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Global value chains and within-country inequality: The role of functional positioning

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ABSTRACT

This work addresses the nexus between Global Value Chains (GVCs) and within-country inequality by distinguishing two key dimensions: the "product-level positioning" of economies, i.e. their involvement in more upstream or downstream industries, and their "functional positioning", defined by the value-adding activities performed along GVCs. Using trade and FDI data on 101 countries in 2003–2015, we show that a more upstream product-level positioning is associated with higher inequality in low- and middle-income countries. This is consistent with these countries' greater involvement in industries supplying raw materials and energy inputs, characterised by a remarkable income polarisation. Conversely, a more downstream product-level positioning goes together with greater inequality in high-income countries, reflecting downward pressures on labour income due to massive outsourcing of inputs to foreign suppliers. As for functional positioning, we find that a greater involvement of economies in pre- and post-production stages is associated with lower income disparities, while a larger engagement in production operations goes together with higher inequality. This result is driven by low- and middle-income countries, suggesting that a greater involvement in knowledge-intensive GVC activities fosters technological upgrading in these economies, with beneficial effects also on the lower segments of the labour force.

1. Introduction

Since the 1980s, the "neoliberal turn" in economic policy, together with the lowering of transport, communication, and coordination costs, have favoured the geographical dispersion of value-adding activities – also called "tasks" or "functions" – and their organization through Global Value Chains (GVCs) (Baldwin, 2016; Timmer et al., 2014; World Bank, 2020).

In this context, a growing literature has focused on the social and economic disparities *across countries* involved in global production networks (Mudambi, 2008; Shin et al., 2012; Baldwin and Evenett, 2015; Baldwin and Ito, 2021). In particular, several contributions on the "smile curve" hypothesis have shed light on the association between the position of countries along GVCs and their uneven value capture opportunities, as well as on the different forms of upgrading that countries may experience by moving from low to higher intangible-intensive activities (Durand and Milberg, 2020; Stöllinger, 2021; Coveri and Zanfei, 2023c). Other streams of literature have explored the impact of import penetration and production offshoring on domestic labour markets, focusing on shifts in labour demand for high- and low-skilled workers and the resulting effects on wage inequality (Autor et al., 2013; Hummels et al., 2018; Cardoso et al., 2021).

However, systematic empirical evidence on the distributional consequences *within countries* of the *positioning* of economies along GVCs has so far been rather limited. Most notably, the relatively few contributions that have addressed this topic have relied almost exclusively on GVC indicators focusing on the intermediate products sourced and supplied by countries along global production lines. In contrast, systematic empirical research on value-adding activities performed by economies – from the design and development of goods to production operations, up to marketing activities – is even scantier (de Vries et al., 2021). In other words, extant literature has emphasised what we will hereafter refer to as the "product-level positioning" of countries, while has so far failed to properly detect how the "functional positioning" of economies affects income disparities.

We argue that disregarding the functions that are carried out along GVCs represents a major drawback in the analysis of the GVC-inequality nexus. In fact, the value-adding activities undertaken along GVCs can be

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associated with different technological spillovers and labour market effects, leading to distinct consequences on income distribution within countries. These effects can hardly be captured by focusing only on the product-level positioning of economies. For instance, an economy may well position itself 'upstream' along the automotive GVC by supplying high-technology components; however, value capture opportunities and the resulting patterns of income distribution may be dramatically different if the economy is involved in the design and development of the same components or in their mere fabrication and assembly.

Accordingly, identifying the functional positioning of economies along GVCs enables us to single out the role played by the involvement of countries in different value-adding activities, particularly in the most knowledge-intensive ones, as potential drivers of income distribution. On the one hand, an increased engagement of economies in knowledge-intensive activities could be associated with inequality-enhancing mechanisms, such as skill-biased wage polarisation and market concentration. On the other hand, greater involvement in the higher value-adding functions in GVCs could induce profound structural changes – due to the emergence of new productive activities, competencies, and institutions – leading to higher growth opportunities and the creation of better-paid jobs, thus resulting in lower income disparities. As we shall show, our analysis cannot directly disentangle the role of such countervailing effects due to data limitations. However, it will provide evidence on the direction of the impact – i.e., whether a GVC positioning in the most knowledge-intensive activities positively or negatively affects inequality –, hence shedding light on which effects are most likely to prevail.

Our analysis is performed on a sample including 101 countries over the period 2003–2015. By examining the distributional consequences of both *product-level positioning* and *functional positioning* of economies along transnational supply chains, this work contributes to the extant empirical literature in the following respects.

First, we use indicators of trade in GVC, based on multi-regional Input-Output tables, to examine how the product-level positioning of countries is associated with personal income distribution. The aim is to isolate how the more 'upstream' or 'downstream' position in which countries are located along global chains of production is related to the ability of the diverse actors of the economy to capture substantial fractions of the income generated.

Second, we complement the analysis based on trade in GVCs indicators with detailed data on inward foreign direct investments (FDIs), from which we draw information on the value chain activities carried out by countries in GVCs. This allows us to explore the distributional effects of a country's changing involvement in production operations as well as intangible-intensive functions like pre- and post-production functions.

Third, we explicitly account for the different level of economic development of countries in order to investigate the heterogeneity in the GVC-inequality nexus. By distinguishing between high- and lower-income economies, we illustrate that trade-based "product-level" indicators and our FDI-based measures of "functional positioning" tell different stories in this respect. The former indicators highlight how unevenly distributed gains from trade are at the product-level, and how inequality is exacerbated by an increase in the involvement of emerging and advanced economies in upstream and downstream industries respectively. In contrast, FDI-based measures of functional positioning shed light on the role played by changes in the involvement of emerging economies in the most knowledge-intensive activities.

The remainder of this paper is organized as follows. Section 2 offers a review of the literature on the GVC-inequality nexus and discusses our research questions. Section 3 outlines our empirical strategy, while Section 4 describes the data used in this work. Section 5 shows the results of our empirical investigation. Section 6 summarizes our main findings and concludes by drawing policy implications.

2. Background literature and research questions

2.1. Global value chains and within-country inequality

The international economics literature has detected several channels through which the rise of GVCs, involving both FDI and trade modes of cross-border fragmentation of production, can impact on within-country inequality. Some scholars have revisited the standard Heckscher-Ohlin model to accommodate the international fragmentation of production. They have shown that the offshoring of low-skill activities (like assembly and packaging tasks) towards emerging economies leads to higher (lower) demand and thus higher (lower) remuneration of high-skilled workers in advanced (emerging) economies, thereby increasing wage inequality in advanced economies while reducing it in less developed ones (Baldwin and Evenett, 2015).

Moreover, from a functional income distribution perspective, offshoring of labour-intensive tasks (e.g., fabrication operations) from capital-abundant economies to labour-abundant ones entails a higher capital-output ratio in the former countries, reducing the wage share in advanced economies to the extent that capital acts as a gross substitute for labour (Harrison, 2005; Elsby et al., 2013; Helpman, 2016; Dao et al., 2020). Since the functional income distribution represents a major driver of personal income distribution (Daudey and Garcia-Penalosa, 2007; Atkinson, 2009; Wolff and Zacharias, 2013; Coveri and Pianta, 2022), changes in the wage share due to an increased participation to GVCs would therefore lead to a non-negligible increase of income inequality in high-income countries.

In addition, the skill- and capital- intensity of production can also increase in emerging economies due to offshoring from high-income countries. In fact, to the extent that emerging economies are marked by a lower level of education and capital endowment than advanced economies, the value chain functions offshored by the latter may result in relatively high-skill, capital-intensive tasks for emerging countries, ultimately increasing wage and income inequality in both advanced and emerging economies (Feenstra and Hanson, 1996, 1997; Zhu and Trefler, 2005). This is compounded by the fact that production in GVCs is often more skill-biased and capital-intensive than traditional trade (Antràs, 2020), because of the higher capabilities required to perform value chain tasks with strong complementarities with other geographically dispersed value-adding activities (Antràs et al., 2006); and of the more skill- and capital-intensive production techniques used by firms operating in GVCs than purely domestic firms (Bernard et al., 2018).

In contrast to these predictions, the "trade in tasks" model proposed by Grossman and Rossi-Hansberg (2008) allows for wages of low-skill workers to increase due to the offshoring of low-skill tasks from high- to low-income countries. Building on a Heckscher–Ohlin-type setting, they show that offshoring can reduce wage inequality in advanced economies if the "productivity effect" (due to the cost savings resulting from offshored tasks) is greater than the labour supply effect (due to the low-skilled jobs displacement) and the relative price effect (resulting from changes in terms of trade).

Adopting a different perspective, other scholars have emphasised the "threat effect" resulting from the fall-back option of firms to offshore production abroad when engaged in wage negotiations. Trade and capital liberalization favours indeed the most mobile production factor, i.e., capital, at the detriment of the relatively less mobile one, i.e., labour (Rodrik, 1997; Harrison, 2005). Accordingly, it has been suggested that the increased footloose character of international production due to the rise of GVCs can pose a credible threat for workers, weakening their bargaining power, reducing the wage share and increasing inequality in both advanced and less developed economies (Burke and Epstein, 2001; Choi, 2001; Coveri and Pianta, 2022; Guschanski and Onaran, 2022, 2023; Jeon and Kwon, 2018, 2021).

