	0.135	0.004	0.011	0.630	0.190	0.056	−0.005	0.157	0.036
LTU	0.480	0.080	0.060	−0.086	0.492	0.164	0.017	−0.094	0.149	0.042
LUX	0.625	0.076	0.008	0.017	0.708	0.190	−0.042	0.027	0.593	0.113
LVA	0.527	0.052	−0.010	−0.048	0.556	0.125	−0.007	−0.060	0.188	0.021
MEX	0.368	0.121	−0.033	−0.030	0.305	0.167	−0.046	−0.035	0.274	0.042
MLT	0.518	0.077	−0.011	−0.005	0.582	0.150	−0.013	0.042	0.417	0.025
NLD	0.604	0.074	−0.028	0.008	0.616	0.120	−0.047	0.025	0.240	0.033
NOR	0.648	0.084	−0.043	−0.003	0.718	0.112	−0.037	0.002	0.188	0.012
POL	0.495	0.066	−0.061	−0.014	0.471	0.111	−0.075	−0.050	0.231	0.089
PRT	0.577	0.104	−0.021	−0.036	0.605	0.147	−0.022	−0.030	0.166	−0.021
ROU	0.479	0.063	−0.048	−0.052	0.418	0.158	−0.018	−0.165	0.216	0.009
RUS	0.710	0.141	0.053	0.092	0.676	0.158	0.038	0.064	0.091	−0.008
SVK	0.516	0.065	−0.040	0.015	0.531	0.116	−0.050	0.020	0.398	0.111
SVN	0.636	0.088	−0.027	0.017	0.680	0.125	−0.020	−0.006	0.239	0.034
SWE	0.559	0.089	−0.012	0.006	0.586	0.165	−0.014	0.015	0.177	0.005
TUR	0.387	0.094	−0.022	−0.003	0.403	0.169	−0.003	−0.004	0.176	0.073
TWN	0.791	0.215	0.069	−0.005	0.779	0.207	0.075	−0.007	0.190	−0.009
USA	0.547	0.081	−0.028	−0.025	0.597	0.138	−0.021	−0.038	0.061	0.022

Vertical and Horizontal Labour shares refer to 2014. We exclude from the computation non-market service (P, Q and U), construction (F), natural resources-based activities (A, B, C19 and D) and real estate (L). GVC integration is measured as the percentage of real value added produced in foreign countries

Table 7 Nace Rev. 2 code description

Code	Description	Broad Classification
A	Agriculture, forestry and fishing	Natural Resources Based
B	Mining and quarrying	Natural Resources Based
Manufacturing		
C-10	Manufacture of food products	Medium Low tech Manufacturing
C-11	Manufacture of beverages	Medium Low tech Manufacturing
C-12	Manufacture of tobacco products	Medium Low tech Manufacturing
C-13	Manufacture of textiles	Medium Low tech Manufacturing
C-14	Manufacture of wearing apparel	Medium Low tech Manufacturing
C-15	Manufacture of leather and related products	Medium Low tech Manufacturing
C-16	Manufacture of wood and of products of wood and cork	Medium Low tech Manufacturing
C-17	Manufacture of paper and paper products	Medium Low tech Manufacturing
C-18	Printing and reproduction of recorded media	Medium Low tech Manufacturing
C-19	Manufacture of coke and refined petroleum products	Natural Resources Based
C-20	Manufacture of chemicals and chemical products	High tech Manufacturing
C-21	Manufacture of basic pharmaceutical products	High tech Manufacturing
C-22	Manufacture of rubber and plastic products	Medium Low tech Manufacturing
C-23	Manufacture of other non-metallic mineral products	Medium Low tech Manufacturing
C-24	Manufacture of basic metals	Medium Low tech Manufacturing
C-25	Manufacture of fabricated metal products	Medium Low tech Manufacturing
C-26	Manufacture of computer, electronic and optical products	High tech Manufacturing
C-27	Manufacture of electrical equipment	High tech Manufacturing
C-28	Manufacture of machinery and equipment n.e.c.	High tech Manufacturing
C-29	Manufacture of motor vehicles, trailers and semi-trailers	Medium Low tech Manufacturing
C-30	Manufacture of other transport equipment	Medium Low tech Manufacturing
C-31	Manufacture of furniture	Medium Low tech Manufacturing
C-32	Other manufacturing	Medium Low tech Manufacturing
C-33	Repair and installation of machinery and equipment	Medium Low tech Manufacturing
Services		
D	Electricity	Natural Resources Based
E	Water supply; sewerage, waste management	Other Services
F	Construction	Construction
G	Wholesale and retail trade; repair of motor vehicles	Other Services
H	Transportation and storage	Other Services
I	Accommodation and food service activities	Other Services
J	Information and communication	Knowledge Intensive Services
K	Financial and insurance activities	Other Services
L	Real estate activities	Other Services
M	Professional, scientific and technical activities	Knowledge Intensive Services
N	Administrative and support service activities	Other Services

