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# Participation in global value chains and varieties of development patterns

ABSTRACT: This article explores the variety of socio-economic outcomes from global value chains (GVCs) participation through a cross-country analysis. In order to bridge the methodological and theoretical gap between GVCs critical insights and recent uses of the framework by international institutions, it proposes a novel definition of trade in GVCs and elaborates new indicators of GVC participation and value capture. Using these indicators and data from the Trade in Value added database it presents new descriptive statistics. Through principal component and cluster analyses it identifies three distinctive development patterns related to various degrees and modes of GVC participation: social upgrading mirage, reproduction of the core, and unequal growth. It finally discusses the complementarity of these patterns and explains why the results obtained challenge the narrative that GVC participation per se is a recipe for development.

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## 1. INTRODUCTION

Since the mid 2000s, international institutions, development agencies and governments have embraced the global value chains (GVC) framework to refine their development policies (Werner et al., 2014), often providing cross-country measurements of GVC involvement to nurture their analyses and recommendations. While some have perceived this popularization of the GVC framework as a contribution to the emergence of enlightened post-Washington consensus development policies (Gereffi, 2014), others point to the disbanding of the critical content of the global chains perspective and its cooptation in service of the neoliberal agenda (Neilson, 2014). Both sides, however,

agree that the framework's journey from the academic universe of critical theory to the world of policy making has been accompanied by significant alterations in the conceptualization of GVCs and GVC related dynamics.

One specific problem arising from this adoption of the GVC perspective by policy institutions concerns the diffusion of GVC related macroeconomic indicators. These measurements are mobilized to build stylized facts and carry out econometric analyses assessing that global value chains provide potential mechanisms for countries to improve income, employment, and/or productivity (Kummritz, 2016; Kummritz et al., 2017; OECD et al., 2013; UNCTAD, 2013; World Bank, 2017). While it is acknowledged that free market policies are insufficient in and of themselves to automatically bring the benefits of GVC participation, the concepts and indicators used by the international institutions nonetheless tend to disregard the relational understanding of GVCs elaborated by the scholarly work[1]. As a result, their cross-country macro-economic analyses obscure the variety of socio-economic outcomes and the complementarities of development patterns along the chains.

This article explores the variety of socio-economic outcomes associated with GVC participation at the country level and attempts to bridge the methodological and theoretical gap between the critical insights of the GVC perspective and the more recent uses of the framework by international institutions. Through a cross-country analysis, we distinguish three complementary development patterns related to various degrees and modes of GVC participation: a *social upgrading mirage*, the *reproduction of the core*, and *unequal growth*. Our contribution to the literature is thus twofold: first, we elaborate new macroeconomic indicators of GVC participation and economic gains that are explicitly based in a theoretically consistent definition of global value chains; second, we identify a variety of complementary development patterns related to GVC

[1] For example, Milberg (2008) and Palpacuer (2008) follow this relational perspective when they explicitly link GVC dynamics of uneven development to financialization. Lee and Gereffi (2015) stress the uneven distribution of upgrading opportunities that benefits lead firms at the expense of the bulk of suppliers.

participation through the use of principal component analysis (PCA) and cluster analysis[2] that relate these new GVC indicators to socio-economic development variables.

In order to build our empirical indicators on solid grounds, the second section begins by clarifying our conceptualization of GVCs. In our view GVCs represent a specific form of the division of labour: a GVC delineates a geographically – and often also legally – fragmented economic space where incomplete commodities are functionally integrated and valorized through a unified labour process. One achievement of this definition is that it allows for a precise delimitation of the frontiers of GVCs. As a result, using the OECD's trade in value-added (TiVA) database, we propose more appropriate measures of GVC participation and value capture than those currently employed in the literature (Section 3). Relying on supplemental sources, we then complement these novel indicators with common indicators of economic and social upgrading (investment rate, median income, labour share, gini index, employment rate) in order to perform a principal component analysis for 51 countries between 1995 and 2008 (Section 4). Our results, discussed in Section 5, challenge the dominant narrative of a positive relationship between GVC participation and social and economic upgrading, and instead describe diverse sets of relationships that support the unevenness of development patterns along GVCs.

## 2. CLARIFYING GLOBAL VALUE CHAINS BOUNDARIES

Over the past few years, research inspired by the value chains perspective has attained a new dimension. While the GVC literature used to be limited to an accumulation of case studies, with a degree of bias toward success stories (Bair, 2009), a more recent and growing strand of research now mobilizes the framework to build cross-country analyses at the macro or industry level (Durand and Miroudot, 2015; Gangnes et al., 2015; Kummritz et al., 2017; Milberg and Winkler, 2013; Miroudot and De Baeker, 2014; Taglioni and Winkler, 2016; Timmer et al., 2014; UNCTAD, 2013). This represents a significant improvement in the way knowledge on GVCs could inform policies, and is a welcome development insofar as the GVC literature has suffered from a long

[2] To the best of our knowledge, these techniques have not been used previously in the GVC literature.

acknowledged micro-macro aggregation problem (Dallas, 2014), lacking a convincing answer to the crucial question '*how does the nature of a firm's insertion into a particular commodity chain map on to a country's incorporation into the global economy?*' (Bair, 2005, p. 166).

Unfortunately, however, the recent attempts of GVC measurement are built on shaky theoretical ground. To take an example, which will be elaborated further in this article (Subsection 3.1), the standard way of measuring GVC participation at the national level by all the major international institutions derives from the two borders rule - GVC trade covers trade where product inputs cross at least two frontiers (Hummels et al., 2001, p. 76) - which is a measure of trade fragmentation alien to the conceptual development of GVC theorists. To be fair, this difficulty in policy-related measurement reflects, in part at least, the theoretical limitations of the GVC framework itself (Yeung and Coe, 2015)[3]. GVCs are most of the time defined in the literature in a descriptive manner, for example as '*the full range of activities that firms and workers perform to bring a product from its conception to end use and beyond*' (Gereffi and Fernandez-Stark, 2016, p. 7)[4]. This kind of definition is symptomatic of the difficulty to move beyond "*a typological description of the immediate outer manifestations of the determinations at stake*" and "*to provide an explanation of the very specific phenomenon that it sets to investigate*" (Starosta, 2010, p. 435). As far as the issue of macro-level indicators is concerned, the consequences of these theoretical limitations is that GVC approaches do not provide a clear-cut

[3] This problem is epitomized by the denominational instability in the field: Global Commodity Chains (GCCs), Global Value Chains (GVCs), Global Production Networks (GPNs), Trade in Tasks, etc. – the instability of the denomination is symptomatic of a lack of clarity. Even more confusing, some terminological opposition is misleading. For example, the distinctions between the GVC and GPN theoretical frameworks are arguably overdrawn and their implications for empirical work overstated (Bair and Palpacuer, 2015). We cannot review here the specific advantages and shortcomings related to these various denominations. Let us just state that we retain the term of global value chains because it is both the most widely used and, more positively, because of the emphasis on value, which points to both productive dynamics and distributional stakes. On February 7 2017, a Google search obtained 414,000 results for 'global value chains', 154,000 for 'global production networks', 53,200 for 'global commodity chains' and 30,500 for 'trade in tasks'.

[4] This definition is very close to the canonical one given in the 2001 *Handbook for Value Chain Research* (Kaplinsky and Morris, 2001, p. 4), testifying to the resilience of this conception.

conceptual understanding of the boundaries of GVCs, which is a prerequisite to building any consistent measurement.

Another popular framework used to analyze global value chains is the transaction costs approach where the frontiers of the chains are drawn by the distinctiveness of the economic relations involved in GVCs vis-à-vis other economic relations. From this perspective, trade within global value chains is qualitatively different from trade in final goods because transactions involving intermediate inputs "*tend to be associated with longer time lags between the time the order is placed (and the contract is signed) and the time the goods or services are delivered (and the contract executed), and they also often entail significant relationship-specific investments and other sources of lock in on the part of both buyers and suppliers*" (Antras, 2014, p. 119). However, the assumption that transaction arrangements are efficient considering the characteristics of production processes and asset specificities is highly problematic[5]. On the other hand, considering global value chains as a *"form of industrial organization"* (Milberg and Winkler, 2013, p. 19) provides a way to account for not only the distinctive modalities of coordination but also the endogeneity of asymmetric market structure along the chains. This is the direction taken by Taglioni and Winkler when they write that GVCs consist of:

> complex networks of production, in which participating firms are specialists in one activity and external international sourcing arrangements imbue inter-firm trade with characteristics similar to intra-group trade: better control from the center, higher levels of bilateral information flow, tolerance of asset specificity, and harmonization and immediate integration of business processes that increase the potential for foreign activities to integrate seamlessly with activities performed at home. (Taglioni and Winkler, 2016, p. 12)

This description is consistent with the notion of the network firm (Chassagnon, 2014; Powell, 2003). The latter differs from other forms of industrial organization in that it describes a hierarchized network of firms with complementary assets and skills that coordinate through various cooperation mechanisms, power exploitation being one of the main ones. Moreover, Taglioni and Winkler's emphasis on the control from the centre points to asymmetric economic relations related to uneven control over the

[5] For a general discussion of the achievements and limitations of this theoretical framework see (Pitelis, 1994).

production process itself, within the legal frontier of the firm (within dispersed affiliates of TNCs) and beyond the legal frontier of the firm (with subcontracting and retailing networks).

This emphasis on the production process takes us beyond the organizational approach and its classical triptych of markets, hierarchies and networks. From a Marxian viewpoint, the relations of production mediate the question of the size of individual units of production and their modes of coordination[6]. In other words, although the legal organizational boundaries between production units may shift from hierarchical to network arrangements, one can also looks at GVCs as a form of the division of labor. In this economic space – whether or not directly internal to a transnational corporation (TNC) - economic powers are unevenly distributed and geographically dispersed productive entities contribute to the making of a commodity[7]. In such a perspective, GVCs design a transnational economic space where the process of valorization occurs.

Within value chains, 'incomplete commodities' are functionally integrated in order to make complete commodities, which will be sold and used beyond the chain. Integration is the key issue here (Nathan and Sarkar, 2011). The criterion to consider a product as an incomplete commodity is that its potential value realization outside the chain would be lower than within it. To put it differently, GVCs exhibits network externalities: because of their complementarity, the diverse products circulating within a value chain have a higher value when they are combined than if they were sold separately, which welds the dispersed entities together. This complementarity manifests a profound unity at a deeper level: the integration of the fragmented components in the chain is supported by a variegated set of command mechanisms through which lead firm(s) shape the labor process (technology, labor standards, etc.). This degree of involvement in the integration process, that is the ability to shape the labor process, is an economic form of power whose manifestation is that transfer prices along the chain gives lead

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[6] Inspired by Yves Duroux, Charles Bettelheim writes that "The system of the units of production and their connection (or the division of social production) also constitutes an effect of the relations of production on the labor processes." (Bettelheim, 1970, p. 57).

[7] Elements of this analysis were previously traced in Aglietta's analysis of sub-contracting networks (Aglietta, 1979); on the related issues of possession and economic property relations see (Bettelheim, 1970; Lipietz, 1989; Poulantzas, 1976).

firm(s) the ability to capture part of the profits generated by the dispersed entities. The frontier of a given value chain is reached where this economic power of integration terminates, that is when price mechanisms become disconnected from the command over production parameters. Arriving at the boundary of a GVC, a product becomes a (full) commodity whose conditions of exchange are governed by institutionally shaped market mechanisms.

In sum, *a GVC organizes an institutional and economic production and valorization space where one (or a small number of) lead actor(s) exert(s) economic power to (partially) centralize profits and control(s) to some degree the labor process over geographically and often legally dispersed productive units*. Defining GVCs as a form of the division of labour delineating a transnational space of production and valorization allows us to establish a theoretical distinction between trade within and outside of GVCs that is not arbitrary (contrary to the two borders rule) and that goes beyond legal formalism (it encompasses both intra-firm international trade and trade between firms). This clear conceptualization of the frontiers of GVCs paves the way for the elaboration of theoretically grounded GVC indicators.

# 3. MEASURING GVC PARTICIPATION, VALUE CAPTURE AND SOCIO-ECONOMIC OUTCOMES: A REAPPRAISAL.

The prevailing state of ambiguity concerning the conceptualization and definition of GVCs finds its mirror image in measures routinely used in the literature to assess the importance of GVC participation and its consequences. Furthermore, as alluded to above, standard GVC indicators at the macro, cross-country level have often been elaborated by scholars affiliated with major policy institutions, whose interests are rather in immediate policy challenges than in the often confusing subtleties of GVC scholars' theoretical refinements. The result is that usual measurements only poorly reflect the analytical breakthroughs of the GVC academic literature. Drawing on our understanding of GVCs as a specific form of the division of labor, we propose new indicators to more consistently and precisely evaluate the importance and the economic

gains of GVC trade at the macro level and to better assess the related socio-economic outcomes.