Overall, the theoretical literature described above points out that offshoring can affect within-country inequality both by changing the share of income remunerating capital and labour and by exerting an

impact on wage inequality. Moreover, the contributions reviewed underline that the distributional consequences of the GVC involvement may differ according to the level of economic development of economies. This literature thus highlights some key mechanisms through which the international fragmentation of production may affect income disparities, and how these can be expected to differ across different country groups. However, there seem to be no clear predictions on how these distributional effects may vary according to the position occupied by economies along GVCs. Accordingly, these theoretical contributions pose a key challenge for empirical research on how to capture the involvement of countries in different value chain activities.

2.2. Review of the empirical literature and research questions

On the empirical ground, an expanding literature has explored the association between the more upstream (or downstream) position of firms, industries, or countries with changes in domestic employment and wages (Shen and Silva, 2018; Cardoso et al., 2021; Szymczak et al., 2022; Szymczak and Wolszczak-Derlacz, 2022). Only a few recent empirical studies have focused on the impact of GVC positioning on income inequality.

Carpa and Martinez-Zarzoso (2022) assessed the relationship between trade in GVC (i.e., backward and forward GVC participation) with personal income distribution – proxied by the Gini index – for 39 countries over the period 1995–2016. They found that, in developing countries, the backward participation (i.e., the most widely used indicator of offshoring) increases inequality in the short run, although it reduces income disparities in the long run; the results for forward participation (measuring a country's engagement in upstream sectors) and the overall positioning of economies in GVCs are mixed and non-statistically significant. Duarte et al. (2022), using a sample of 67 economies over the period 1995–2018, found a U-shaped association between the level of "upstreamness" – i.e., a trade in GVC indicator measuring the distance of countries' output to final demand (Antràs et al., 2012) – and within-country income inequality for developed economies, as well as for Latin American and East and Southeast Asian countries.

Recently, Riccio et al., 2023 exploited the "functional specialization" measures introduced by Timmer et al. (2019) (calculated by combining input-output measures of GVC participation with labour force statistics on workers' occupations) to assess the relationship between functional positioning and labour income share. Focusing on a sample of 35 manufacturing sectors belonging to 41 countries over the period 2000–2007, they identified the functional specialization of industries providing intermediate inputs along value chains (reflecting the intensity of backward GVC linkages). They found that, in both developed and developing economies, the labour share is negatively associated with increases in the functional specialization in fabrication and marketing functions of supplier industries along the chains, and that this is especially true for labour income shares remunerating fabrication activities. Nonetheless, they do not investigate how income inequality within countries changes according to their own specialization across value-adding functions, thus not capturing the impact of the overall GVC positioning of economies on income distribution.

Reshef and Santoni (2023) explored the correlation between standard input-output measures on the GVC positioning of industries and the shares of labour income (over total value added embodied in exports) that remunerate workers performing different functions. Using data on 30 industries belonging to 39 countries over the period 1995–2014, they found that the growing forward GVC participation of industries has accelerated the decline in the labour share. Moreover, focusing on changes in the labour share over the period 2001–2007 for a cross-section of sectors, they showed that a more upstream position of industries, as measured by both forward GVC participation and the "upstreamness" indicator, is associated with negative changes in labour shares remunerating fabrication functions (and to a much lesser extent management and marketing functions). They also found a positive association between increases in the "downstreamness" of industries (measuring the distance of a given country from primary production inputs) and changes in the labour income share of R&D functions (while a non-significant relationship emerges between the latter and increases in the upstreamness of industries). The authors suggest that these results are due to the higher capital intensity of exports of intermediate inputs by industries positioning more upstream along the value chain. In other terms, as industries move upstream by offshoring assembly activities, they require more capital and less labour, contributing to lower the labour share.

Although of great interest, this work also suffers the limitations of all studies relying on "upstreamness" indicators to draw information on the value chain functions offshored and related distributional consequences. As pointed out in recent studies (de Vries et al., 2021; Coveri and Zanfei, 2023b), input-output measures of upstreamness do not *per se* inform about what countries and industries actually do (in terms of, e.g., design, assembly or marketing activities), which is instead what defines their *functional positioning* along GVCs. In other terms, these industry-based indicators account for *the product-level positioning* of countries in GVCs, thus identifying *where* a given country or industry product is positioned with respect to final demand (or primary production inputs), not *what value-adding activities* are undertaken by the same country to bring that product to market. Accordingly, making inference on the value-adding activities performed (or offshored) by countries, industries, and firms by relying on these input-output statistics might lead to misleading interpretations of results.[1]

In this work, we argue that it is worth *distinguishing* the GVC position of countries in terms of the amount of intermediate products sourced and supplied along transnational production lines (*'where'*) from the value chain functions they perform (*'what'*). Indeed, countries' participation in upstream and downstream industries (however disaggregated these may be to identify specific good or service categories) should be disentangled from the functions countries carried out in order to explore the impact of the GVC positioning on income inequality. This emphasis on value chain functions rather than industry products is consistent with an extensive literature on GVCs and development, which has documented that it is the value-adding activities (or functions) performed by countries along GVCs that mostly determine the degree of market competition they are subject to and the knowledge spillovers they can benefit from, and hence their value capture opportunities (Mudambi, 2008; Sturgeon, 2008; Sturgeon and Gereffi, 2009; Durand and Milberg, 2020; Stöllinger, 2021; Coveri and Zanfei, 2023c).

To disentangle "product-level positioning" from "functional positioning", we complement standard trade in GVC indicators based on input-output tables with granular data on inward FDI projects, which report direct information on the value chain functions they are aimed to perform. Using FDI data by function to build indicators on the involvement of countries in different value-adding activities along

[1] For example, the service sectors 'Scientific research and development' (code 72 in the NACE Rev. 2 classification) is typically considered an 'upstream' sector in analyses using the "upstreamness" indicator introduced by Antràs et al. (2012) – see, *inter alia*, Ito and Vézina (2016), Rungi and Del Prete (2018), Meng et al. (2020). Conversely, as shown by de Vries et al. (2021), 'Scientific research and development' is one of the most downstream sectors according to such an indicator, because most R&D spending is classified as an investment in R&D assets, and investment represents one component of final demand in input-output tables. This consideration can help explain the positive association between changes in the downstreamness indicator used by Reshef and Santoni (2023) and the labour share remunerating R&D functions. Another example provided by de Vries et al. (2021) concerns the 'Advertising and market research' service sector (code 73 in the NACE Rev. 2 classification), typically considered a 'downstream' industry in previously mentioned works, which is conversely shown to be one of the most upstream sectors according to measures based on input-output tables.

transnational supply chains is consistent with recent developments in the literature on the cross-country distribution of value in GVCs (Stöllinger, 2021; Coveri and Zanfei, 2023c). However, to the best of our knowledge, this kind of FDI-based measures of GVC involvement have never been leveraged to explore the impact of the functional positioning of economies on within-country income disparities.

FDIs in different GVC functions can be expected to have a differentiated impact on the domestic economic structure, resulting in heterogeneous effects on income inequality. In particular, inward FDIs in pre- and post-production stages at the upper ends of the value chain (e.g., research, design and development, as well as specialized logistics, marketing, and after-sales services) might allow domestic firms to take advantage of international technological spillovers, fostering skill and functional upgrading and dynamic returns to scale (Castellani and Zanfei, 2006; Saliola and Zanfei, 2009; Fu et al., 2011; Morris and Staritz, 2017). On the one hand, they may therefore promote the structural change of recipient economies, offering better-paid jobs in new and high-growth sectors. To the extent that technological upgrading associated with inward FDIs in knowledge-intensive functions is sufficiently widespread in host economies, productivity gains may also benefit the low-wage segments of the labour force, leading to a reduction in income inequality. On the other hand, a larger share of FDIs in these functions might exacerbate the skill- and task-biased character of production in GVCs, increasing the skill premium and rising disparities (Bogliaccini and Egan, 2017; Hale and Xu, 2016). It follows that the effects of inward FDIs in knowledge-intensive segments of the GVC will depend on the balancing of these opposite effects.

The reviewed literature leads us to formulate two research questions (RQs), which we aim to address through a systematic empirical analysis conducted on a large number of both high- and low-income countries:

RQ1: to what extent does product-level positioning, measured in terms of trade in GVCs, affect within-country inequality?
RQ2: to what extent does functional positioning, i.e. the involvement of economies in distinct value-adding activities, measured in terms of their ability to attract FDIs in specific GVC functions, affect within-country inequality?

In what follows we provide an empirical investigation on a large sample of both developed and developing economies to shed light on these different dimensions of country involvement in GVCs and how they are associated with income inequality.

3. Empirical strategy

Our empirical approach is based on panel methodologies, which allow us to explore the association between countries' GVC positioning and within-country inequality while controlling for the other main economic, technological, and institutional determinants of income disparities. In particular, we aim to disentangle the "product-level positioning" from the "functional positioning" of economies along GVCs by combining trade-related measures with FDI-based indicators.