Table 7 (continued)

Code	Description	Broad Classification
O	Public administration and defence; compulsory social security	Non-Market Services
P	Education	Knowledge Intensive Services
Q	Human health and social work activities	Non-Market Services
R	Arts, entertainment and recreation	Other Services
S	Other service activities	Other Services
T	Activities of households as employers	Other Services
U	Activities of extraterritorial organisations and bodies	Non-Market Services

Table 8 Country code, development level (1=Advanced), and country group

Code	Country	Development	Country group
AUS	Australia	1	Advanced Non European
AUT	Austria	1	Advanced European
BEL	Belgium	1	Advanced European
BGR	Bulgaria	0	Emerging European
BRA	Brazil	0	Developing Non European
CAN	Canada	1	Advanced Non European
CHE	Switzerland	1	Advanced European
CHN	China	0	Developing Non European
CYP	Cyprus	0	Emerging European
CZE	Czech Republic	0	Emerging European
DEU	Germany	1	Advanced European
DNK	Denmark	1	Advanced European
ESP	Spain	1	Advanced European
EST	Estonia	0	Emerging European
FIN	Finland	1	Advanced European
FRA	France	1	Advanced European
GBR	United Kingdom	1	Advanced European
GRC	Greece	1	Advanced European
HUN	Hungary	0	Emerging European
IDN	Indonesia	0	Developing Non European
IND	India	0	Developing Non European
IRL	Ireland	1	Advanced European
ITA	Italy	1	Advanced European
JPN	Japan	1	Advanced Non European
KOR	Republic of Korea	1	Advanced Non European
LTU	Lithuania	0	Emerging European
LUX	Luxembourg	1	Advanced European
LVA	Latvia	0	Emerging European

Table 8 (continued)

Code	Country	Development	Country group
MEX	Mexico	0	Developing Non European
MLT	Malta	1	Advanced European
NLD	Netherlands	1	Advanced European
NOR	Norway	1	Advanced European
POL	Poland	0	Emerging European
PRT	Portugal	1	Advanced European
ROU	Romania	0	Emerging European
RUS	Russian Federation	0	Emerging European
SVK	Slovakia	0	Emerging European
SVN	Slovenia	0	Emerging European
SWE	Sweden	1	Advanced European
TUR	Turkey	0	Developing Non European
USA	United States	1	Advanced Non European

Appendix C: Regression analysis

See Tables 9 and 10.

Table 9 Descriptive statistics and sources of variables introduced in regression Eq. 10

		Mean	SD	Source
GDP pc	$	32279	16606	Penn World Table 10.1
Final Demand	Millions $	215833	79874	World Input-Output Table (WIOT)
Capital per worker	Thousands $	2.15	1.62	Socio-Economic Accounts (SEA)
Union Density	%	22.77	4.48	ICTWSS dataset (Visser, 2019)
GVCsh	%	20.08	13.81	Socio-Economic Accounts
Devshoring	.	0.27	0.21	Authors' computation based on WIOT
Manshoring	.	2.12	0.92	Authors' computation based on WIOT
Labour Share	%	0.567	0.032	Authors' computation based on WIOT & SEA