This section presents the key differences between the standard measurements and our own indicators of GVC participation and economic gains. Following the literature's emphasis on value capture, these gains are understood in a relational perspective as "climbing the value-added ladder" (Gupta, 2017). We additionally present cross-country descriptive statistics highlighting the differences arising from measurement based on our conceptual and empirical proposals vis-à-vis standard measurements for participation and economic gains. The section will conclude with a rapid description of the more standard socio-economic indicators that will be used alongside our novel participation and gain indicators in the following section's econometric analysis.

## 3.1. GVC participation measurement

The standard way of measuring GVC participation in the literature derives from the two borders rule: GVC trade covers the portion of a given product that crosses at least two frontiers (Hummels et al., 2001, p. 76). Country participation in GVCs is then measured in terms of vertical specialization with a backward and a forward dimension: the backward component (VS) - foreign value-added content of total exports - assesses how dependent a country's export sector is on foreign inputs; the forward component (VS1) – domestic value-added in third countries' exports – shows how domestic exports rely on other countries' exports. VS and VS1 are sometimes taken separately as independent measures in order to see whether participating as a buyer or as a seller can have a different impact (Kummritz et al., 2017; Taglioni and Winkler, 2016). More commonly, VS plus VS1 are taken together as a share of exports to measure a country's total (backward and forward) participation in GVCs. Using such a measure, most countries count somewhere between 30 to 60 per cent of their gross exports as GVC related trade, that is, either VS or VS1 (Miroudot and De Baeker, 2014, pp. 11–12). For the world as a whole, the share of global trade that is GVC related peaks at around 52 percent in 2008 (Gangnes et al., 2015, p. 114).

The combination of VS and VS1 as a proxy for GVC trade leaves considerable room for further precision[8] in light of the conceptualization of the frontiers of GVC activity offered in this article. **Erreur ! Source du renvoi introuvable.**1 highlights the differences between the products included in our proposed measurement of participation in GVCs as a form of the division of labor and the standard VS + VS1 measure of vertical specialization.

**Table 1: Standard versus authors' measurement of traded products included in GVC trade**

| *Approach* | *Numerator* | | | *Denominator* |
|---|---|---|---|---|
| | PRODUCTS | IMPORTS | EXPORTS | |
| **STANDARD** vertical specialization | All products | Re-exported intermediate inputs (VS) *Intermediate inputs absorbed domestically and finished products not included* | Intermediate inputs re-exported by the importer (VS1) *Intermediate inputs absorbed by the importer and finished goods not included* | All Exports |
| **AUTHORS'** GVCs as a form of the division of labor | Non primary products | All intermediate inputs *Finished products not included* | All intermediate inputs and final products | GDP |

Deriving from the accounting strategy delineated in Equation 1, the full measure that we use for the rate of GVC participation is as follows:

**Equation 1: GVC participation rate as a form of the division of labor**

$$\frac{(XDVA) * (1 - ppX) + ipM * (1 - ppM)}{GDP}$$

[8] Wang et al.'s (2017) recent move away from the two border rule for characterizing GVC trade represents an important step among trade economists in recognizing the limitations of the VS+VS1 definition of GVC participation.

Where 'XDVA' is domestic value added in gross exports, 'ppX' is the share of primary products in total exports, 'ipM' is gross imports of intermediate products and 'ppM' the share of primary products in total imports

The first key difference between our measurement of GVC participation and the standard measure concerns the exclusion of primary products[9]. Primary products are relatively homogenous in terms of quality and their prices are highly volatile due to the low elasticity on both the demand and the supply side and the resulting strong sensibility to geopolitical shocks and/or climactic variations (Dicken, 2011, pp. 253–271; Lavoie, 2015, pp. 125–126). Primary products are also material inputs that have a generic character; with a wide array of potential uses and buyers, they are often traded on the open market and, thanks to their liquidity, they constitute an asset class on financial markets (Newman, 2009, pp. 550–556). The quality settings, the production process and the pricing of this kind of products are thus generally not dependent upon inter-firm negotiations and repeated interactions. According to our definition, this implies that primary products trade occurs beyond GVCs as a form of the division of labor; they are in most cases full commodities exchanged in an economic space where market coordination dominates.

Clearly, some significant distortions arise when one moves from the theoretical realm to the realm of empirical complexity. Our use of primary products as an area of non-GVC trade does therefore raise some issues. For example, some agricultural production processes are extensively framed by interactions with buyers, as shown for fresh vegetables exported from Kenya to European markets (Humphrey et al., 2004), grapes and other fruits in Brazil's São Francisco Valley (Selwyn, 2009; Selwyn, 2012) or Thai cassava's exports to China (Kaplinsky et al., 2011). It is also true that some intermediate manufactured products such as iron and steel bars or standard memory chips are inputs so widely used that they are standardized in generic terms and traded in commodity-like conditions. The primary-product exclusion rule should thus be considered not as a

[9] Specifically, following UNCTAD's product groupings convention, we exclude primary commodities, precious stones, and non-monetary gold, that is, SITC categories 0+1+2+3+4+68+667+971.

perfect reflection of our theoretical understanding, but rather as a proxy to delineate the extent of GVC participation that is theoretically grounded and, empirically, allows one to work with country level aggregated data. It is also useful that it removes the booms and busts of commodity prices (Powell, 2015) which are not directly relevant for GVC analysis. Finally, it should also be noted that the most recent revision of the UN Statistical Committee's broad economic categories (BEC) is further refining product categorization in a way that will align the country level data more closely with our theoretical understanding in the future, something that will make empirical work along our theoretical lines even more precise (see Section 1.2 of the online appendix for details).

Although it is the norm in GVC inspired macro studies to include primary products trade in GVC measurement, some recent studies have begun to exclude certain groups of primary commodities (Kummritz et al., 2017; Taglioni and Winkler, 2016, p. 88). Revealingly, the reason for this exclusion is not theoretically articulated, but rather justified by the idea that natural resource-intensive countries introduce a bias in aggregate measurements and international comparisons. There is a problem of consistency here: either what is important is the two borders rule, in which case the composition of trade is not relevant to measure GVC participation; or, if it is relevant to differentiate among the products traded, then the specificities of trade within GVCs have to be specified and, in this case, there is no reason to maintain the two borders rule.

Our definition characterizing GVC trade by a degree of transnational command over production is able to provide a consistent approach that both justifies the exclusion of primary products and also relaxes the two borders rule. Departing on this point from the standard measurement, we consequently include all imports and exports of non-primary products as GVC trade, with the exception of the direct import of a finished product for domestic use. This exception allows us to exclude the imports of finished goods when calculating the GVC participation of the importer- a Volkswagen car produced in Mexico imported by the US, an I-phone imported from China to Italy, machinery bought by Korean SMEs from Siemens in Germany – although they are taken into account when calculating the GVC participation of the exporting country. These

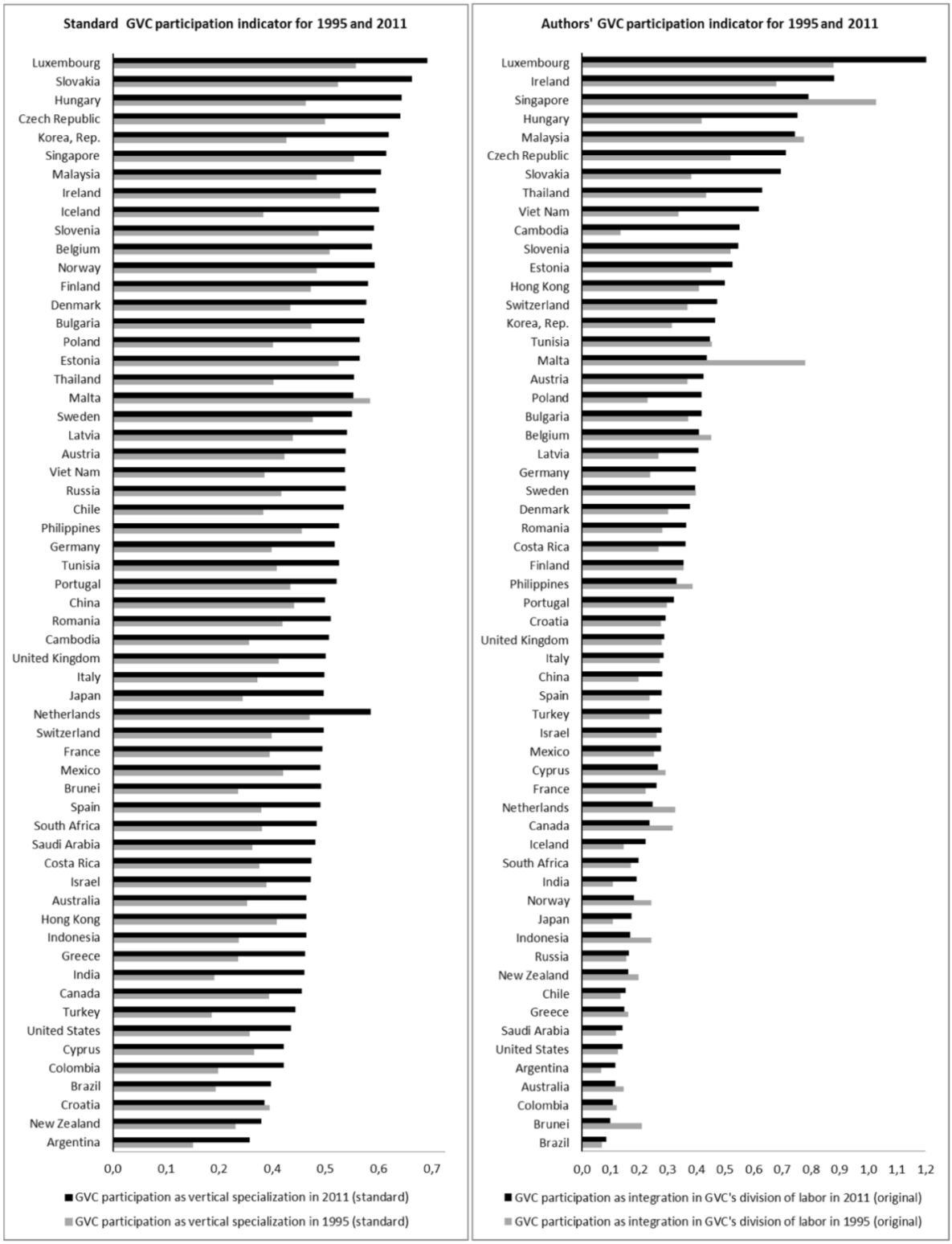
transactions should not be considered GVC trade for the importing country, as there is no transnational command over production exercised by the importer. However, at the same time this choice contains the flaw of not taking into account GVC related trade when the importer country is at the same time the location base of the lead firm. For example, when a Nike shoe is imported from Bangladesh to be sold by a Foot Locker store in New York, it will not be counted as GVC trade in spite of the fact that this import relies to a considerable degree on transnational command on the part of Nike based in the US over production in Bangladesh. However, to the best of our knowledge there is no simple way to overcome this limitation when using country-level trade statistics.

One last difference between our measure of GVC participation and the standard in the literature is that we opt for a ratio that divides by GDP rather than following the usual practice of dividing by gross exports. This is because our purpose is not seeing how much of world trade has become GVC trade, but rather looking at the developmental effects of the GVC division of labor. From this point of view, it is more relevant to gauge the level of GVC openness in relation to the economy itself. In other words, our indicator can be interpreted as a measure of the value involved in GVC trade relative to the value created in a country, that is relative to the size of a country's economy.

Figure 1 illustrates the differences between our indicator and the standard VS+VS1 measure. It displays the value of a given country's GVC participation according to the different indicators, for the longest possible time span and greatest amount of countries

that the existing trade in value-added data permit. That is, for 59 countries for the period that goes from 1995 to 2011.

**Figure 1: Standard and authors' measurement of countries' participation in GVC trade in 1995 and 2011.**




The countries are ranked in order of their 2011 participation values. We do see some similarities between the two indicators, for example the 10 leading countries according to both indicators share seven countries in common. The differences between the two

graphs, however, demonstrate the greater precision of our indicator in capturing GVC dynamics.

First, as expected, our indicator offsets the effects of the 2000s commodity boom. This is reflected in the slower growth, on average, of GVC participation seen throughout the countries in our indicator in comparison with the standard indicator. The difference is particularly noticeable for major commodity exporters such as Australia, Brazil, Russia, Indonesia, South Africa and, in a particularly extreme case, Brunei. Moreover, our measure more easily identifies a limited number of countries that dramatically increased their involvement in GVCs, namely Germany, China and a handful of mostly East Asian and Eastern European countries.