Notably, by using data on FDIs by value-adding function we are also able to shed light on a key dimension of GVCs that can only partially be captured with trade data, i.e., the specific impact of multinational corporations (MNCs) in the international fragmentation of production and thus on income distribution. More precisely, by jointly considering both FDI- and trade-based modes of countries' participation in GVCs, our empirical analysis allows to distinguish the distributional impact of captive or hierarchical type of governance of GVCs (which largely rely on transnational investments by MNCs across different value-adding activities) from that resulting from firms' international outsourcing strategies (which greatly fuels trade in intermediate inputs within GVCs) (Gereffi et al., 2005).

Formally, we estimate the following regression equation:

$$Gini_{i,t} = \beta_0 + \beta_1\left(Trade\ in\ GVC_{i,t}\right) + \beta_2\left(FDI\ variables_{i,t}\right) + \beta_3 X_{i,t} + \gamma_i + \delta_t + \varepsilon_{i,t} \quad (1)$$

where $Gini_{i,t}$ is the Gini index for household market income and represents our measure of income inequality in country i at time t. We take the Gini index in logarithm terms to mitigate heteroskedasticity and increase the efficiency of the fixed effects estimator. $Trade\ in\ GVC_{i,t}$ includes different indices of GVC participation and positioning of economies based on input-output tables, while $FDI\ variables_{i,t}$ stands for the FDI-based indicators proxying the involvement and positioning of countries in GVCs from a functional perspective (namely by putting attention on the value chain activities performed by the receiving countries).

The term $X_{i,t}$ includes an array of country-year variables controlling for key determinants of income distribution identified in the literature and regarding mainly the economic, technological, and institutional characteristics of countries. The terms γ_i and δ_t stand for country and time fixed effects, accounting respectively for unobserved time-invariant country-specific characteristics (e.g., geographical location) and year-specific events that may have an impact on both dependent and explanatory variables. Finally, β_0 stands for the intercept and $\varepsilon_{i,t}$ is the error term.

Our dataset includes 101 countries over the period 2003–2015. Specifically, we selected all countries which received at least one FDI per year and that we can therefore observe over the whole period. This procedure gives us the possibility to work on a remarkably large and balanced panel dataset while avoiding losing much information, as countries that did not receive at least one FDI per year still suffer from missing data for most of the other variables included in our model. As for the time span of the empirical analysis, 2003 is the first year for which FDI data from the fDi Markets database are available, while 2015 is the last year for which data on the upstreamness indicator based on EORA Multi-Region Input-Output (MRIO) tables are available (Mancini et al., 2024). Furthermore, avoiding the inclusion of data beyond 2015 allows us to increase the reliability of the FDI data used (see Appendix A).

4. Data

This section details the data sources and metrics used to construct the trade in GVC and FDI-based variables, together with the other control variables included in our empirical analysis.

4.1. Gini index

In this work, we use the Gini index for household market income to measure income inequality within countries. This widely adopted indicator has two important advantages. First, it is a comprehensive measure of income inequality of economies, as its evolution accounts for changes in both the functional distribution of income (i.e., the share of income remunerating capital and labour) and wage inequality (i.e., the distribution of income across different segments of the labour force). Since previous theoretical contributions have shown that the GVC participation and positioning of economies can affect within-country income inequality by influencing both the functional and personal income distribution (see Section 2.1), we believe that this indicator is the most appropriate to provide an overall assessment of the distributional

consequences of the countries' GVC involvement. Although this indicator does not allow us to distinguish the distributional dimension that is most influenced by our focal regressors, the thorough analysis of the estimation results (reported in Section 5) will allow us to infer which of the mechanisms affecting income inequality is most likely to prevail.[2]

The second important advantage provided by the Gini index is that it is available for a wide range of both high- and low-income countries and covers a remarkably long time-span, making it the most suitable for our longitudinal analysis. Data are drawn from the Standardized World Income Inequality Database (SWIID), which aggregates a wide array of official data sources that provide clear welfare definition and a scale of equivalence for household income (Solt, 2020).

Notably, we choose to focus on the Gini index based on market income instead of disposable income to soften the impact of redistributive policies of countries, the latter representing confounding factors whose data are missing for several countries included in our dataset (thus being factors it is hard for us to control for). The Gini index ranges from 0 to 1, corresponding to perfect equality and inequality of income distribution, respectively.

Fig. 1 shows a world map of income inequality based on the average values of the Gini index over the period 2003–2015 for all countries included in our database. Darker shades are associated with higher ranges of the Gini index value (and vice versa). Above all, the figure allows to appreciate the broad cross-sectional coverage of the dataset, with countries for which no data are available concentrated in Africa and the Middle East (grey areas in the figure). The figure also shows the heterogeneity in income inequality experienced by countries, with no clear patterns emerging between high-, middle- and low-income economies.

4.2. Trade-based GVC variables: capturing "product-level positioning"

As already mentioned, the empirical literature on GVCs has largely exploited industry-based indicators based on international input-output tables, which allow to trace the direct and indirect amount of value added embodied in export flows (Hummels et al., 2001; Johnson and Noguera, 2012; Timmer et al., 2014; Giammetti et al., 2022). Accordingly, the main indicators of trade in GVC used in our analysis are represented by trade in value added (TiVA) variables, namely the GVC participation index and the GVC position index (Guilhoto et al., 2022).

In particular, the *GVC position index* represents one of the focal variables of our work. For the purpose of our analysis, we will use this index to capture the GVC positioning of countries at the "product-level". This indicator is aimed at measuring the relative magnitude of forward and backward GVC linkages of countries, assuming higher values the more upstream countries are along global production lines. Backward linkages are equal to the foreign value added embodied in each country's exports ($FVA_{i,t}$), so that the higher this magnitude is, the more downstream a country is along global production lines. Forward linkages are computed as the amount of domestic value added embodied in each country's exports which is further re-exported by importing countries ($DVX_{i,t}$), meaning that the greater this magnitude is, the more upstream a country is along global production lines. This indicator was first proposed by Koopman et al. (2010) and is computed as follows:

$$GVC\ position\ index_{i,t} = \ln\left(1+\frac{DVX_{i,t}}{EXP_{i,t}}\right) - ln\left(1+\frac{FVA_{i,t}}{EXP_{i,t}}\right) \quad (2)$$

where $EXP_{i,t}$ is the total value added embodied in domestic gross exports. It follows that this indicator takes on greater values the higher the forward linkages (DVX) and/or the lower the backward linkages (FVA).

Since the GVC position index measures the relative magnitude of backward and forward linkages, it could assume similar values for countries showing very different levels of involvement in global production networks. Accordingly, when introducing in our model the GVC position index, we also control for the overall participation of countries in GVCs by including the *GVC participation index*. This indicator accounts for both the backward and forward GVC linkages of economies and is given by the sum of these two factors over the total value added embodied in domestic gross exports ($EXP_{i,t}$). Formally, for country i at time t this indicator is computed as follows:

$$GVC\ participation\ index_{i,t} = \frac{DVX_{i,t} + FVA_{i,t}}{EXP_{i,t}} \quad (3)$$

Data on these indicators are drawn from the UNCTAD-Eora GVC Database (Casella et al., 2019), since it allows us to include in our investigation the largest number of countries at global level.

As a robustness check, we also adopt a second type of trade in GVC indicators based on a measure of countries' distance from final demand, i.e., the *upstreamness* indicator. This indicator was developed by Fally (2012), Antràs et al. (2012), and Antràs and Chor (2013, 2019) and captures the average number of production steps the output of a country goes through before reaching final demand, thus allowing to measure the distance to final consumption for a country along GVCs. It is also worth noting that this distance-orientated indicator reports the absolute value of the (average) number of production steps "separating" a country's or industry's output from the final end of sequential global chains of production. It follows that an increase in the value of this indicator can be both due to a changing GVC positioning (e.g., a country's upgrading pattern) or GVCs' overall lengthening (Antràs and Chor, 2019). To achieve consistency with TiVA variables, we compute the upstreamness indicator at the country level by relying on EORA's MRIO data included in the dataset recently compiled by Mancini et al. (2024).[3]

As already stressed in Section 2.1, all these trade in GVC variables are not intended to capture the value chain functions performed by economies (Timmer et al., 2019; de Vries et al., 2021). Hence, we combine these indicators with variables based on FDI data to proxy the functional profile of countries along GVCs.

4.3. FDI-based GVC variables: capturing "functional positioning"

We draw data on FDI flows from the fDi Markets database, an online

[2] As known, the Gini index gives more weight to changes occurring in the middle part of the income distribution, while it is less sensitive to changes in the tails (the latter being better captured by percentile ratios). Empirically exploring how the GVC participation and positioning of economies may influence different dimensions of income inequality is beyond the scope of this paper and is left for future research.