Table 10 Cross correlation of variables introduced in Table 9

	Labour Share	GDP per capita	Final Demand	Capital per worker	Union Density	GVC share	Devshoring	Manshoring
Labour Share	*1*							
GDP per capita	*0.119*	*1*						
Final Demand	−0.079	−0.001	1					
Capital per worker	−0.398	0.218	0.119	1				
Union Density	0.101	0.071	−0.124	−0.099	1			
GVC share	0.103	0.136	−0.398	0.029	0.014	1		
Devshoring	−0.295	−0.158	−0.137	0.104	0.182	−0.070	1	
Manshoring	−0.104	−0.260	−0.078	−0.324	−0.092	0.160	0.105	1

Table 11 Regression results of the OLS estimation with perturbation of the baseline specification in Eq. 10

	Dependent variable: foreign inputs labour share						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
y	0.015***	0.014***	0.012***	0.006***	0.010***	0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Final Demand	−0.003***	−0.002***	−0.000	−0.004***	−0.001**	−0.002***	−0.001**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Capital/Emp.	−0.012	−0.011	−0.019***	−0.066***	−0.032***		−0.087***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)		(0.007)
Union Density		0.031***				0.066***	0.074***
		(0.009)				(0.009)	(0.008)
GVCsh			0.017***			0.009***	0.009***
			(0.002)			(0.003)	(0.002)
Devshoring				−0.037***		−0.028***	−0.040***
				(0.002)		(0.002)	(0.002)
Manshoring					−0.029***	−0.013***	−0.022***
					(0.005)	(0.004)	(0.005)
Observations	16,613	16,611	16,609	16,609	16,607	16,607	16,605
R-squared	0.510	0.514	0.537	0.610	0.546	0.613	0.662
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix D: Robustness checks

In this appendix, we perform a battery of robustness checks on the baseline specification in Eq. 10. We use OLS and FE estimators excluding the lagged dependent variable to avoid potential endogeneity problems. In column 1, we introduce the baseline controls namely, GDP per capita in the final stage of the chains, final demand, and the average capital per worker of the foreign inputs of the GVCs. In columns from 2 to 5, we introduce one by one the independent variables related to the GVC integration, confirming the sign and significance of the coefficients estimated in the baseline specification. In column 6, GVC-related regressors are included, excluding the proxy for capital per worker to check its relevance and potentially rule out endogeneity issues. Finally, column 7 includes all the regressors of Eq. 10 but including the lagged dependent variable. Overall, we find support for the baseline specification, confirming the main results and the appropriateness of the estimation strategy. Our preferred specification is the use of the Least Square Dummy Variable (LSDV) Estimator, proposed by Bruno (2005), to account for the persistence of the dependent variables addressing eventual bias in the dynamic panel (See Tables 11, 12.).

Table 12 Regression results of the fixed Effect estimation with perturbation of the baseline specification in Eq. 10

	Dependent variable: foreign inputs labour share						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
y	0.019***	0.017***	0.022***	0.009**	0.017***	0.006	0.008**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Final Demand	−0.003***	−0.003***	−0.004***	−0.003***	−0.003***	−0.004***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Capital/Emp.	−0.031***	−0.031***	−0.030***	−0.048***	−0.040***		−0.061***
	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)		(0.007)
Union Density		−0.025*				0.003	0.027***
		(0.013)				(0.007)	(0.008)
GVCsh			0.004			−0.003	−0.001
			(0.002)			(0.002)	(0.002)
Devshoring				−0.044***		−0.039***	−0.045***
				(0.003)		(0.004)	(0.003)
Manshoring					−0.041***	−0.029***	−0.038***
					(0.005)	(0.006)	(0.005)
Obs.	16,613	16,611	16,609	16,609	16,607	16,607	16,605
R-squared	0.487	0.494	0.502	0.571	0.527	0.565	0.588
N. id	1145	1145	1145	1145	1145	1145	1145
Id FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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Declarations

Conflict of interest All authors declare that they have no conflicts of interest.

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