The greater nuance of our measure can also be seen by looking at individual countries. For example, Iceland features among the top countries for 2011 participation by the standard indicator, with a very large growth in participation since 1995. Yet we know that this growth in trade in Iceland's case is partially marked by commodity-based trade and significantly marked by financial trade (Wade, 2009) rather than a GVC based expansion, which explains why Iceland features much lower in the 2011 participation ranking according to our measure, with a more modest 1995-2011 GVC growth. Similarly, the cases of France and Germany are instructive. Whereas the standard indicator tells a similar story for the two countries, in reality the period in question saw Germany become much more active in GVC trade through re-localizing production in Eastern Europe, in particular as a way of revitalizing its export competitiveness (Bohle and Greskovits, 2012; Krzywdzinski, 2014; Stockhammer et al., 2016). In comparison to France, the main feature of this German transformation is the vitality of imports and exports relative to GDP, a phenomenon better captured by our indicator.

Section 3.1 of the online appendix shows that, of the three methodological differences between indicator and the standard GVC participation indicator, the non-inclusion of the two borders rule is the one that has the higher impact in terms of altering the country ranking, followed by the exclusion of primary commodities, while the change of the denominator from gross exports to GDP has a limited impact. The theoretical

advancement leading us to abandon the arbitrary two borders rule and exclude primary products thus accounts for most of the differences between our evaluation of GVC participation and that of the standard measurement.

## 3.2. GVC value capture measurement

Although the measurement of economic upgrading in GVCs is not as standardized in the literature as it is in the case of GVC participation, the most commonly used indicator is based on the domestic value-added share of exports (Milberg and Winkler, 2013; Taglioni and Winkler, 2016; UNCTAD, 2013). The logic of this type of indicator sees economic upgrading as something that is done relative to others, in keeping with the academic literature's emphasis on moving up the value-added chain. It thus also implies the possibility of downgrading, as the measure highlights the amount of value-added in trade being retained by one country as opposed to being lost to others. For this reason we call it a 'value capture' measure, as opposed to other approaches to upgrading that place the emphasis on upgrading as an absolute rather than a relative endeavor.

Table 2 summarizes the most recent approaches to measuring value capture in GVCs.

**Table 2: Standard versus authors' measurement of value capture in GVCs**

| INDICATOR | FORMULA | SOURCES | STRENGTHS / LIMITATIONS |
|---|---|---|---|
| Domestic value added share of exports | XDVA / X | Taglioni and Winkler 2016; UNCTAD 2013 | Considers DVA gains in relation to exports but not in relation to GVC trade |
| Domestic value added in exports (per capita) | XDVA / population | Kowalski et. al 2015 | Typically increases for all with increased GVC participation |
| Domestic value added by industry | DVAi | Kummritz, Taglioni and Winkler, 2017 | Very distant to GVC trade |
| Import content of export expansion ratio | ICt – ICt-1 * (Xt/Xt-1) | Jiang and Milberg 2014 | Considers DVA gains in relation to exports but not in relation to GVC trade |
| Domestic value added in GVC trade | XDVA / (GVCX + GVCM) | Authors' | Captures DVA gains in relation to total GVC related trade |

Our understanding of economic upgrading agrees with the most common approach of utilizing a value capture measure, but innovates in taking domestic value-added in exports as a share of total GVC trade, which for us includes imported intermediates and excludes primary products (see section 3.1 above), rather than merely as a share of exports.

The formula that emerges to calculate our measure of economic upgrading from GVC participation, therefore, is as follows:

**Equation 2: XDVA in GVC trade**

$$\frac{(\text{XDVA}) * (1 - \text{ppX})}{(\text{XDVA}) * (1 - \text{ppX}) + \text{ipM} * (1 - \text{ppM})}$$

Where 'XDVA' is domestic value added in gross exports, 'ppX' is the share of primary products in total exports, 'ipM' is gross imports of intermediate products and 'ppM' the share of primary products in total imports

As the reader will notice, the numerator of Equation 2 corresponds to the total value captured by a country when exporting non-primary products (that is, the total value captured by a country through GVC-related trade) and the denominator to the total value of GVC-related trade as defined above (the numerator of Equation 1).

The reason for including domestically absorbed intermediate imports in the denominator of our GVC gain ratio stems directly from our above conceptualization that sees all secondary goods and services trade (excluding the import of finished products) as GVC trade. This type of GVC import therefore represents a real cost that could offset some of a country's gains in terms of capturing value through GVC exports. In the case of some countries where the cost of such imports is particularly high due to an underdeveloped domestic input sector, omitting domestically absorbed intermediate imports from the denominator of the value capture measure would therefore give an unrealistically high GVC gain rate. Including such real costs of GVC participation as well as the gains from domestic value-added in exports provides a more precise measure of the real gains from participation.

**As can also be seen in**

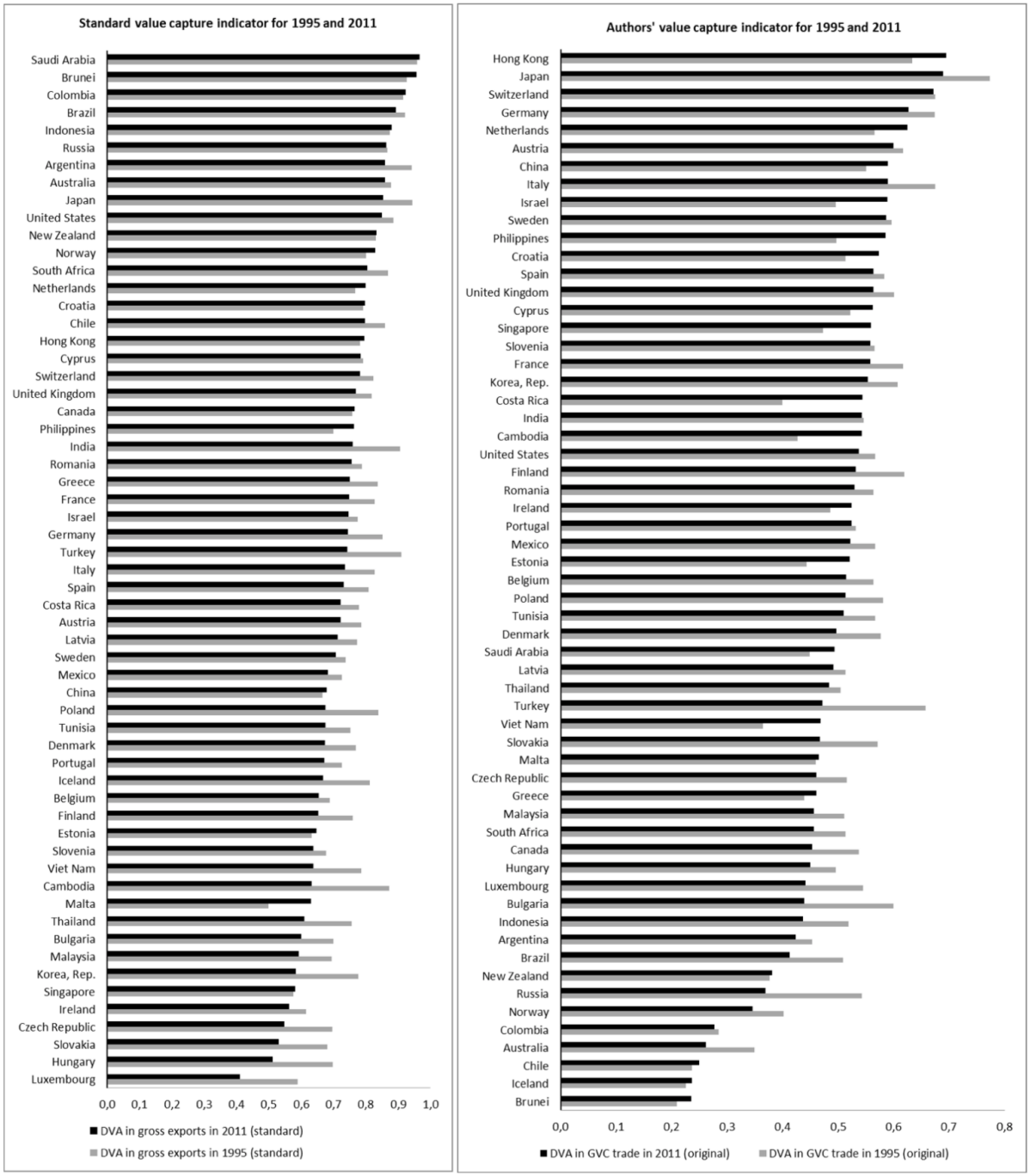
Table 2, domestic value-added in exports per capita or variants of GDP per capita or GDP by industry are sometimes used as indicators of GVC economic gains. However, as these are not relational measures they do not directly reveal the relative positioning of countries in GVCs, which is the very idea of upgrading. It is true that there can be a short-term trade off in potentially entering an upgrading path through increased GVC participation that reduces the share of domestic value capture (Kowalski et al., 2015; OECD et al., 2013, 2014; UNCTAD, 2013), yet there are nonetheless major problems with discarding the share of value capture in favor of non-relational indicators. Simply increasing per capita domestic value added in exports, something every single country in our sample has unsurprisingly accomplished during an era where world trade has mostly outpaced GDP growth (Escaith and Miroudot, 2015), does not necessarily surmount a GVC integration trajectory of high sales at low-value added levels of a value chain, identified in the literature as a new form of 'thin industrialization' or a 'low-level equilibrium trap' (Milberg et al., 2014, p. 171).

We therefore view a value capture based gain indicator, and particularly our value capture measure which takes XDVA as a share of all GVC trade, as a more direct economic outcome of GVC participation, and therefore a more precise measure of economic upgrading in GVCs, as long as it is used in a comparative perspective. Indeed, because increasing trade fragmentation automatically results in a reduction in the share of domestic value-added in exports, we need to look at value capture dynamics relatively among countries, in order to capture upgrading/downgrading processes.

Figure 2 illustrates the differences between our value capture measure, taking XDVA as a share of total GVC trade, and the most commonly used value capture indicator that only takes XDVA as a share of gross exports. As with

Figure 1 in the previous section, the same 59 countries are ordered by their 2011 values while also providing their 1995 values.

**Figure 2: Standard and authors' measurement of countries' value capture in GVC trade in 1995 and 2011.**




Here the most striking thing to notice is again the greater precision of our indicator in identifying the value captured *in global value chains* by netting out the overall non-GVC dynamics of the overlapping commodity boom period. Notice, for example, that eight out of the top 10 countries in terms of 2011's value capture by the more standard measure are major commodity exporters, with primary products ranging from 65 per cent of total exports (Brazil) to 97 per cent (Brunei), far above the sample average of 37 per cent for 2011. Their high levels of value capture are therefore misleading, since this is value captured overwhelmingly through the commodity boom and not through participation

in GVCs. Indeed, with our indicator, these countries are concentrated among the *bottom* ten countries in 2011, reflecting the weak involvement of their domestic production in GVC trade. Among the 10 highest-ranking countries according to the standard measure in 2011, only Japan and the United States deserve to be there on account of value captured within GVCs, as they have below-average primary product exports and remain toward the top of the list by our measure. At the same time, our indicator shows that the countries that gained the most relative to their involvement in GVC trade are high-income industrialized countries plus China while, among countries ranking in the middle, one finds developing countries and peripheral European countries.

Aside from the primary products issue, the other significant advantage arises from the fact that the denominator of our indicator includes both intermediate imports and exports, in sharp contrast to other measurements of value capture relating domestic value-added to exports alone. Consequently, our indicator is able to weigh countries' gain against their reliance on intermediate imports. This difference shows up in Figure 2, as countries with a notorious trade deficit, such as the United States and Greece, score much lower in value capture with our measure. This is especially striking for the United States, which descends from the second highest non-commodity exporting country to the middle of the pack. The other side of the same dynamic can be seen with major trade surplus countries such as Japan and Germany, which shoot toward the very top of the list when our indicator is used.

A final indication of the greater precision of our indicators for value capture, and also for GVC participation, can be seen by looking at the standard deviation for the countries' rate of change between 1995 and 2011, which is considerably larger by our measure both for GVC participation (49.9 per cent versus 19.7 per cent for the standard measure) and value capture (14 per cent versus 9.9 per cent). In other words, we are better able to capture the heterogeneity of participation and country gain trajectories throughout the period, allowing us to more accurately contrast the divergent fates of countries in the GVC era while at the same time reducing the theory-measurement gap.

Let us point out that the changes introduced with respect to the traditional value capture indicator (using GVC-related trade in the denominator instead of gross exports

and excluding primary commodities) are relevant in explaining the shifts in country rankings between the two indicators, and the relevance of having excluded commodities seems to grow over time, which is consistent with the timing of the commodity boom. For a detailed analysis please refer to Section 3.2 of the online appendix.