[3] We also tested the robustness of our results by using the *downstreamness* indicator, namely a trade in GVC variable measuring countries' distance from primary production inputs. This indicator was originally proposed by Fally (2012) and captures the distance of a given country from the primary inputs (e.g., raw materials), meaning that a country is relatively more downstream along GVCs if its production embodies a larger value of intermediate inputs compared to value added from primary factors of production. It follows that, taken together, the upstreamness and downstreamness indicators measure the average production length of GVCs a country or industry is involved in. However, a couple of warnings must be raised about these indicators. While being among the most famous measures of positioning of economies along GVCs, a somewhat puzzling correlation – close to +1 – exists between the value of upstreamness and downstreamness of several countries (Antràs and Chor, 2019). According to a recent work by Bartolucci et al. (2023, p. 8), this is "simply due to structural and unavoidable algebraic constraints that I-O tables and their surrogates must satisfy". Moreover, at industry level, the ranking of sectors according to upstreamness is not the mirror image of the ranking according to downstreamness, which suggests an inconsistency in measurement (Wang et al., 2017). Therefore, we consider upstreamness and downstreamness indicators more cautiously than variables on trade in GVC based on TiVA statistics.

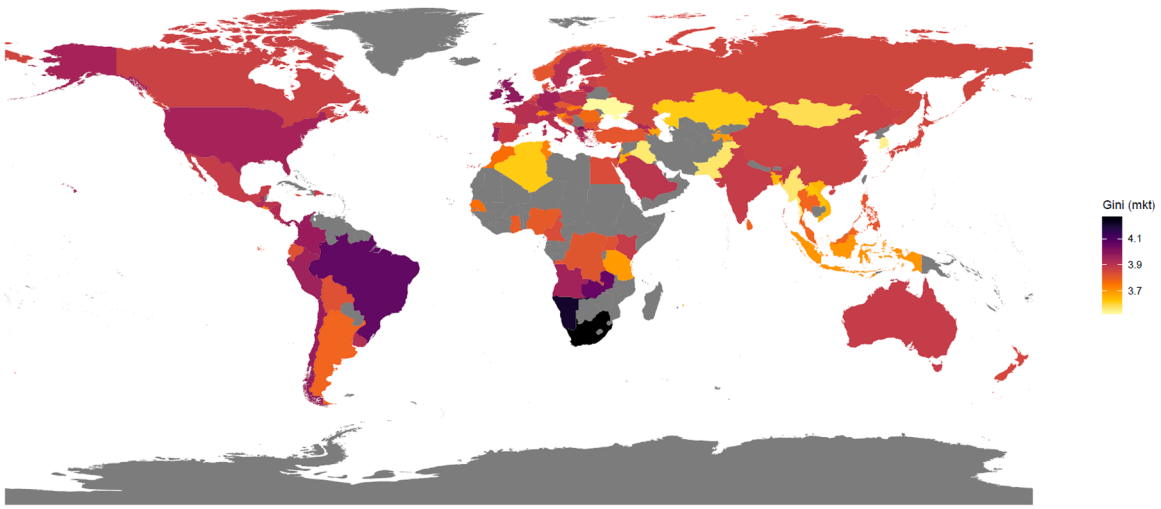

Fig. 1. World map of the Gini index, average values (2003–2015).
Source: authors' elaboration. Note: darker (lighter) shades are associated with higher (lower) values of the Gini index (expressed in log terms); grey areas indicate countries for which data are not available.

database maintained by fDi Intelligence – a specialist division of Financial Times Ltd –, collecting detailed information on announced cross-border greenfield investments and covering all countries and industries worldwide from 2003 onwards (see Appendix A for further details).

Most notably, fDi Markets provides information on the value-adding activity each FDI project is aimed to perform, i.e., the value chain function – from headquarters activities, R&D, design and testing to fabrication and assembly operations, up to logistics, branding, and sale services – needed to bring an industry product to market and beyond (as functions also include after-sales services).

Leveraging this key information, we first group inward FDI projects by adopting the canonical three-stage classification of GVC activities: pre-production functions (e.g., headquarter services, knowledge-intensive tasks as R&D, design and training), production functions (e.g., fabrication and assembly) and post-production functions (e.g., logistics, marketing and post-sales services) (Mudambi, 2008; Baldwin and Evenett, 2015; Stöllinger, 2021; Coveri and Zanfei, 2023c). Then, we calculate the share of inward FDIs related to each GVC stage over the total number of FDIs received by each country i at time t.

It is worth noting that we compute our FDI-based indicators by relying on the number of FDIs instead of the monetary amount of capital invested. This is because the capital investment of FDI projects reported by fDi Markets is almost exclusively based on estimated values and the criteria for value estimation are not explicitly stated by the data provider. Information on the capital investment is therefore less reliable than the frequency of FDIs, reason why a large number of empirical works based on fDi Markets data have used the frequency of FDI projects rather than data on capital investment (Ramasamy et al., 2012; Castellani et al., 2013; Castellani and Pieri, 2013; 2016; Crescenzi et al., 2014; 2016; Ascani et al., 2016a, 2016b; Castellani et al., 2016; Aiyar et al., 2024). Accordingly, we prefer to focus on the number of investments for conducting our empirical analysis.[4]

Table 1 reports the correlation matrix of our trade in GVC and FDI-based variables over the whole period of investigation (2003–2015). Besides allowing us to exclude multicollinearity problems among our key regressors, the matrix shows that FDI-based indicators on the functional positioning of countries report a very low correlation with variables on the GVC positioning of countries based on input-output tables. For example, the GVC position index (assuming higher values the more upstream countries are along global production lines) is negatively correlated especially with the share of FDI in pre-production functions, suggesting that the two kinds of indicators capture different dimension of GVC positioning.

Table 2 provides the average values for our main variables of interest by grouping countries according to their income level based on the World Bank Analytical Classifications.[5] The first row shows that the Gini index for market income was on average larger in high- and upper middle-income countries compared to lower middle- and low-income countries over the period. Rows 2–4 highlight that, as expected, both the shares of inward FDIs in pre- and post-production functions were greater in high- and upper middle-income countries compared to poorer economies, while the opposite emerges with respect to the share of FDI in production operations. High-income countries are also the most involved in GVCs according to the GVC participation index, followed at a distance by upper middle-income and then lower-income countries (row 5).

Most notably, row 6 shows that high-income countries are located more "downstream" in GVCs according to the GVC position index, while a more "upstream" position is prerogative of lower-income countries. Consistently, the richest economies are the only ones reporting a negative value of the GVC position index. These correlations reflect the prominent role of lower-income countries as suppliers of raw materials and intermediate goods in GVCs, while high-income countries resort to a greater extent to production offshoring. Once again, this highlights a key difference with respect to functional positioning indicators based on inward FDIs, which see high-income countries dominating the most intangible-intensive pre- and post-production activities. Finally, row 7 shows that high- and low-income countries report greater values of the upstreamness indicator, although overall the differences across country groups are rather small.

[4] Notably, Crescenzi et al. (2016, p. 651) also highlighted that the number of investment decisions in a given geographical destination is often a more appropriate unit of analysis than project value, insofar as it has been shown that such decisions are broadly independent of the amount of capital invested (Amighini et al., 2014; Sutherland and Anderson, 2014). See Appendix A for further details on the relative importance of FDI inflows and stocks to countries' GFCF and GDP, respectively.

[5] See https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

Table 1
Correlation matrix of the trade in GVC and FDI-based variables.

	FDI pre-prod. sh.	FDI prod. sh.	FDI post-prod. sh.	GVC part.	GVC posit.	Upstreamness
FDI pre-prod. sh.	1					
FDI prod. sh.	−0.352***	1				
FDI post-prod. sh.	−0.101***	−0.896***	1			
GVC Part.	0.168***	−0.092***	0.018	1		
GVC Posit.	−0.263***	0.212***	−0.100***	−0.327***	1	
Upstreamness	0.041	0.037	−0.058*	0.355***	−0.051	1

Source: authors' elaboration.

Table 2
Descriptive statistics by country group, average values (2003–2015).

		High-income countries (H)	*Upper middle-income countries (UM)*	*Lower middle-income countries (LM)*	*Low-income countries (L)*
(1)	Gini index	47.320	48.092	45.212	42.977
(2)	FDI pre-prod. sh.	0.154	0.092	0.084	0.089
(3)	FDI prod. sh.	0.199	0.319	0.386	0.441
(4)	FDI post-prod. sh.	0.647	0.589	0.531	0.470
(5)	GVC participation	64.6	53.6	47.3	48.3
(6)	GVC position	−0.049	0.019	0.096	0.165
(7)	Upstreamness	2.1	1.94	1.94	1.99

Source: authors' elaboration.

4.4. Control variables

Building the dataset, we aimed at achieving the widest possible countries' coverage (including as many low and lower-middle countries as possible). Accordingly, the selection of variables controlling for other time-varying features of economies is constrained by the availability of data for the large array of countries included in our investigation. Nonetheless, our empirical analysis accounts for several key characteristics of countries which affect their distributional patterns.

First of all, we control for the GDP per capita in constant 2017 international PPP dollars, both in linear and squared terms. This is in line with the seminal contribution by Kuznets (1955), who suggested that the evolution of within-country income inequality shows an inverted U-shaped relationship with the level of economic development of countries.

Moreover, technological change represents a well-known driver of income disparities, especially because of the positive impact it may exert on wage inequality in advanced countries (Autor et al., 1999; Card and DiNardo, 2002; Acemoglu and Autor, 2011). Controlling for the technological progress of economies is especially important in our analysis in order to disentangle the specific impact of countries' involvement in GVCs from the effects that technology may have on wage income polarization (Goos et al., 2014). In fact, phenomena of skill- and routine-biased technological change can resemble the distributional effects predicted by the literature on production offshoring, therefore representing a confounding factor in our empirical estimates (Acemoglu and Autor, 2011; Jaumotte et al., 2013; Reijnders and de Vries, 2018). Unfortunately, data on the different aspects of technological change are not available for a large subset of (low-income) countries included in our sample. Nonetheless, all our model specifications include two variables aimed at capturing the role played by technological progress. First, we control for the number of mobile-cellular subscriptions per 100 inhabitants, which is an ICT indicator available for a wide range of countries at global level (Paglialunga et al., 2022).[6] Second, we control for the share of gross fixed capital formation (GFCF) over GDP, which provides a measure of the pace of (both tangible and intangible) capital accumulation of economies, thus representing a further proxy for technological (especially process) innovation (Stockhammer, 2017). In addition, we follow Hartmann et al. (2017) by also accounting for the number of years of compulsory education. This variable represents a proxy (albeit rough) of the overall level of skills the workforce is equipped with, allowing us to further control for potential skill-biased effects on wage income dispersion due to technological change and international fragmentation of production (De Gregorio and Lee, 2002; Bergh and Fink, 2008; Van Reenen, 2011).

Furthermore, two variables on the level of integration of countries in the global economy are included in our model specification, namely the trade openness of economies and their level of financial globalization. Trade openness is computed as the ratio of the sum of total exports and total imports to the countries' GDP and allows us to detect the distinctive impact of trade in GVC from the effect on income inequality due to the overall involvement of economies in international trade flows (Constantinescu et al., 2019). The financial globalization of economies is measured by the KOF Financial Globalisation Index (*de facto*), which allows us to distinguish the impact of the financial globalization (largely driven by short-term capital flows) on income inequality (Claessens and Perotti, 2007; Furceri and Ostry, 2019) from the distributional consequences of GVC-related forms of countries' participation in the global economy, namely by trade in GVC and FDI flows.

Finally, given that middle- and low-income countries represent a substantial subsample of the high number of economies included in our dataset, we control for the percentage share of rural population with access to electricity. This control variable is aimed at capturing the access to basic services for rural population, which can have a potentially strong scope for alleviating income disparities especially in developing countries (Castañeda et al., 2018; Sarkodie and Adams, 2020).

Data on all these variables are drawn from the World Bank's World Development Indicators (WDI) database, except for the KOF Financial Globalisation Index, whose data are retrieved from the KOF Swiss Economic Institute database of ETH Zurich (Dreher, 2006; Gygli et al., 2019).

Table 3 shows the summary statistics of all variables included in our empirical analysis.

5. Results and interpretation

5.1. Baseline model

5.1.1. Fixed effects estimates

We start by estimating a model where the Gini index is regressed against the linear and squared GDP per capita, the full set of control

[6] Data are drawn from the World Bank and sourced from the World Telecommunication/ICT Indicators Database of the International Telecommunication Union.

Table 3
Summary statistics.

	N	Mean	Std. Dev.	min	max
Dependent variable					
ln(Gini for market income)	1329	3.831	0.132	3.484	4.281
Key regressors					
FDI-based GVC variables ("functional positioning")					
FDI share in pre-production functions	1391	0.11	0.098	0	0.667
FDI share in production functions	1391	0.316	0.223	0	1
FDI share in post-production functions	1391	0.574	0.209	0	1
Trade-based GVC variables ("product-level positioning")					
GVC participation index	1391	0.545	0.143	0.246	0.942
GVC position index	1391	0.034	0.161	−0.392	0.485
Upstreamness	1391	2.019	0.36	1.381	4.117
Control variables					
ln(GDP per capita)	1378	9.582	1.023	6.597	11.656
ln(total inward FDI)	1391	3.604	1.496	0	7.458
Compulsory education (years)	1337	9.618	2.23	4	16
Mobile cellular subs. per capita	1391	0.872	0.434	0.001	2.394
GFCF (over GDP)	1338	0.234	0.057	0.054	0.577
Trade openness	1366	0.91	0.609	0.119	4.426
Access to electricity (share of rural pop.)	1391	0.819	0.298	0	1
KOF Financial Globalisation Index	1391	0.645	0.185	0.149	0.998

Source: authors' elaboration.

variables, the GVC participation and position indices and our FDI-based variables introduced step by step. The estimate results are shown in Table 4.

First of all, the signs of the linear and squared GDP per capita suggest an inverted-U shape relationship between economic development and inequality, providing a confirmation of the Kuznets curve. The first term is positive while the second is negative across all specifications of the model, and both are statistically significant, meaning that increasing per capita income is associated first with an increase and then a reduction in inequality. As for the control variables, the years of compulsory education and the mobile cellular subscriptions per capita show always negative and significant coefficients, resulting therefore associated with lower income inequality within countries, while the coefficient of GFCF is not significant in these model specifications. Conversely, trade openness shows always positive and significant coefficients, resulting thus adversely associated with inequality. As expected, the share of population with access to electricity is negative and statistically significant across all specifications, while the index of *de facto* financial globalization and total incoming FDIs always report positive but not significant coefficients.

As for the trade in GVC variables, the GVC participation and the GVC position index do not result identified in these specifications of the model.[7] This might be due to the differential effects they exert across high- and low-income economies, as predicted by Heckscher-Ohlin-like models reviewed in Section 2.1. We will explore this perspective further in Section 5.2.

The most interesting results come from the coefficients of the FDI-based variables aimed at proxying the functional dimension of the GVC positioning of countries. By introducing one by one the share of inward FDIs in pre-production, production, and post-production functions, we find that both the former and the latter show negative coefficients (although only the one related to pre-production functions is significant), while the coefficient of the share of FDIs in production functions is positive and statistically significant (columns 1–3). These findings are strengthened by results reported in column 4, showing that – using the FDI share in production operations as baseline – FDI shares in both pre- and post-production functions have negative and significant coefficients, with the former being greater in magnitude.

Overall, these findings suggest that larger shares of FDIs in intangible-intensive activities (especially pre-production functions like R&D) are associated with lower inequality. In other terms, being

Table 4
Fixed effects model with trade in GVC and FDI variables.

	(1) FE	(2) FE	(3) FE	(4) FE
ln(GDP per capita)	0.487***	0.496***	0.483***	0.503***
	(0.141)	(0.141)	(0.140)	(0.141)
ln(GDP per capita)^2	−0.027***	−0.028***	−0.027***	−0.028***
	(0.007)	(0.007)	(0.007)	(0.007)
Compulsory education duration (years)	−0.007***	−0.007***	−0.007***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Mobile cellular subs. per capita	−0.032***	−0.032***	−0.032***	−0.032***
	(0.012)	(0.012)	(0.012)	(0.012)
GFCF (over GDP)	−0.052	−0.048	−0.049	−0.049
	(0.034)	(0.034)	(0.034)	(0.034)
Trade openness	0.021*	0.020*	0.020*	0.021*
	(0.011)	(0.011)	(0.011)	(0.011)
Access to electricity (share of rural pop.)	−0.133***	−0.131***	−0.132***	−0.132***
	(0.039)	(0.038)	(0.038)	(0.038)
KOF Financial Globalisation Index	0.042	0.045	0.046	0.043
	(0.030)	(0.029)	(0.030)	(0.030)
ln(total inward FDI)	0.004	0.004	0.004	0.004
	(0.002)	(0.002)	(0.002)	(0.002)
GVC participation index	0.053	0.050	0.054	0.049
	(0.093)	(0.093)	(0.093)	(0.093)
Trade-based GVC variables ("product-level positioning")				
GVC position index	0.070	0.074	0.075	0.071
	(0.068)	(0.067)	(0.067)	(0.067)
FDI-based GVC variables ("functional positioning")				
FDI share in pre-production functions	−0.013*			−0.021**
	(0.007)			(0.008)
FDI share in production functions		0.011**		
		(0.005)		
FDI share in post-production functions			−0.006	−0.010**
			(0.004)	(0.005)
Constant	1.784**	1.728**	1.800**	1.712**
	(0.697)	(0.697)	(0.695)	(0.697)
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	1248	1248	1248	1248
R-squared	0.332	0.334	0.332	0.335
Number of countries	101	101	101	101

Note: the dependent variable is the natural log of the Gini index for market income. Robust standard errors clustered at country level in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

[7] Estimates including the upstreamness indicator are reported by Table B.1 in Appendix B. The coefficient of this indicator is positive and statistically significant in all model specifications, suggesting that a more pronounced positioning of economies at the upstream end of global production lines is associated with greater income inequality. This finding is at least partially in line with those by Reshef and Santoni (2023), who find that increases in the upstreamness of industries are associated with reductions of the wage share. We also tested the joint inclusion of upstreamness and downstreamness indicators and, while only the upstreamness index remains statistically significand, all other findings are completely unchanged (results are available upon request).

"upstream" and, to a lower extent, "downstream" *in terms of value-adding functions* goes together with lower income disparities. Although further research is needed to explore the mechanisms underlying these findings, they appear to be in line with several contributions that have emphasized the key role played by intangibles in fostering value capture opportunities in GVCs (Mudambi, 2008; Durand and Milberg, 2020; Stöllinger, 2021; Coveri and Zanfei, 2023c). An increased functional positioning in the most knowledge-intensive stages of the value chain may indeed stimulate the upgrading of productive structures and promote technological spillovers, spurring growth and the expansion of better-paid jobs.