## 3.3. Socio-economic outcomes

To obtain a more multi-dimensional picture of upgrading or downgrading in GVCs, we decided to complement our above GVC participation and value capture measures with independent indicators that can capture the dimensions of the growth of the productive structure of a country as well as the social outcomes observed during the transformations wrought by the expansion of global value chains. In order to do so, we had to restrict the time period to the years from 1995 to 2008. This is because the majority of social indicators (median income, gini index, and labor's share of income) pose significant data unreliability problems beyond the year 2008 (see section 1.6 of the online appendix).

Table 3 succinctly summarizes the indicators described in this section that will be used in our empirical analysis as well as the sources from which each of them were retrieved or from which they were built. They are presented in more detail throughout Section 1 of the online appendix.

Table 3: Criteria of development patterns. Definitions and sources

| | INDICATORS | SOURCES |
|---|---|---|
| INVESTMENT | Investment/GDP | IMF World Economic Outlook |
| VALUE CAPTURE | See above formula | OECDStat / UNCTADStat |
| SOCIAL | Median Income<br>Employment rate<br>Wage share<br>Gini index | LIS / PovcalNet<br>World Bank<br>OECDStat, Trapp 2015<br>LIS / PovcalNet |
| GVC PARTICIPATION | See above formula | OECDStat / UNCTADStat / World Bank |

# 4. QUALITATIVE ECONOMETRIC ANALYSIS

As the aim of this contribution is to show the diversity of GVC integration patterns, we cannot rely on cross-national macro regressions that mask the heterogeneity of relationships among the variables by sub-groups of countries (Rodríguez and Rodrik, 2000). We therefore perform a principal component analysis (PCA), a methodology that is perfectly suited to capture the heterogeneity of behaviors between variables (participation, value capture, investment and social variables) among groups of observations (countries).

We run our PCA for 51 countries for the period from 1995 to 2008 (Subsection 4.1), and then use the results to perform a cluster analysis that leads to the identification of three groups of countries that represent three GVC related *development* patterns (Subsection 4.2).

## 4.1. Principal component analysis

### *Outline of the evolution of the variables*

Before performing the principal component analysis (PCA), we take a look at the direction in which the analyzed variables evolved in order to provide a first glance of the general trends for the 51 countries in our dataset (listed in full in Section 1.6 of the online appendix).

**Table 4: Distribution of country evolution and mean percentage change between 1995 and 2008 for each indicator**

| | PARTICIPATION | VALUE CAPTURE | INVETSMENT RATE | LABOR SHARE | EMPLOYMENT RATE | GINI (-1) | MEDIAN INCOME |
|---|---|---|---|---|---|---|---|
| COUNTRIES WITH POSITIVE EVOLUTIONS | **84%** | 27% | **67%** | 22% | **63%** | 53% | **88%** |
| COUNTRIES WITH NEGATIVE EVOLUTIONS | 16% | **73%** | 33% | **78%** | 37% | 47% | 12% |
| MEAN CHANGE | 29% | -4% | 10% | -6% | 2% | 0% | 37% |

Table 4 shows some general trends in the variations of the raw variables analyzed. As expected, participation in GVCs increased for the vast majority (84 per cent) of countries, on average by 29 per cent. On the other hand, value capture decreased for 73 per cent of them, although the mean decrease is negligible (-4 per cent). The investment rate, the employment rate and especially median income increased for most countries and on average. It is worth noting that the two variables chosen to measure inequality, the labor share and the gini index, tell different stories. Measured in terms of labor share, inequality increased in 78 per cent of countries and rose by 6 per cent on average, whereas using the gini coefficient, inequality rose in roughly half of the countries and did not evolve on average. This reinforces our decision to include both variables to measure inequality.

### *Treatment of data in order to perform the analysis*

In order to perform a principal component analysis, the data and variables already presented in Section 3.3 were treated in two significant ways. First of all, for each variable we decided to create an index that weighs percentage increases between 1995

and 2008 by the value of each variable at the beginning of the period under analysis, that is, its value in 1995. The justification for this is straightforward. Consider China, whose investment rate increased by only eight per cent during the period, which is little more than the sample's mean. Such a seemingly lackluster performance completely misses the fact that an eight per cent increase on the basis of an astonishing average investment rate throughout the period of 36.5 per cent of GDP is actually a very considerable increase, of a far different order than a similar eight per cent increase would be for a country that began the period with a very low investment rate. In other words, it is difficult to increase investment by much when investment rates are already very large. The same argument can be held for the other variables. Thus, merely using percentage increases would have made comparisons between countries misleading since the starting values of variables vary significantly between countries and, therefore, relative increases alone are not directly meaningful.

Equation 3 presents the manner in which we weight the 1995-2008 percentage change for each variable with its starting value. In order to conserve a reasonable equilibrium between the two, we give a weight of 50 per cent to each. Since percentage changes and starting values are expressed in different units, we first standardize both of them and then take the mean of the two to obtain the index. Thus, for any variable X we have:

**Equation 3: General equation to calculate the indexes used in the PCA**

$$INDEX\_X = ST(VAR\_X\_DELTA) * 0.5 + ST(VAR\_X\_1995) * 0,5$$

Where ST() stands for the standardization of the value between brackets, "VAR_X_DELTA" is the percentage change between 1995 and 2008 of variable X and "VAR_X_1995" stands for the value of variable X in 1995. As a test of robustness we also performed the PCA with only the percentage change as the input variable, that is without weighing the variable by the starting value. The variable composition of the axes remains very similar, which confirms the robustness of our PCA and the fact that the use of the above-mentioned index helps in contrasting the position of the countries along the axes without altering the overall dynamic of the test.

**The second treatment of the data undertaken is the creation of a composite social upgrading variable that combines the four previously mentioned social variables, in order to not over-represent social variables in our analysis and to give each of the criteria of integration patterns summarized in**

Table 3 (participation, value capture, investment and social outcomes) the same weight. Indeed, had we included the four social variables in the PCA separately, the social dimension of the analysis would have accounted for most of the variables in the PCA (four out of seven).

In order to build the indicator, we first created an index for each independent social variable following the methodology described in Equation 3. We then took the mean of the four social variables that resulted in the composite variable "SOCIAL_INDEX" used in the PCA (the names of all indexes created for the PCA are presented in Table 5). To confirm our choice of using a composite social variable, we ran an alternative PCA that used the four social variables separately as inputs instead of using a composite social variable and we can report that the four variables (median income, gini index, labor share and employment rate) were correlated and represented on the same side of the same axis.

**Table 5: Indexes created for the PCA analysis**

| *Variables* | *Indexes* |
|---|---|
| Investment rate | INVESTMENT_INDEX |
| Value capture in GVCs | VALCAPT_INDEX |
| Median Income<br>Employment rate<br>Wage share<br>Gini index | SOCIAL_INDEX |
| GVC participation | PART_INDEX |

## *Results*

**Following the Kaiser criterion (Kaiser, 1960), we retain three axes (F1, F2 and F3) in the PCA (see appendix section 2). The information contained in these axes concentrates 83.14 per cent of the variables' information.**

**Table 6 shows the coordinates of the variables for each axis and table 7 the contributions of each variable to each axis. Particularly important coordinates and contributions are highlighted in bold.**

Figure 3 shows the correlation circle on axes F1 and F2 that resulted from the PCA.

**Table 6 Factor loadings of each variable for axes F1, F2 and F3**

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | **0,76** | 0,36 | 0,20 |
| VALCAPT_INDEX | 0,03 | **0,91** | -0,15 |
| INVESTMENT_INDEX | **0,78** | -0,37 | 0,04 |
| SOCIAL_INDEX | -0,19 | 0,08 | **0,97** |

Table 7 Contributions of the variables to axes F1, F2 and F3 in percentage points

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | **47,4** | 12,0 | 4,1 |
| VALCAPT_INDEX | 0,1 | **75,2** | 2,3 |
| INVESTMENT_INDEX | **49,7** | 12,2 | 0,1 |
| SOCIAL_INDEX | 2,8 | 0,6 | **93,5** |

Figure 3: Correlation circle on axes F1 and F2

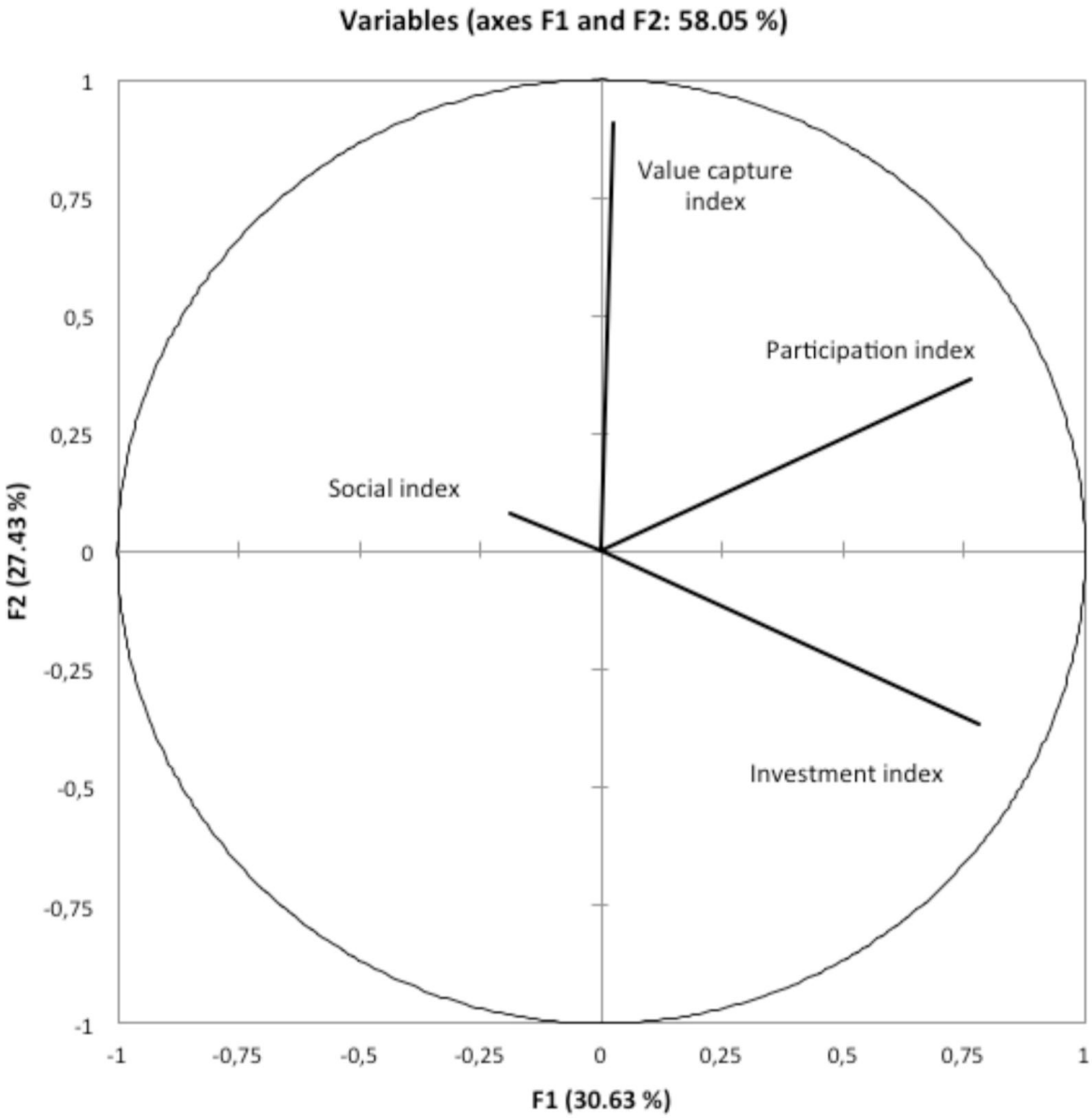



Table 7 shows that the right side of axis F2 is strongly characterized by the variable VALCAPT_INDEX and that the variable SOCIAL_INDEX is highly represented on one side of axis F3. Both PART_INDEX and INVESTMENT_INDEX are associated with the right side of axis F1. Although these two variables have coordinates of 0.36 and 0.37 respectively in axis F2, they should not be interpreted as being associated with axis F2, since, as shown in Table 7, the share of their information contained in axis F2 is small. Finally, as the reader will notice by observing the lower-right cell of Table 6, the variable SOCIAL_INDEX is highly correlated with axis F3. The variable factors map being two-dimensional, this correlation cannot be visualized in Figure 3.

Some preliminary conclusions can be made. First, the fact that PART_INDEX VALCAPT_INDEX and SOCIAL_INDEX are represented along different orthogonal axes indicates that these three variables are independent of each other. This result confirms that there is no direct correlation between GVC participation, value capture and social outcomes. Second, INVESTMENT_INDEX and PART_INDEX being both associated with the right side of axis F1 indicates that, in general terms, countries that have increased their participation indexes the most are also the ones that have increased their investment indexes the most. Bearing in mind that the indexes are comprised of the percentage change of the variables in the 1995-2008 period and their starting 1995 values in equal parts, this can be interpreted in two non-mutually exclusive ways: countries that have most increased their participation in GVCs are countries that have also seen the largest increases in their investment rates in percentage terms and/or they are countries that already had large investment rates in 1995.

## 4.2. Cluster analysis

*Methodology*

The PCA analysis confirms that our variables are not correlated with each other for all countries in our data set as a whole. We now turn to a cluster analysis in order to identify groups of countries for which the four indexes (GVC participation, value capture, investment and socio-economic outcomes) evolved in the same direction.

The first step with this econometric technique is to define the relevant number of classes (i.e. groups of countries). In order to do so, we test two methods. Three classes emerge as the most solid clustering (see appendix section 2). This indication of the existence of three distinct configurations of relationships between our four variables (GVC participation, value capture, investment, and socio-economic outcomes) among sub-groups (countries) of our data points to three distinct GVC development patterns for the 1995-2008 period.

*Results*

Table 8 shows the country composition of each class along with the number of countries in each (for more statistical results regarding the composition of the classes see section 2 of the Appendix).

**Table 8 : Country composition of the classes (World Bank country abbreviations)**

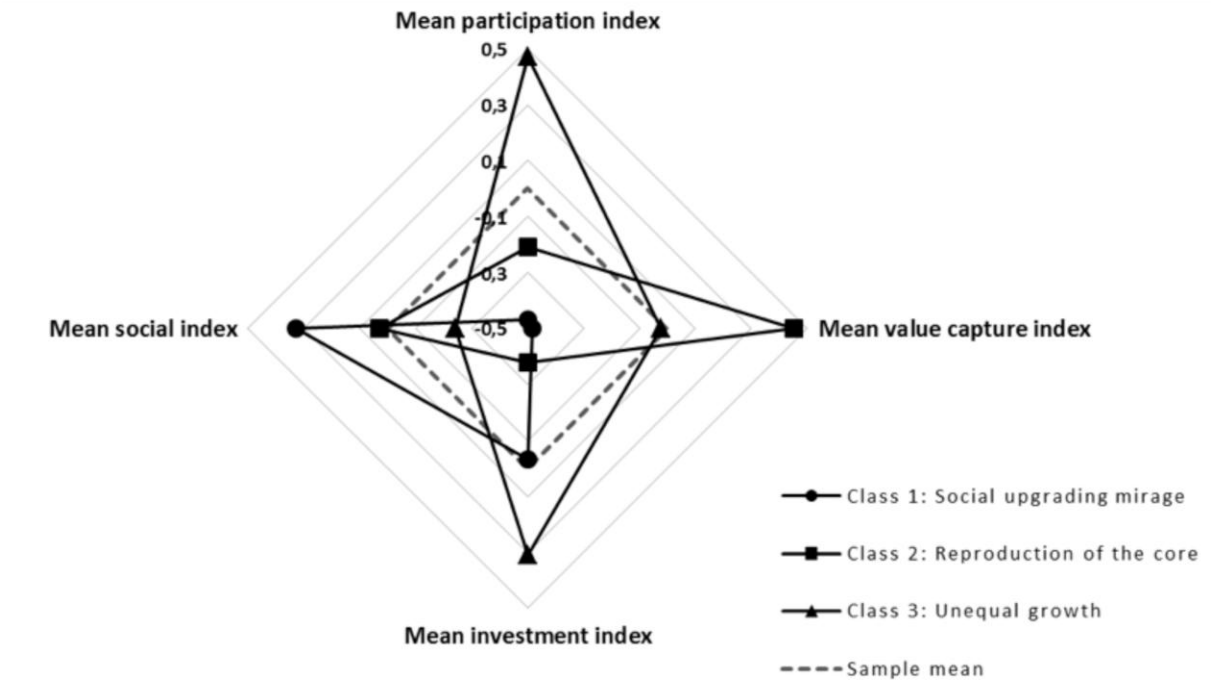
| Class | 1 | 2 | 3 |
|---|---|---|---|
| | Argentina | Austria | China |
| | Australia | Brazil | Costa Rica |
| | Belgium | Switzerland | Czech Republic |
| | Canada | Colombia | Estonia |
| | Chile | Germany | Finland |
| | Denmark | France | Croatia |
| | Spain | United Kingdom | Hungary |
| | Greece | Israel | India |
| | Indonesia | Italy | Ireland |
| | Iceland | Japan | South Korea |
| | Norway | Cambodia | Luxembourg |
| | New Zealand | Netherlands | Mexico |
| | Portugal | Philippines | Malaysia |
| | Russian Federation | Sweden | Poland |
| | | Turkey | Romania |
| | | United States | Slovakia |
| | | | Slovenia |
| | | | Thailand |
| | | | Tunisia |
| | | | Viet Nam |
| | | | South Africa |
| Number of observations | 14 | 16 | 21 |

Let us note that when we performed the same analysis using the traditional GVC participation and value capture indicators instead of the authors' indicators introduced in section 3, the country composition of the classes was profoundly altered. Moreover, the three classes presented close-to-average values for all variables except for value capture in class 2, which shows that, if traditional GVC and value capture indicators are

used, the cluster analysis is inconclusive. For a detailed analysis please refer to Section 3.3 of the online appendix.

To understand the specific features of these three country groupings, we now turn to their intrinsic characteristics. We proceed by calculating the mean value of the four variables used in the PCA for each class and we compare them to the sample mean. The rationale for this method is simple: when the mean of one of the variables for a class is significantly higher/lower than the mean of all countries in the sample we can say that a high/low value of that variable is characteristic of the class. Given that the raw variables were standardized in order to build the indexes, the mean of the sample is equal to 0 for each index. Figure 4 shows the result of these calculations in a radial graph. Shapiro-Wilk, Anderson-Darling, Lilliefors and Jarque-Bera normality tests run at a significance level of 0.05 for each variable and class conclude that, for each class, all the variables follow a normal distribution; it is therefore safe to interpret the mean of each variable for each class shown in Figure 4 as representative of its corresponding class. The individual countries included in each class are listed in table 8.

**Figure 4: Mean value of each variable by class and for the sample**



*Interpretation of the results*

As Figure 4 shows, class 1 is characterized by a very small increase in GVC participation and value capture, an average increase in investment and a high increase in social variables. Taking into account the country composition of the class, two different trajectories that converge into the same GVC development pattern can be construed.

The first one corresponds to a 'GVC resource curse' and applies to countries like Argentina, Australia, Canada, Chile, Indonesia, Iceland, New Zealand, Norway and Russia. Here the countries are net primary commodity exporters[10] that benefited from the historically exceptional increase in the international prices of commodities. Given the definition of our indicators, this implies a disengagement from GVCs and a loss in value capture coming from GVCs. Investment did not particularly evolve due to this dynamic but, on the contrary, the policies implemented and social dynamics that took place between 1995 and 2008 contributed to the use of these commodity-related income gains to obtain social improvements in terms of equality, median income and employment.

The second trajectory found in this first cluster is that of peripheral European countries that benefited up to the 2008 crisis from foreign financial inflows which allowed for temporary social improvements (Stockhammer et al., 2016). These countries lagged behind in GVC participation and economic upgrading, which led to underperformance in terms of GVC-related value capture. Yet, this same process brought about a flow of financial-related income that was distributed in a way that led to an increased median income and decreased inequality. In the case of Greece, Spain and Portugal, they benefited from capital inflows with their integration in the Eurozone and, by that means, were able to undergo a process of social upgrading. Nonetheless, this process adversely affected their competitiveness and resulted in a lag in GVC participation and economic upgrading. The severe economic crises these countries are undergoing since 2008 illustrate the mirage-like quality of the non-GVC led social upgrading path of class 1.

[10] UNCTAD data are presented for the early 2010s in "Commodity dependency" (Economist, 2015) http://www.economist.com/blogs/graphicdetail/2015/08/commodity-dependency

Class 2 is characterized by medium to low scores in GVC participation and investment rates coupled with an average score in the social variable and a very positive evolution in terms of value capture. The countries that constitute this class are mainly developed countries[11]. This suggests a trajectory characterized by a slow increase in GVC participation but in which participation was increasingly concentrated in the tiers of value chains that are able to capture more value. Given that these countries have been developed for decades if not centuries, they already had developed productive structures that allowed them to achieve highly profitable positions in GVCs without a sharp increase in investment. That this class of countries' social index score is at the sample mean suggests, looking back at Table 4, that the populations of these countries benefited from an increase in median income compatible with their sharp increase in GVC-related value capture but that employment did not significantly increase and inequality did not change or even increased, depending on the specific case. In this sense, we can think of this dynamic as a reproduction of the core trajectory: the most developed countries in 1995 did not increase their GVC participation as much as others during the globalization boom, yet they were able to capture more value than the others. They were thus able to reproduce their dominant position in the global economy through GVC trade without producing much in terms of social upgrading for their populations.

Class 3 is characterized by very high scores in GVC participation and investment rates, a slight decrease in value capture and low scores in social terms. This can be characterized

[11] As the reader will notice, some of the countries in this class (Brazil, Colombia, Cambodia, Philippines and Turkey) are developing countries with heterogeneous development patterns. Their belonging to class 2 illustrates the limitations of cluster analyses conducted based on observations' factor scores in a PCA. The grouping and its consequent class variable composition reflect general trends in the observations of the sample, but each class' characteristics cannot be interpreted straightforwardly to be fully representative of every observation (country) of the class concerned. Nevertheless, the homogeneity of the development pattern among the developed countries of class 2 that is explained in this section accounts for two thirds of the observations of the class, which makes our characterization of the "reproduction of the core" development pattern reliable. Moreover, the reader should bear in mind that, as explained above, the three groups clustering choice was verified to be the most prudent one.

as a pattern of 'unequal growth.' The countries that compose this class are mainly developing countries in Asia and Eastern Europe that in many cases were starting to undergo a process of integration into global capitalism after decades of socialist or developmental regimes. Their economies opened sharply and they joined the globalization boom by participating strongly in GVCs, which, consequently, implied sharp increases in their investment rates that bolstered their productive structures. Value capture, however, slightly decreased in contrast to countries of class 2 ('reproduction of the core'). Moreover, in terms of social upgrading this GVC development pattern was not beneficial overall: inequalities increased more than in any other group of countries and employment evolution was virtually null, clearly the slowest compared to the other two classes. However, median income saw an average increase, sometimes even a spectacular one in countries such as China where, as is known, the 1978-2015 period saw real average income per adult grow 38 fold, putting even the bottom 50 per cent of the population's average income growth at around 4.5 per cent per year despite their share of national income being roughly halved due to sharp increases in inequality (Piketty et al., 2017).

To summarize, then, this statistical analysis shows that there is no single story concerning the relationship between GVC participation and outcomes relating to value capture, investment or social standards at the country level. On the contrary, three distinct configurations of relationships among these variables were identified for sub-groups of countries in our dataset, indicating three development patterns that we have identified as a social upgrading mirage (that includes a GVC resource curse for some countries), a reproduction of the core and a pattern of unequal growth.

# 5. DISCUSSION

The mainstream story of GVC development patterns points to a *rosy scenario* whereby a country improves its economic and social situation as it increases its participation in global value chains (Kowalski et al., 2015; OECD et al., 2013, 2014; UNCTAD, 2013). The theoretical mechanisms underpinning this *rosy scenario* are generally not made explicit but nonetheless derive from comparative advantage arguments about the benefits of

specialization and the opportunities for knowledge spillovers (Romer, 1993). They could be summarized as follows: a country increasingly engaged in global value chains benefits from a productivity spillover thanks to learning processes and cheaper inputs; this translates into greater domestic value-added and trickles down to the whole economy through higher profits and investment, higher wages and higher tax collection, which altogether contribute to improved socio-economic outcomes. This idea has been radically challenged by scholars emphasizing that the combination of value-capture dynamics and tax optimization strategies tends to reproduce global inequalities between firms, countries, classes and genders (Quentin and Campling, 2017). Milberg and Winkler (2011) confirmed empirically that the rosy scenario is far from automatic; economic upgrading is not a given and it is not necessarily associated with social upgrading. This observation justifies a rather cautious statement from the World Bank that, by itself, the '*internationalization of production processes helps with very few (…) development challenges, but it provides the policy space to address them*' (Taglioni and Winkler, 2016, p. 4).