5.1.2. Robustness check: two-stage system GMM estimator

A potential bias in our estimates may be due to the violation of the strict exogeneity assumption, since inequality is a persistent phenomenon, and the level of the Gini index may be correlated over time. Moreover, the explanatory variable may be correlated with the error term if a shock affects both inequality and the participation in GVCs of a given country *i*, e.g., an agreement is signed between country A and country B such that MNCs in the latter have now an incentive to move part of their production in the former. The participation and positioning of countries along GVCs and the number of inward FDIs might also be affected by the distributional patterns of economies. For example, MNCs searching for low-cost labour and cheaper production inputs are affected by differences in capital and labour remuneration across countries, with the latter being a crucial determinant of within-country income inequality. This can induce reverse causality between our dependent variable and our key regressors, giving rise to endogeneity concerns.

To get rid of this potential source of endogeneity and account for the autocorrelation of the Gini index, we provide a robustness check of our baseline model using the dynamic panel estimator introduced by Arellano and Bover (1995) and Blundell and Bond (1998), namely the Two-Step System Generalized Method of Moments (GMM). We take a precautionary approach and treat all our key regressors (i.e., trade in GVC and FDI-based variables) and all our control variables – except for the years of compulsory education, share of rural population with electricity access and the KOF financial globalization index – as endogenous covariates.[8]

Table 5 reports our empirical findings when using this estimator. First, the strong persistency over time of the Gini index is highlighted by the positive and strongly significant coefficient of its first lag, whose magnitude always results very close to one. Moreover, the coefficient of total inward FDIs turns out to be positive and significant across all specification, confirming the expected adverse effect of cross-border investments on income disparities (Lipsey, 2002; Taylor and Driffield, 2005).

As for trade in GVC variables, the GVC participation index shows a positive and significant coefficient in all specifications, meaning that it exerts a worsening impact on income inequality. This in line with models suggesting that a higher GVC involvement provides firms with the fall-back option of outsourcing production abroad when engaged in wage negotiations, exerting downward pressure on wages, and reducing the labour share (Rodrik, 1997; Jeon and Kwon, 2018). As in the fixed effects estimations, the impact of the GVC position index is not identified, though (columns 2 and 5).[9]

Table 5
Two-step System GMM with trade in GVC and FDI variables.

	(1) GMM	(2) GMM	(3) GMM	(4) GMM	(5) GMM
L.ln(Gini for market income)	0.991***	1.004***	0.939***	0.999***	0.994***
	(0.025)	(0.029)	(0.063)	(0.022)	(0.023)
ln(total inward FDI)	0.002**	0.002**	0.004*	0.003***	0.003***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
GVC participation index	0.050*	0.047*		0.045*	0.043**
	(0.026)	(0.028)		(0.025)	(0.018)
Trade-based GVC variables ("product-level positioning")					
GVC position index		0.005			0.001
		(0.038)			(0.028)
FDI-based GVC variables ("functional positioning")					
FDI sh. in pre-prod. functions			−0.007*	−0.007*	−0.008*
			(0.004)	(0.004)	(0.004)
FDI sh. in post-prod. functions			−0.003	−0.000	−0.000
			(0.003)	(0.002)	(0.002)
Year dummies	YES	YES	YES	YES	YES
Observations	1154	1154	1154	1154	1154
Number of countries	101	101	101	101	101
Number of instruments	55	51	33	65	70
AR(1) p-value	0.00396	0.00437	0.00954	0.00350	0.00350
AR(2) p-value	0.210	0.212	0.188	0.183	0.175
Hansen p-value	0.162	0.103	0.323	0.104	0.102

Note: Two-step System GMM estimator with finite sample correction (Windmeijer, 2005). The dependent variable is the natural log of the Gini index for market income. Controls included but not reported: constant, GDP per capita, GDP per capita squared, no. of years of compulsory education, mobile cellular subscriptions per capita, GFCF (over GDP), trade openness, access to electricity (share of rural pop.), KOF Financial Globalisation Index (*de facto*). All explanatory variables, except years of compulsory education, the share of rural population with electricity access and the KOF financial globalization index, are treated as endogenous. AR(#) tests on the serial correlation of residuals. Hansen tests of overidentification of restrictions. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Finally, and most notably, in columns 3 to 5 the shares of FDIs in pre- and post-production functions are introduced simultaneously to test whether a larger attraction of cross-border investments in the most intangible-intensive functions of the value chain has a beneficial effect on income distribution. We find that the coefficient of the FDI share in pre-production activities always reports a negative and significant coefficient, consistently with our fixed effects estimates. As expected, also the share of inward FDIs in post-production functions always show a negative coefficient, although it is now not significant.[10] These findings

[8] The three control variables treated as exogenous refer to purely institutional aspects (i.e., compulsory years of education), long-term structural characteristics of countries (i.e., share of rural population with electricity access) and the overall level of financial globalization of economies. Unlike other endogenous regressors, we are not aware of strong theoretical reasons why these variables should be considered endogenous with respect to within-country inequality. Most notably, considering the relatively large number of controls included in our model, treating them all as endogenous can give rise to the well-known problem of over-proliferation of instruments, resulting in biased GMM coefficients and weakening the power of over-identification tests (Roodman, 2009).

[9] GMM estimates in which the GVC participation and position indices are replaced by the upstreamness indicator are reported by Table B.2 in Appendix B. While the negative impact of larger FDI-shares in pre-production functions is confirmed, the results show that we are not able to identify any effect of upstreamness on inequality, whose coefficients turn out not significant. Furthermore, the Hansen's test for model specifications in columns from 1 to 3 signals that the internal instruments generated are not strong enough to over-identify the model.

[10] When accounting for the lagged dependent variable, the coefficient of the generic explanatory variable x only depends on the variation in x that is not included in the lagged dependent variable. Hence, in case of high persistence, a relatively large amount of variation is explained by the lagged dependent variable rather than by the other explanatory variables (i.e., if the coefficient of the lagged dependent variable is close to 1, part of the variability of x is incorporated in the lagged variable).

further suggest that a higher involvement of economies in the most knowledge-intensive activities, with special reference to pre-production functions like R&D, fosters technological upgrading and greater capture of the rents generated along GVCs, with beneficial effects also on lower labour force segments.

5.2. Exploring heterogeneity in the GVC-inequality nexus across country groups

To further investigate the association between the GVC positioning of economies and income distribution, we test whether our key regressors – namely the trade-based GVC position index and our FDI-based variables on functional positioning – show a heterogenous association with income inequality depending on the level of economic development of countries (i.e., high- vs. middle- and low-income). This is accomplished by introducing a variable which measures the GVC positioning of countries reporting a given level of economic development (e.g., high-income countries), and that is zero otherwise.[11] We follow this procedure for all our key regressors and report the results in Table 6. Several findings emerge from this empirical exercise.

As for the product-level positioning of economies, the coefficient of the GVC position index is statistically significant in all model specifications and for both country groups, but its sign is heterogenous depending on the level of economic development of the countries: while it is negative for high-income countries, it is negative for middle- and low-income countries.

It is worth reminding that greater values of the GVC position index may be driven by both higher forward linkages and/or lower backward linkages. In the case of developed economies, higher values of the GVC position are mostly driven by lower backward linkages, hence, the negative coefficient of this indicator for the high-income group suggests that a lower level of backward linkages (higher level of GVC positioning) is associated with lower values of the Gini index. Our results therefore show that a more (less) 'downstream' position along global production lines is associated with higher (lower) income inequality in high-income countries. In other terms, this finding suggests that production offshoring has mostly worsened income distribution in developed economies, arguably by displacing manufacturing jobs and lowering workers' bargaining power. A lower GVC position is indeed associated with a relatively greater backward participation, which is typically the result of international outsourcing strategies putting downward pressure on labour income.

Conversely, a more "upstream" position along global production line is associated with higher inequality in middle- and low-income economies, which largely act as suppliers in global production networks. Notably, the fiercer competition among sellers of intermediate inputs located across developing economies, as well as the remarkable concentration of profits in upstream industries providing raw commodities and energy materials, represent two factors which could explain this result (Parcero and Papyrakis, 2016; Durand and Milberg, 2020; Savoia and Sen, 2021).

As for the FDI-based variables proxying the functional positioning of economies, their coefficients exhibit the same sign and are always statistically significant for middle- and low-income countries. However, we are not able to identify the coefficients of the FDI-based variables for the high-income countries, that turn out always not significant. We suggest that this result may be driven by the structural characteristics of economies and especially by the different role played by cross-border capital investments for high- and lower-income countries. In fact, incoming FDI flows often represent the main injections of fixed capital in lower-income economies, especially in pre- and post-production functions. Furthermore, the technology and productivity gap between MNCs' foreign subsidiaries and domestic firms is arguably larger in middle- and low-income countries than in high-income ones. It follows that the overall economic and distributional impact of FDI inflows is likely to be larger in poorer economies, making it more easily identifiable. Conversely, inward FDIs represent a capital injection of lesser importance in developed countries, both in quantitative and qualitative terms (although there is much heterogeneity even among advanced economies). As a result, the distributional effect of cross-border capital flows may be more nuanced and difficult to identify due to the many confounding factors which characterize complex economies such as high-income ones.