Our conceptualization of GVCs as a form of the division of labor and the resulting conceptual and empirical clarifications allow for a rigorous understanding of GVC development dynamics in the sense that it better evaluates the importance of GVC participation and the resulting relational gains than standard measurements used by international institutions. At the same time, in contrast to most of the academic GVC literature, this framework proposes a solution to solidify the notion of GVCs and delineate the boundaries of GVC trade, which facilitates empirical study using cross-country macroeconomic data. It thus provides a way to overcome the risk of a fallacy of composition weighing on conclusions based on case studies and a strategy to bring to the table statistical results supporting a critical assessment of GVC development dynamics.

Based on these conceptual and methodological achievements, the PCA and cluster analyses conducted in this paper question the idea that the internationalization of production processes fosters development or provides policy space to address developmental challenges. It relates and contrasts three broad development patterns found in GVCs between 1995 and 2008: a *social upgrading mirage*, *the reproduction of*

*the core* and *unequal growth* (Table 9). Our findings echo earlier work by Milberg and Winkler (2013: 198-202) in showing that relations between GVC outcome variables differ significantly depending on the specific grouping of countries considered, with the difference being that Milberg and Winkler formed their country groupings through pre-selected institutional categories whereas ours emerge through the process of statistical analysis.

**Table 9: The complementarity of three observed development patterns**

| | REPRODUCTION OF THE CORE<br>*RENTIER'S INTEGRATION* | UNEQUAL GROWTH<br>*PRODUCTIVE INTEGRATION* | SOCIAL UPGRADING MIRAGE<br>*NON-GVCS LED DYNAMICS* |
|---|---|---|---|
| GVC PARTICIPATION | +/- | + | - |
| VA CAPTURE | + | +/- | - |
| PRODUCTIVE DEVELOPMENT | - | + | +/- |
| SOCIOECONOMIC OUTCOMES | +/- | - | + |

Strikingly, our analysis does not show any *rosy scenario* where GVC participation goes along with relative improvements in terms of value capture, productive development and socio-economic outcomes. Rather, it shows an apparent complementarity between three regimes revealed by the polarization in each of the dimensions of our typology, which suggests that development patterns in GVCs need to be understood as constitutive parts of a global process of uneven development. This finding reconnects with one key insight of the original research on global commodity chains: the relational character of development patterns along the chains (Hopkins and Wallerstein, 1977).

In the case of the *reproduction of the core* pattern, a category that comprises most of the biggest, high-income economies, value capture is disconnected from productive development measured in terms of investment. It echoes the possibility that GVC

participation could lead to greater value capture thanks to the exercise of market power. Such market power could be related to economic barriers to entry or to an asymmetric political structure resulting in the protection of standards and intellectual property-rights. In such cases, benefits from GVC participation do not result from higher productivity but from the ability to extract rent from foreign actors, an idea already raised by dependency theorists (Palma, 1978). For example, the ability of global buyers to benefit from cheaper inputs could be completely disconnected from any productive improvement, in which case its overall impact will depend on the distribution and the uses of the gains (Milberg, 2008).

The counterpart of this privilege of the core is a process of *unequal growth* where increases in the quality or quantity of output resulting from productivity gains are more than compensated by diminishing prices, resulting in lower value capture. In such cases greater productive efficiency does not translate into greater economic gains but rather leads to social downgrading as previous uses of resources have been disrupted by the involvement in GVCs (Kaplinsky, 2004, 2000; Kaplinsky et al., 2002; Mohan, 2016). This second kind of pattern corresponds to the fate of mainly developing countries who experienced a rapid insertion in GVCs along with important productive development and, in the meantime, poor social outcomes. Even as median income improved – sometimes spectacularly as in the case of China - growing personal and functional income inequality and/or poor employment performances point to a pattern of partially skewed development associated with growing involvement in GVCs .

It is important here to stress that even when value capture improves, social upgrading is far from evident, depending on the internal unfolding of class relations. Indeed, if economic gains are captured by capital, they could fuel higher inequality and limit the spillover effect that should increase the population's income. Moreover, higher profits do not necessarily translate into higher investment – they could result in higher financial payments, which means that the overall impact on employment is not straightforward. Thus, as a result of greater inequality or unproductive uses of profits, greater value capture resulting from GVC participation can be associated with social downgrading. Conversely, positive social outcomes necessitate that labor, which represents the bulk of the population, manages to capture part of the gains, either directly through higher wages or, indirectly, through tax-funded public welfare. For such

an outcome to occur, the key mechanisms are a higher labor demand resulting from productive uses of profits and workers' ability to mobilize some structural and/or associational power (Selwyn, 2013; Wright, 2000).

Interestingly, the best social outcomes revealed by our analysis occurred in countries that stayed relatively insulated from GVC dynamics. We nonetheless call this configuration a *social upgrading mirage* because it rests on external conditions of possibility which are, on the one hand, the commodity boom of the 2000s and, on the other hand, the massive financial inflows in countries from the southern European periphery during the first decade of the Euro. These conditions favored overall improvements in terms of median income, employment and sometimes inequality, but unfortunately they later proved unsustainable as these countries were among the most heavy hit by the reversal of the commodity boom and the 2008 financial crisis and its destabilizing effect on the European monetary area.

With this overall picture in mind we can come back to the importance of our initial conception of GVCs as a specific form of the division of labor. One of the core elements of this conceptualization is that within the boundaries of GVCs the economic ability to capture the gains and the ability to frame the productive processes are unevenly but interdependently distributed. This allows for an original understanding of the diversity and complementarity of uneven development patterns along value chains. Uneven development patterns typically result from the fact that GVCs delineate transnationally fragmented labor processes, often dispersed among formally independent entities that are nonetheless to some degree economically unified under a dominant locus of valorization. Positions of market power reflect some degree of control over labor processes that descends along the chains and allows value capture at considerable geographical removal from the countries where productive development takes place. This focus on fragmented-unified valorization processes also sheds a new light on social outcomes. They cannot directly be deduced from GVC participation and can only be understood if one takes into account the distribution of capitals' powers along the chain in addition to other dimensions such as the institutional set of constraints and regulations or the position of labor at the point of production. In this perspective, the complementarity between the three development patterns described by our empirical

investigation is a reflection, at the inter-country level, of a strongly hierarchized organization of the world economy that is spreading at a more granular level among unequal power nodes within trade, financial and policy networks.

# 6. CONCLUSION

In order to overcome the disjuncture between theoretical developments in the GVC literature and macro, multi-country measurements, this contribution presented an original theoretical conceptualization of GVCs as a form of the division of labor and on such a basis offered new indicators of GVC participation and value capture along with new stylized facts concerning their evolution, as well as a preliminary econometric inquiry into the different patterns of development taking place along GVCs.

Focusing on GVC dynamics at the macro-level, our PCA and cluster analyses indicate three main patterns of development in GVCs between 1995 and 2008: *a social upgrading mirage*, *the reproduction of the core* and *unequal growth*. Contrary to the mainstream narrative about the expected positive effects of GVC participation, we show a more nuanced reality where gains from GVC participation are unevenly distributed between and within countries and point to the complementarity of the diverse GVC development patterns reflecting the specificities of the global division of labor within value chains.

This paper thus identifies economic mechanisms that are difficult to disentangle through case studies and does not suffer from the inability of common econometric analysis to account for heterogeneous trajectories. We hope that it will contribute to new avenues for theoretical discussion and empirical inquiry within the GVC community. In such a perspective, a first step would be to conduct empirical analysis at the industry level, using the same conceptual framework, which would permit the circumvention of some limitations of state centered analyses. Further research should also include financialization, which is relevant at the level of the uses of profits by lead firms and as a countervailing force of productive and social dynamics.

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# APPENDIX

The appendix is divided into three parts. The first one refers to the construction of the raw indicators analyzed in section 3 and with which the indexes used as variables for the PCA were built. Information about sources, data treatment and all the methodological choices made to build the database are detailed for every raw indicator. The second part offers more statistical output of the PCA that has not been included in the paper. The third section concludes the appendix by providing further information on the impact that our main methodological and theoretical changes had on the different results we obtain.

## 1. RAW INDICATORS

### 1.1. COUNTRIES AND TIME PERIOD OF COVERAGE

Data are available for value added trade from OECDStat's Trade in Value Added (TiVA) database for only 61 countries. As both the GVC participation and value capture variables are indispensable to the analysis and dependent on the existence of value-added trade data, our data selection for all variables is necessarily limited to these 61 cases where such data are available. After gathering data for productive investment and our social upgrading indicators, discussed below, eight of these 61 cases were eliminated from our data set due to the non-availability of data present across more than one indicator, rendering statistical estimation unreliable. Those eight countries – Brunei Darussalam, Cyprus, Hong Kong, Lithuania, Malta, Saudi Arabia, Singapore, and Taiwan – are therefore included in Figures 1 and 2 in Section 3 of the paper, as such figures do not require the use of productive investment or social upgrading indicators, but excluded from the econometric analysis in Section 4. After dropping two further countries, Bulgaria and Latvia, for reasons explained in section 1.5 of the appendix below, we are left with 51 countries in our dataset. They are listed in full in the "Social Indicators Data Table" of section 1.6 of the appendix below.

The time period available in the same TiVA database are the years from 1995 to 2011. The starting point of 1995 follows the practice of other studies examining the evolution of the GVC era (De Backer & Miroudot, 2014; Timmer, Erumban, Los, Stehrer, & de Vries, 2014) and is also very close to the beginning of the era of the rapid take-off of GVC expansion in the early 1990s (Milberg et al., 2014, p. 151).

As mentioned in section 3.3 of the paper, we had to restrict the end point of the time period to 2008 rather than the TiVA database's final year of 2011. Our reason for doing so can be seen in section 1.6 of the appendix below, as the majority of social indicators (median income, Gini index, and labor's share of income) pose significant data unreliability problems beyond the year 2008.

## 1.2. GVC INDICATORS AND THE TIVA DATASET

Here we will first briefly speak about the commonalities between the two novel indicators that we constructed, that of GVC participation and value capture before separately mentioning the specificities of each measure.

The OECD TiVA source of these indicators is straightforward, except for two points that should be mentioned here.

First, in order to eliminate primary products we chose to use the SITC classification since it is more appropriate than the ISIC classification upon which the OECD TiVA database is constructed. This is largely because the latter system draws the line between primary and secondary sectors too early in the production process and thus treats many primary products as processed intermediates (Radetzki, 2008, p. 23). Therefore, we used UNCTADStat's SITC-based database in order to capture the percentage of primary products in a country's imports and exports, following their classification of "primary commodities, precious stones and non-monetary gold." The second additional source of

data that we used is the World Bank's World Development Indicators for the GDP figures in the GVC participation denominator. Aside from these exceptions, then, all data for both GVC-based indicators is from the OECD TiVA database.

There are two drawbacks to be kept in mind about the TiVA dataset.

One potential bias is that transfer prices recorded for trade between foreign affiliates of the same firm may not accurately reflect arms-length market prices (Diewert, Alterman, & Eden, 2005). Of course, the same problem besets any statistical dataset concerning international trade, as statistical offices are only as good as fiscal authorities in accurately capturing such dynamics (Escaith, 2008, p. 25- 26).

A final drawback of the TiVA dataset is that it has not yet incorporated the new changes brought about in the 5th revision of the classification by Broad Economic Category (BEC), approved in 2016 by the UN Statistical Commission. These changes introduce a "specific" processed intermediate goods category in order to better disentangle the previous "processed intermediate goods" category that often included what are effectively unprocessed primary products that should not be treated as GVC related trade (UN Statistical Commission, 2016, p. 13). Therefore, there is considerable ground for future precision in measurement according to our conception of GVCs if the TiVA dataset or any other eventually provides value-added trade data based on the new categories of the 5th revision of the BEC. For the moment, of course, the OECD TiVA dataset remains the best practice available.

### 1.3. GVC participation

To provide more specific information about the GVC participation measure, recall that the GVC participation rate is defined as the sum of the non-primary product portion of domestic value added in exports plus intermediate imports over GDP. The formula to determine the GVC Participation rate, as mentioned in sub section 3.1 of the paper, is:

$$\frac{(XDVA) * (1 - ppX) + ipM * (1 - ppM)}{GDP}$$

Where "XDVA" is domestic value added in gross exports, "ppX" is the share of primary products in total exports, "ipM" is gross imports of intermediate products and "ppM" the share of primary products in total imports

Domestic value added content of gross exports and gross imports of intermediate products are taken from OECDStat's Trade in Value Added (TiVA) database, October 2015 version, in US dollars. The shares of primary products in total exports and imports are taken from UNCTADStat (see above section 1.2 of the appendix for the reason for using UNCTADStat for primary product data). Primary commodities, precious stones and non-monetary gold (SITC 0 + 1 + 2 + 3 + 4 + 68 + 667+ 971) as total volumes in US dollars of exports and imports for each country were made into shares by dividing by total exports and imports in US dollars from the same database. GDP figures are from the World Bank's "GDP at market prices (current US$)" variable in its World Development Indicators data set, and are given in current prices converted into US dollars through the exchange rate.