Overall, the findings reported by Table 6 shows that a greater involvement of countries in the most intangible-intensive activities, i.e., pre- and post-production functions, is associated with lower income inequality, and that this result appears to be driven by middle- and low-income countries. On the one side, this means that – at least in these countries – the impact of FDIs in value-adding functions at the upper ends of the value chain lowers income disparities. Therefore, our results suggest that the greater value appropriation and subsequent generation of new and better-paid jobs in lower-income countries tends to outweigh the inequality-enhancing factors that could be associated with this functional positioning, such as skill-biased technological change and increased monopoly rents captured by actors controlling intangible-assets. On the other side, these results highlight that the trade-based GVC position index and the FDI-based variables tell a different story, confirming that is worth distinguishing the product-level positioning from the functional positioning of the economies along GVCs. In fact, while the trade-based indicator of GVC position shows that a more 'upstream' positioning of middle- and low-income countries is associated with higher income inequality, the coefficients concerning the FDI-based indicators highlight that being more 'upstream' (and 'downstream') from a functional perspective is associated with lower income disparities.

Our results thus support our line of argument, namely that these distinct measures of GVC positioning do capture different mechanisms concerning the GVC-inequality nexus. On the one hand, a more 'upstream' position along global production lines for middle- and low-income countries is associated with adverse distributional consequences especially because of the increasingly fierce global competition among suppliers of raw commodities and manufactured goods. This contributes to slow down the wage growth rate in these economies, while allowing profits from export earnings to be concentrated in the hands of a few leading companies. The described mechanism is also consistent with the positive and significant relationship between the share of FDIs in production functions and income inequality for middle- and low-income countries. On the other hand, higher shares of FDI inflows in pre- and post-production activities denote a greater involvement of economies in the most intangible-intensive segments of the value chain. In line with some of the contributions recalled in Section 2, countries playing an active role in these GVC segments capture larger portions of the value generated along GVCs and are likely to be more exposed to knowledge spillovers and technological upgrading opportunities (Durand and Milberg, 2020; Coveri and Zanfei, 2023c). This may translate into higher growth prospects and the expansion of better-paid jobs, especially in developing economies, with beneficial effects on income distribution.

6. Conclusions

This work provided a comprehensive empirical assessment of the GVC-inequality nexus by exploring how different dimensions of the GVC

[11] We cluster countries based on the income group they belong to according to the World Bank classification. Specifically, we assign countries to the income group they belonged to in the first year (i.e., 2003) of the period over which we perform our empirical analysis (i.e., 2003–2015). This strategy is used to avoid losing observations due to countries shifting from one income group to another over the period. In other terms, this allows us to fully preserve the longitudinal structure of our dataset.

Table 6
Fixed effects model with trade in GVC and FDI variables distinguished by country groups.

	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE	(7) FE
ln(GDP per capita)	0.506***	0.468***	0.500***	0.490***	0.509***	0.557***	0.566***
	(0.144)	(0.137)	(0.141)	(0.140)	(0.141)	(0.146)	(0.146)
ln(GDP per capita)^2	−0.028***	−0.026***	−0.027***	−0.027***	−0.028***	−0.030***	−0.031***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Compulsory education duration (years)	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Mobile cellular subs. per capita	−0.036***	−0.034***	−0.031***	−0.032***	−0.031***	−0.032***	−0.032***
	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)
GFCF (over GDP)	−0.042	−0.058*	−0.055*	−0.056*	−0.056*	−0.040	−0.041
	(0.035)	(0.032)	(0.033)	(0.033)	(0.033)	(0.035)	(0.035)
Trade openness	0.018*	0.018*	0.017	0.017	0.017	0.016	0.016
	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
Access to electricity (share of rural pop.)	−0.131***	−0.134***	−0.131***	−0.132***	−0.132***	−0.128***	−0.128***
	(0.038)	(0.039)	(0.038)	(0.039)	(0.038)	(0.037)	(0.037)
KOF Financial Globalisation Index	0.046*	0.038	0.041	0.042	0.039	0.046*	0.045*
	(0.027)	(0.033)	(0.032)	(0.032)	(0.032)	(0.026)	(0.027)
ln(total inward FDI)	0.003	0.004	0.004	0.004	0.004	0.003	0.003
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
GVC participation index	0.066	0.014	0.015	0.017	0.016	0.072	0.072
	(0.091)	(0.077)	(0.077)	(0.077)	(0.077)	(0.092)	(0.092)
Trade-based GVC variables ("product-level positioning")							
GVC posit. in high-income countries	−0.369***					−0.390***	−0.389***
	(0.133)					(0.141)	(0.141)
GVC posit. in low-income countries	0.164**					0.165**	0.165**
	(0.073)					(0.072)	(0.072)
FDI-based GVC variables ("functional positioning")							
FDI share in pre-prod. in high-income		−0.010			0.004		0.019
		(0.023)			(0.034)		(0.035)
FDI share in pre-prod. in low-income		−0.015**			−0.024***		−0.017**
		(0.007)			(0.009)		(0.008)
FDI share in prod. in high-income			−0.017			−0.035	
			(0.029)			(0.026)	
FDI share in prod. in low-income			0.013***			0.012**	
			(0.005)			(0.005)	
FDI share in post-prod. in high-income				0.019	0.019		0.037
				(0.022)	(0.029)		(0.026)
FDI share in post-prod. in low-income				−0.008*	−0.012**		−0.011**
				(0.004)	(0.005)		(0.005)
Constant	1.655**	1.894***	1.719**	1.775**	1.681**	1.384*	1.344*
	(0.710)	(0.671)	(0.688)	(0.682)	(0.690)	(0.718)	(0.718)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Observations	1248	1248	1248	1248	1248	1248	1248
R-squared	0.366	0.329	0.333	0.331	0.334	0.374	0.375
Number of countries	101	101	101	101	101	101	101

Note: the dependent variable is the natural log of the Gini index for market income. "High-income" and "low-income" stands for high-income and low-income countries, respectively. Low-income countries include upper middle-, lower middle- and low-income countries according to the World Bank classification. Robust standard errors clustered at country level in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

participation and positioning of countries are associated with income disparities within countries. To this aim, we combined indicators of trade in GVC, measuring the "product-level positioning" of countries along global production lines (i.e., their involvement in more upstream and downstream industries) with inward FDI-based variables proxying their "functional positioning" (i.e., the involvement of economies in different value-adding activities such as headquarter and R&D activities, production operations, and marketing, sales, and after-sales services).

Using trade-based indicators of "product-level positioning", we have shown that a higher involvement in more upstream industries is associated with higher inequality in the case of low- and middle-income countries. We have argued that this result is consistent with the relatively larger involvement of these countries in primary industries supplying energy and raw materials, typically characterised by a remarkable income polarisation (Parcero and Papyrakis, 2016; Savoia and Sen, 2021). We have also found that a more downstream product-level positioning goes together with greater inequality in high-income countries, reflecting their massive outsourcing of inputs and subsequent downward pressures on labour income (Milberg and Winkler, 2013).

When using FDI-based indicators of "functional positioning", we find that greater involvement of economies in pre- and post-production stages is associated with lower income disparities, while a larger engagement in production operations goes together with higher inequality. This result is driven by middle- and low-income countries, suggesting that a greater involvement in knowledge-intensive GVC activities represents a key driver of technological upgrading in these economies, with beneficial effects also on the lower segments of the labour force.

Disentangling the mechanisms underlying the observed links between functional positioning and inequality goes beyond the scope of this paper. Nonetheless, our findings are consistent with the idea that greater involvement in the most knowledge-intensive GVC stages is a key driver of structural change, with important effects on growth and income distribution. In fact, by increasingly engaging in more knowledge-intensive functions, emerging economies are likely to benefit from the emergence of new productive activities, competencies, and institutions, leading to higher growth opportunities and the creation of better-paid jobs. Our evidence thus suggests that the positive impact that these structural changes may have on income distribution more than

offsets other inequality-enhancing factors that could be associated with technological progress, such as skill-biased wage polarisation and market concentration.

The road to combining functional upgrading with socially inclusive development is nevertheless likely to be quite challenging, especially for low- and middle-income countries (Humphrey and Schmitz, 2002; Tokatli, 2013; Gereffi, 2019; Morris and Staritz, 2019). Its undertaking requires a mix of factors and efforts at firm and institutional levels that cannot be taken for granted. From this perspective, Van Der Straaten et al. (2023) have argued that MNCs have historically represented a fundamental ingredient in the quest for more even global development, as their expansion might have (often unintended) beneficial effects in emerging countries by prompting industrialization and reducing "inequality of opportunities".

Most importantly, GVC-orientated policies are needed to foster the technological upgrading of national economies in global production networks (Kergroach, 2019; Castellani et al., 2022). To capture the gains from participation in GVCs and favour their even distribution within countries, FDI promotion policies are not sufficient. FDI selection policies and aftercare initiatives are needed to attract foreign investors, including lead firms in GVCs, that are likely to bring in valuable assets, undertake knowledge-intensive activities locally, and build stronger ties and better interactions with domestic firms. By the same token, industrial policies should selectively support local suppliers in order to develop their technological capabilities, enabling them to establish more rewarding linkages with chain leaders and learn from the interaction with them (Fu et al., 2011; Morrison et al., 2013).