For this indicator there were no missing data points, nor was there a need for any additional treatment of the data, with the exception of the treatment of the outlier Cambodia, whose rate of change between 1995 and 2008 was more than 4 times higher than the second highest value in the entire data set. The percentage change between 1995 and 2008 for Cambodia was therefore replaced by the second highest variable in order to not overly skew the results.

### 1.4. Value capture

Recall that the value capture rate is defined as the non-primary product portion of the domestic value added content of exports over the non-primary product portion of total exports plus intermediate imports. The formula to determine value capture or the GVC gain rate, mentioned in subsection 3.2 of the paper, is:

$$\frac{(XDVA) * (1 - ppX)}{(XDVA) * (1 - ppX) + ipM * (1 - ppM)}$$

Where "XDVA" is domestic value added in gross exports, "ppX" is the share of primary products in total exports, "ipM" is gross imports of intermediate products and "ppM" the share of primary products in total imports

The sources for domestic value added content of gross exports, the share of primary products in total exports and imports, and gross imports of intermediate products are the same as used to construct the GVC participation indicator.

For this indicator there were no missing data points, nor was there a need for any additional treatment of the data.

### 1.5. Productive investment

Gross capital formation was taken as an indicator of the scope of productive investment in an economy and its growth alongside the evolving relations with GVCs, a process distinct from whatever the trends may be with regard to value capture. The specific indicator is "total investment (percent of GDP)" from the IMF's World Economic Outlook database, defined as "the total value of the gross fixed capital formation and changes in

inventories and acquisitions less disposals of valuables for a unit or sector," all in current local currency.

The use of gross capital formation as a proxy for investment is generally taken as a more reliable indicator of long-term structural changes in productive capacity and capital accumulation (Duménil and Lévy 2013) with more relevance for economic development than measures such as total factor productivity (Felipe & McCombie, 2003). The main limitation with the measure relates to the inclusion of residential investment which could make it difficult to distinguish real capital accumulation from real estate bubbles. Gross capital formation also does not take into account the original level of capital stock which can be assumed to vary enormously between countries. Both of these limitations are obviously to be kept in mind while interpreting the results.

For this indicator there were no missing data points, nor was there a need for any additional treatment of the data, with the exception of the treatment of the outliers Bulgaria and Latvia. Due to an unusually low starting point in 1995, which is highly likely to be an underestimate, Bulgaria would have had a rate of change more than four times the second highest value, Latvia, itself already 41.5 percent higher than any other value in the data set. After trying several methods to deal with these outlying values (replacing by the next highest value of the sample, replacing by the mean; eliminating them and estimating the missing values) that nonetheless continued to over-weight the role of the variable INVESTMENT_INDEX in the PCA and, especially, in the country-composition of the classes that emerged from the clustering based on the PCA, we decided to exclude both Bulgaria and Latvia from the sample.

## 1.6.SOCIAL INDICATORS

Due to the multifaceted nature of what might be involved in "social upgrading" (Milberg and Winkler 2013: 251), we chose four separate indicators that all capture important aspects of "wages, employment, and social standards" (238), without being directly reducible to each other.

### *Employment rate*

The employment rate indicator was taken from the "Labor force participation rate, total (% of total population ages 15+)" data provided by the World Bank, defined as "Labor force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labor for the production of goods and services during a specified period" (World Bank, 2016).

This indicator was chosen instead of a simple unemployment rate figure because of the huge problem of informality in developing countries, making a cross-country comparison of unemployment rates of dubious value. To take an example, India has a mere 4.1 percent unemployment rate in the same World Bank database for 2008, and 4 percent for 1995, performing significantly above the average in both years as well as for the percentage change between the two years. Yet the LABORSTA (ILO) database has 84 percent of India's non-agricultural workforce in informal employment in 2009. While a reliable measure of total formal employment as a percentage of the working age population would therefore be ideal, the lack of sufficient data in the ILO database or elsewhere makes the World Bank's "labor force participation rate" the best available indicator (India scores, more realistically, significantly below average with this indicator).

There were no missing data points with this indicator, nor was there a need for any additional treatment of the data.

*Median income*

Median income was chosen as a measure of the improvement or lack thereof in real income for the median individual in a given country's income distribution. It was chosen for this purpose as a more precise measure than average income, which is subject to relative variations in top incomes. The biggest challenge for median income data is finding a database that would be internally consistent by providing median income data for all the the majority of countries in our sample throughout the years of interest. Unfortunately, no such dataset exists, thus forcing us to take our data principally from combining two sources: the Luxembourg Income Study for countries where data is available, and the World Bank's PovcalNet database for the remainder of countries. The methodology of combining the two sources follows that of the Pew Research Center (Kochhar, 2015), and has also been employed in a similar manner by (Hellebrandt & Mauro, 2015).

PovcalNet data came from the query of the database by Dykstra, Dykstra and Sandefur (2014) where "the population of each country is divided into 10,000 equal-size groups, where each group represents 0.01% of a country's population. The groups are ranked by per capita income or consumption" (Kochhar 2015). The median income score was taken as the $50^{th}$ percentile of these 10,000 equal-size groups, which is not a precise median at the individual level but the closest thing available for many developing countries (Kochhar 2015). For greater comparability the Luxembourg Income Study data was treated in the same way, splitting the distribution into 10,000 equal size groups and taking the $50^{th}$ percentile of these groups. Since the PovcalNet data is given at the level of individuals rather than households or equivalized scales, the Luxembourg Income Study data was also taken at the individual level by dividing each observation's disposable income total (which is at the household level) by the variable "number of household members" in order to transform the individual household observation into multiple numbers of individual observations (as many as exist in a given household) with the same individual income level (that of their household divided by its number of members). As with the methodology of the Pew Research Center, this method is not able to capture economies of scale inside households, and thus likely overestimates the real income gap between wealthy countries with smaller family units and poorer countries

with larger ones (Kochhar 2015). This is the main data limitation for the median income variable, along with the potential incompability of taking consumption data in the countries where it was presented and income data in others (all LIS data is disposable household income data while Povcal is either income or consumption data depending on the survey year and country). Nonetheless, combining income and consumption data for cross country comparisons in this manner is common in the literature (Birdsall, 2010; Hellebrandt and Mauro 2015). Furthermore, since both of the listed limitations barely enter the picture when the rate of change inside one country is measured between two years, rather than the comparison between countries at a given year's values, these limitations are strongly mitigated in our analysis since the variable that eventually entered our principal component analysis is 50 percent determined by the rate of change in a given country between 1995 and 2008 (see Equation 3 in Section 4.1 of the paper).

In all cases for both the median incomes and the gini indicators, data was taken as available as close as possible to the years 1995 and 2008, up to 3 years before or after the benchmark years (i.e. from 1992 to 1998 and from 2005 to 2010). For the median income, if the reported data came from one of the surrounding years that was not the benchmark year, it was extrapolated to the benchmark year following Kochhar's method of assuming an annual rate of change equal to 70 percent of the change in real household consumption expenditures, with the data taken from the World Bank's "household final consumption expenditure per capita growth (annual %)" variable in its Data Catalog.

All data was put in 2005 constant local currency prices in order to compare the rate of change between 1995 and 2008, and the 1995 values were put into 2011 international PPP dollars in order to have a comparable figure between countries for the 50 percent weight with beginning values that entered the principal component analysis. These conversions were done using the World Bank's International Comparison Program 2005 PPP to local currency convertors where applicable (that is, for all PovcalNet data since it is reported in 2005 PPPs) and the World Bank data catalog's "consumer price index (2010=100)" both to put non-PovcalNet data in 2005 local currency units and to bring

all 1995 data to 2011 local currency units in order to use the 2011 International Comparison Program PPP (Table R3, "individual consumption expenditure by households") convertors to put the values into 2011 PPP dollars. Where data was missing from the World Bank's consumer price index, the IMF's World Economic Outlook Database (updated on January 19, 2016) was used for the same purpose (this was the case for Argentina, Chile, and China).

In addition to these adjustments, other adjustments that were necessary included multiplying the PovcalNet figures by 12 (they are reported as monthly estimates) to get a yearly estimate comparable with the Luxembourg Income Study data, and using Eurostat's "former euro area national currencies vs. euro/ECU – annual data" convertors in cases where the reported data of countries was done in the old national currency of countries who now use the Euro (and thus the 2011 PPP convertor is in Euros). This was the case for the 1995 values for Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, and Spain, in order to put them in 1995 local Euros before bringing them to 2005 Euros to make the rate of change calculation. It would have been done for the 1995 value with Slovenia as well, but the result gave an unreliable estimate (a 30% decrease in median income between 1995 and 2008), so the rate of change was estimated instead (see below

Table 10) while the Euro reported 2008 value was deemed reliable. Late Euro adopters Estonia and Slovakia were treated differently, since not only their 1995 values but also their 2008 values were reported in their pre-Euro local currency. Their 1995-2008 rates of change were therefore calculated by leaving both years in 2005 pre-Euro local currencies, while their 1995 beginning values were converted to Euros in order to make the 2011 PPP estimate.

If reported values for any countries were available for both 1995 and 2008 from both the Luxembourg Income Study and the PovcalNet database, the LIS data was chosen as

more consistent with the rest of the dataset. The only exception here is Mexico, where there was a large difference between the numbers given by the LIS and the PovcalNet database concerning the rate of change between 1995 and 2008 – an astronomical 122 percent increase with LIS data versus a below the mean 25 percent increase with PovcalNet data. Given what is known about Mexican real income stagnation during this period (CONEVAL 2014: 51), the LIS data was deemed unreliable (in all likelihood the LIS 1995 figure is far too low, since the 2008 values themselves in 2011 PPP dollars are not very different, PovcalNet's are even a bit higher -- $2,556 PPP versus $2,492 PPP). The PovcalNet data were therefore used uniquely in Mexico's case when both PovcalNet and Luxembourg Income Study data were available.

If values were not available for both years in either the Luxembourg Income Study or the PovcalNet database, the best alternative estimate consistent between the two years was sought, and statistical estimation was used in the cases where nothing could be found (some combination of finding other sources or using statistical estimation by the NIPALS method occurred for only 9 out of 51 countries).

Table 10 below describes the data used for every country for both median incomes, gini values, and labor's share of the income, along with the years of the reported data (the column is for the median income and gini variables, where there was more variation, while any variation from 1995 or 2008 for labor's share is noted inside the labor's share column itself) and whether there were any complications and, if so, how they were handled.

It should also be noted that median income was one variable influencing our need to restrict the end date of the period used in our overall analysis to 2008, rather than the TiVA database's end point of 2011, as we did not want to go too far away from having internally consistent data. Even with 2008 as an end point, there are 9 countries without data in either of our two combined sources, thus necessitating the use of other sources to find estimates, as mentioned in the previous paragraph. But there are a further 13

countries that do not pose data problems for 2008, but would, with a 2011 end point, necessitate either using 2008 or 2009 data or seeking 2011 data in other sources that would further weaken the internal consistency of the data.