Accordingly, GVC-orientated policies can be thought of as largely complementary to the National Innovation System (NIS) approaches of the 1990′s and early 2000′s (Lundvall, 1992; Nelson, 1993; Edquist, 2005). Indeed, foreign and domestic-owned MNCs have always been considered key components of NIS as multinationality is associated with greater innovation capacity. The renewed attention to NIS approaches in combination with GVC-orientated policies has led to emphasise the aim of strengthening the national industrial base as a means to enter international production networks from a better position. From this perspective, Pietrobelli (2022) argued in favour of a stronger co-evolution between GVC- and NIS-orientated policies to enable local firms to 'capture the gains' from the presence of foreign firms. In particular, he suggested that governments should be selective in offering public goods (e.g., research centres) or introducing business-friendly fiscal interventions (e.g., tax exemptions). In other words, policies should be designed to attract and harness foreign capital in targeted sectors in order to strengthen national innovation systems, thereby also improving countries' position in GVCs.

These views are quite consistent with our emphasis on inward FDIs as vehicle for productive- and knowledge-assets transfer, especially when occurring in the most intangible-intensive activities at the upper ends of the value chain. Policies to attract and retain foreign presence in key industries and functions are likely to create more "equality of opportunities". Nonetheless, the actual transformation of these opportunities into more inclusive economic development requires that foreign capital injections combine with substantial domestic private and public investments to enrich domestic capabilities and infrastructures, and to create a technological and institutional environment more conducive to structural change, economic growth, and the diffusion of its beneficial effects.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. The fDi Markets database

Like all databases, fDi Markets has pros and cons. One limitation is that fDi Markets includes information on planned future investment projects, meaning that some FDI projects may not be realised or may be realised differently than reported. Although the dataset is updated daily, recent data suffer the most from this shortcoming. By limiting our empirical analysis to the period 2003–2015, we greatly increase the reliability of the data used. A second, widely acknowledged limitation is that the database only refers to greenfield investment projects, (i.e., new wholly-owned subsidiaries, including joint ventures leading to a new physical operation), while it does contain information on mergers and acquisitions (M&A). As stressed also by other authors who have made use of this database, while the absence of data on brownfield investments limits the coverage of international operation modes, it also reduces the noise associated with the merely financial motivations that often underlie M&A strategies.[12]

As for our FDI-based variables, these are aimed at proxying the functional positioning of economies by measuring their ability to attract foreign investment projects in specific value-adding segments of the value chain. FDI flows have indeed increased significantly in recent decades, largely contributing to the global dissemination of production stages and to the involvement of middle- and low-income countries in GVCs (Gereffi et al., 2005; UNCTAD, 2013; World Bank, 2020). This is also evidenced by the significant weight that FDI flows and stocks have achieved compared to the GFCF and GDP of world economies, respectively. According to data provided by UNCTAD (2023, p. 50), the ratio of FDI inflows to GFCF was close to 8% at the global level in 2019 (although the cross-country variance is remarkable). For illustrative purposes only, Table A.1 shows the average share (%) of FDI flows over GFCF based on fDi Markets data, for both high- and lower-income countries over the period 2003–2015, as well as this ratio unpacked by GVC segment (i.e., pre-production, production, and post-production). Although these figures should be taken with caution, the table shows that the FDI/GFCF ratio was on average higher than 25% for the countries included in our sample over the considered period.

[12] Additional details on the fDi Markets database are described in Coveri and Zanfei (2023a).

As for the stock of inward FDI, UNCTAD does not calculate it using fDi Markets due to the lack of information on divestments. Still, UNCTAD (2023, p. 50) reports that the ratio of inward FDI stock over GDP was higher than 40% at the global level in 2019 (although the cross-country variance is again considerable).

Table A.1
Average value of inward FDI in terms of capital investment over GFCF (share %).

	High-income countries			Medium- and low-income countries			World		
	2003–2008	*2009–2015*	*2003–2015*	*2003–2008*	*2009–2015*	*2003–2015*	*2003–2008*	*2009–2015*	*2003–2015*
FDI / GFCF (%)	26.4	25.6	**26.0**	25.0	25.4	**25.2**	25.4	25.5	**25.4**
FDI in pre-prod./GFCF (%)	4.5	7.1	**5.9**	2.1	3.6	**2.9**	2.8	4.6	**3.8**
FDI in prod./GFCF (%)	17.0	9.7	**13.1**	19.7	17.1	**18.3**	19.0	15.1	**16.9**
FDI in post-prod./GFCF (%)	4.9	8.8	**7.0**	3.1	4.6	**3.9**	3.7	5.8	**4.8**

Source: authors' elaboration based on fDi Markets and World Bank data.

Appendix B. Model estimates with upstreamness as trade in GVC variable

Table B.1
Fixed effects model with upstreamness and FDI variables.

	(1) FE	(2) FE	(3) FE	(4) FE
ln(GDP per capita)	0.486***	0.492***	0.479***	0.499***
	(0.126)	(0.126)	(0.126)	(0.126)
ln(GDP per capita)^2	−0.027***	−0.028***	−0.027***	−0.028***
	(0.007)	(0.007)	(0.007)	(0.007)
Compulsory education duration (years)	−0.007***	−0.007***	−0.007***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Mobile cellular subs. per capita	−0.027**	−0.027**	−0.027**	−0.027**
	(0.011)	(0.011)	(0.011)	(0.011)
GFCF (over GDP)	−0.056*	−0.052	−0.053	−0.053
	(0.033)	(0.033)	(0.033)	(0.033)
Trade openness	0.008	0.007	0.007	0.008
	(0.010)	(0.010)	(0.010)	(0.010)
Access to electricity (share of rural pop.)	−0.130***	−0.129***	−0.129***	−0.129***
	(0.040)	(0.039)	(0.039)	(0.039)
KOF Financial Globalisation Index	0.039	0.041	0.042	0.039
	(0.031)	(0.030)	(0.031)	(0.031)
ln(total inward FDI)	0.005**	0.005*	0.005*	0.005**
	(0.002)	(0.002)	(0.002)	(0.002)
Trade-based GVC variable ("product-level positioning")				
Upstreamness	0.065***	0.065***	0.065***	0.065***
	(0.020)	(0.020)	(0.020)	(0.020)
FDI-based GVC variables ("functional positioning")				
FDI share in pre-production functions	−0.013*			−0.020**
	(0.007)			(0.008)
FDI share in production functions		0.011**		
		(0.004)		
FDI share in post-production functions			−0.005	−0.010**
			(0.004)	(0.004)
Constant	1.725***	1.683***	1.753***	1.661***
	(0.621)	(0.622)	(0.622)	(0.621)
Country FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	1248	1248	1248	1248
R-squared	0.360	0.362	0.360	0.363
Number of countries	101	101	101	101

Note: the dependent variable is the natural log of the Gini index for market income. Robust standard errors clustered at country level in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table B.2
Two-step System GMM with upstreamness and FDI variables.

	(1) GMM	(2) GMM	(3) GMM	(4) GMM
L.ln(Gini for market income)	0.989***	0.989***	0.995***	0.951***
	(0.025)	(0.027)	(0.028)	(0.045)
ln(total inward FDI)	0.003**	0.002**	0.002**	0.004*
	(0.001)	(0.001)	(0.001)	(0.002)

(*continued on next page*)

Table B.2 (*continued*)

	(1) GMM	(2) GMM	(3) GMM	(4) GMM
Trade-based GVC variable ("product-level positioning")				
Upstreamness	−0.001	−0.002	−0.001	−0.000
	(0.005)	(0.005)	(0.005)	(0.006)
FDI-based GVC variables ("functional positioning")				
FDI share in pre-production functions	−0.006*			−0.007*
	(0.004)			(0.004)
FDI share in production functions		0.001		
		(0.002)		
FDI share in post-production functions			0.001	−0.003
			(0.002)	(0.003)
Year dummies	YES	YES	YES	YES
Observations	1154	1154	1154	1154
Number of countries	101	101	101	101
Number of instruments	42	42	42	35
Year dummies	YES	YES	YES	YES
AR(1) p-value	0.00444	0.00538	0.00502	0.00693
AR(2) p-value	0.188	0.202	0.199	0.175
Hansen p-value	0.00261	0.00149	0.00173	0.157

Note: Two-step System GMM estimator with finite sample correction (Windmeijer, 2005). The dependent variable is the natural log of the Gini index for market income. Controls included but not reported: constant, GDP per capita, GDP per capita squared, no. of years of compulsory education, mobile cellular subscriptions per capita, GFCF (over GDP), trade openness, access to electricity (share of rural pop.), KOF Financial Globalisation Index (*de facto*). All explanatory variables, except years of compulsory education, the share of rural population with electricity access and the KOF financial globalization index, are treated as endogenous. AR(#) tests on the serial correlation of residuals. Hansen tests of overidentification of restrictions. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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