**Table 10 : Social indicators data table**

| Country | Country code | Median income source | Type of data / complication | GINI Source | Years of reported data | Labor's Share Source |
|---|---|---|---|---|---|---|
| Argentina | ARG | PovcalNet | Income | Same as median | 1995, 2008 | Trapp 2015 (2008 not available, 2007 used) |
| Australia | AUS | Luxembourg Income Study | Income | Same as median | 1995, 2008 | OECD Stat |
| Austria | AUT | UNU Wider – WIID 3.3 | Income (Available for 1995 only in the LIS, but not taken since it is available for both years from the same source from the European Commission gathered by the WIID database, which makes the rate of change calculation more reliable) | Luxembourg Income Study is available for 1995 but not for 2008. For 2008, it is listed at 27.8 by two different data sets gathered by the "all the Ginis" (Milanovic) database, with a close number from yet another in 2005 and no far away values, so the 27.8 figure was taken. | 1995, 2006 for median income. 1995, 2008 for GINI. | OECD Stat |
| Belgium | BEL | UNU Wider – WIID 3.3 | Income (Available for 1995 only in the LIS, but not taken since it is available for both years from the same source from the European Commission gathered by the WIID database, which makes the rate of change calculation more reliable) | Luxembourg Income Study is available for 1995 but not for 2008. For 2008, it is listed at 28.5 by two different data sets gathered by the "all the Ginis" database, with a close number from yet another in 2005 and no far away values, so the 28.5 figure was taken. | 1995, 2006 for median income. 1995, 2008 for GINI. | OECD Stat |
| Brazil | BRA | PovcalNet | Income | Same as median | 1995, 2008 | Trapp 2015 |
| Cambodia | KHM | PovcalNet | Consumption | Same as median | 1994, 2008 | No data available |
| Canada | CAN | Luxembourg Income Study | Income | Same as median | 1994, 2007 | OECD Stat |
| Chile | CHL | PovcalNet | Income | Same as median | 1994, 2009 | Trapp 2015 |
| China | CHN | PovcalNet | Consumption | Same as median | 1996, 2008 | Trapp 2015 |
| Colombia | COL | PovcalNet | Income | Same as median | 1996, 2008 | Trapp 2015 |
| Costa Rica | CRI | PovcalNet | Income | Same as median | 1995, 2008 | Trapp 2015 |
| Croatia | HRV | PovcalNet | Consumption | Same as median | 1998, 2008 | Trapp 2015 (1995 and 2008 not available; 1996 and 2007 used) |
| Czech Republic | CZE | Luxembourg Income Study | Income | Same as median | 1996, 2007 | Trapp 2015 (2008 not available, 2005 used) |
| Denmark | DNK | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| Estonia | EST | Luxembourg Income Study / PovcalNet | 1995 value from PovcalNet, consumption; 2008 value from Luxembourg Income Study, income | Same as median | 1995, 2007 | Trapp 2015 (2008 not available, 2005 used) |
| Finland | FIN | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| France | FRA | Luxembourg Income Study | Income | Same as median | 1994, 2010 | OECD Stat |
| Germany | DEU | Luxembourg Income Study | Income | Same as median | 1994, 2007 | OECD Stat |
| Greece | GRC | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat (1995 value is an estimated value by OECD Stat) |
| Hungary | HUN | Luxembourg Income Study | Income | Same as median | 1994, 2007 | Trapp 2015 (2008 not available, 2006 used) |
| Iceland | ISL | Luxembourg Income Study | Income (to calculate the final 2008 value. However, as no data is available for the years surrounding 1995, the rate of change between 1995 and 2008 needed to be estimated). | The final 2008 value could be calculated with the 2008 LIS data. However, due to the lack of a 1995 estimate anywhere, the rate of change between 1995 and 2008 was estimated. | 2007 | OECD Stat (1995 is an estimated value by OECD Stat) |
| India | IND | PovcalNet | Consumption | Same as median | 1993, 2009 | Trapp 2015 |
| Indonesia | IDN | PovcalNet | Consumption | Same as median | 1996, 2008 | No data available |
| Italy | ITA | Luxembourg Income Study | Income | Same as median | 1995, 2008 | OECD Stat |
| Ireland | IRL | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| Israel | ISR | Luxembourg Income Study | Income | Same as median | 1997, 2007 | OECD Stat |
| Japan | JPN | UNU Wider – WIID 3.3 | Income. However, given that the data provided was at the household level without available information on the micro level regarding persons per household, the figure was divided by the 1995 average household size in Japan (NIPPSR 1998) and the 2010 average household size in Japan as a proxy for 2008 (Gu et al. 2015). | The GINI is available to calculate from LIS for 2008 only. For 1995, the "all the Ginis" database provided 4 sources with very close estimates for 1993 and one outlier for 1994. An average of the 1993 estimates was taken. | 1995, 2006 for median income data. 1993, 2008 for the GINI calculation. | OECD Stat (1995 is an estimated value by OECD Stat) |
| Luxembourg | LUX | Luxembourg Income Study | Income | Same as median | 1994, 2007 | OECD Stat |
| Malaysia | MYS | PovcalNet | Income | Same as median | 1995, 2007 | No data available |
| Mexico | MEX | PovcalNet | Income | LIS data was available for both years, the only country with both years available in both the PovcalNet and LIS databases. LIS data was deemed reliable for the income dispersion to calculate GINIs. But PovcalNet was more reliable for the absolute levels of median income. | 1994, 2007 for median income. 1994, 2008 for GINI. | Trapp 2015 |
| Netherlands | NLD | Luxembourg Income Study | Income | Same as median | 1993, 2007 | OECD Stat |

| Country | Country code | Median income source | Type of data / complication | GINI Source | Years of reported data | Labor's Share Source |
|---|---|---|---|---|---|---|
| New Zealand | NZL | UNU Wider – WIID 3.3 | Income (Not available near the years desired in either LIS or PovcalNet, data comes from OECDStat gathered by the WIID database). Due to its consistency it was used to calculate the rate of change. However, given that it was household reported income and not individual income, the 2008 income level was estimated in order to construct the composite variable of 2008 final value + rate of change between 1995 and 2008 | Due to the consistency of the source reporting the GINIs for 1995 and 2008 in the WIID database, coupled with the larger variation around 1995 in the different sources reported in the "all the Ginis" database, the WIID estimates were taken for both 1995 and 2008. | 1995, 2008 | OECD Stat |
| Norway | NOR | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| Philippines | PHL | PovcalNet | Consumption | Same as median | 1994, 2009 | Trapp 2015 |
| Poland | POL | Luxembourg Income Study | Income | Same as median | 1995, 2007 | Trapp 2015 |
| Portugal | PRT | UNU Wider – WIID 3.3 | Income (Not available near the years desired in either LIS or PovcalNet, data comes from the European Commission gathered by the WIID database) | Due to the consistency of the source reporting the GINIs for 1995 and 2008 in the WIID database, coupled with the non-availability of data in the "all the Ginis" database, the WIID estimates were taken for both 1995 and 2008. | 1995, 2006 | OECD Stat |
| Romania | ROU | PovcalNet | Consumption | Same as median | 1998, 2008 | Trapp 2015 |
| Russia | RUS | PovcalNet | Consumption | Same as median | 1996, 2008 | Trapp 2015 |
| Slovakia | SVK | Luxembourg Income Study | Income | Same as median | 1996, 2007 | Trapp 2015 (2008 not available, 2006 used) |
| Slovenia | SVN | Luxembourg Income Study | Income (However, the rate of change was estimated, because there seems to have been a problem with the 1995 data for Slovenia in LIS, thus making a rate of change calculation difficult although the 2008 data is reliable for the final 2008 value). | Luxembourg Income Study (the problem with the 1995 data for Slovenia relates to the absolute magnitude of the 50$^{th}$ percentile value and not to the relative dispersal of income among the whole population, so it was still considered reliable to calculate the GINI. | 1997, 2007 | OECD Stat |
| South Africa | ZAF | PovcalNet | Consumption | Same as median | 1995, 2008 | Trapp 2015 |
| South Korea | KOR | Data not available | Estimated | The GINI is available to calculate from LIS for 2008 only. For 1995, the "all the Ginis" database provides two estimates with the same figure for 1998, one of which also provides a 1993 estimate. The 1993 estimate was therefore taken. | 1993, 2006 for GINI. | OECD Stat |
| Spain | ESP | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| Sweden | SWE | Luxembourg Income Study | Income | Same as median | 1995, 2005 | OECD Stat |
| Switzerland | CHE | Report – "L'évolution des inégalités de revenus en Suisse" | Income (Available for 1995 only from the LIS, but not taken since it is available for both years from the same source as an individualized income through the household equivalence scale, the best available data to calculate an internally consistent rate of change) | Luxembourg Income Study is available for 1995 but not for 2008. For 2008, it is listed at 32.3 by two different data sets gathered by the "all the Ginis" database, without any far away values from other data sets, so the 32.3 figure was taken. | 1998, 2006 for median income. 1992, 2008 for GINI. | OECD Stat |
| Thailand | THA | PovcalNet | Consumption | Same as median | 1994, 2008 | Trapp 2015 |
| Tunisia | TUN | PovcalNet | Consumption | Same as median | 1995, 2010 | Trapp 2015 |
| Turkey | TUR | PovcalNet | Consumption | Same as median | 1994, 2008 | Trapp 2015 (2008 not available, 2006 used) |
| United Kingdom | GBR | Luxembourg Income Study | Income | Same as median | 1995, 2007 | OECD Stat |
| United States | USA | Luxembourg Income Study | Income | Same as median | 1994, 2007 | OECD Stat |
| Vietnam | VNM | PovcalNet | Consumption | Same as median | 1998, 2008 | No data available |

*Gini coefficient*

The gini coefficient was used as a general measure of inequality in a country. Since, unlike the other variables, a lower gini score reflects a better outcome (in this case, lower inequality), the gini score was accordingly adjusted in order to vary in the same direction as the other variables (so that a higher score reflects a better outcome). In the case of the rate of change, this was done by the formula: (2008 Gini / 1995 Gini) – 1. In the case of the 1995 value for the composite measure (see below), this was done by the formula: 100 – 1995 Gini.

In terms of the calculations to get the gini coefficients, these were in the vast majority of cases computed with the same income distribution data that provided the median income values (principally the Luxembourg Income Study and PovcalNet data – thus the gini variable posed a similar weight as median income in the need to restrict the end point to 2008).

The gini coefficients, when data was available in the Luxembourg Income Study database, were calculated according to the method provided by the Luxembourg Income Study (2016: 27). The gini coefficient for "per capita income" was used, in order to be consistent with the way the data from PovcalNet is presented. The gini scores that were calculated by the distribution income provided by PovcalNet were calculated according to the method developed by Datt (1998) by using the "povcal software" calculator listed in Datt's paper to perform the calculations, taking the Beta Lorenz curve estimates. All ginis were double checked against all sources with data available for the given years in the "All the Ginis" database. The "All the Ginis" dataset lists all ginis available from any of eight original sources for all countries for all years from 1950 to 2012. The problem is one of direct comparability between the sources, with no single source providing estimates for the desired years for most countries. The direct calculations from the Luxembourg Income Study and PovcalNet were therefore more desirable for the majority of the countries (see above Table 1). The method of double checking the LIS and PovcalNet calculated ginis against the "All the Ginis" dataset was to compare the calculated value with all values given within 3 years of the benchmark year from any

source reporting in the "All the Ginis" dataset. The direct calculations used from the LIS and PovcalNet data were in all cases within a 20 percent variation range of the majority of available estimates within three years of the benchmark year in the "All the Ginis" database, with the exception of Russia and Romania for 1995, although both of the latter corresponded to the PovcalNet estimate reported in the "All the Ginis" database and thus were kept.

For the eight cases where LIS or PovcalNet data were not available for a gini calculation for either one year or both (see above

Table 10), the most consistent number appearing closest to the benchmark years from the "All the Ginis" was taken or, in the cases of New Zealand and Portugal, where there was no consistent figure, the UNU Wider WIID 3.3 database estimate was taken which corresponded to the median income figure and was thus internally consistent. As can be seen in the above

Table 10, Iceland needed to be estimated for 1995 to calculate the rate of change, since none of the above options provided a reliable figure.

### *Labor's share of income*

As the gini coefficient is unable to distinguish between trends in primary and secondary income flows, labor's share of income was also taken as a measure of the balance of power between capital and labor in the production process itself. The data were taken from OECDStat's "labour income share ratios – total economy" for most OECD countries

and from the data set constructed by Katharina van Treeck that measures labor's share in low and medium income countries (Trapp, 2015). The above Table 1 lists the source for all countries, in addition to mentioning if a surrounding year was used rather than the benchmark year in cases of incomplete data, and the three cases where the 1995 value from OECDStat was an estimation on their behalf (all in the labor's share source column).

Since the database that van Treeck constructed is more robust and finely attuned to the reality of extensive self-employment in many developing economies, data were taken from this data set whenever they were available in both data sets. This was the case for Czech Republic, Estonia, Hungary, Mexico, Poland, Romania, Slovakia, Turkey. While Trapp's data was taken in all eight of these cases, there was only 1 case out of 8 where the 1995 values from the different data sets differed by more than 20 percent, and only 2 cases out of 8 where this was the case for the 2008 values. In the case of four countries (Cambodia, Indonesia, Malaysia, Vietnam) where data was not available in either data set, the values were estimated using the NIPALS method.

Labor's share is another variable leading us to restrict the end year of the time period to 2008, as in addition to the 4 countries needing to be estimated in 2008, a 2011 end point would lead to using 2008 or pre-2008 values for eight other countries, or searching for 2011 values for such countries from other data sources, further weakening internal consistency.

# 2. PRINCIPAL COMPONENT ANALYSIS

In this second part of the annex we present some statistical output of the principal component analysis that have been excluded from the paper and can interest some readers that would like to enter further into the details. When pertinent to the appraisal of the methodological choices explained in the paper, information regarding the axis that has not been retained (axis F4) has been included. We retained three axes for the

following three reasons. First, following the Kaiser criterion (Kaiser, 1960), axes F1, F2 and F3 were the ones with eigenvalues above 1. Second, while the decrease in eigenvalues from F1 to F3 where smooth, the decrease from axis F3's eigenvalue to axis F4's was sharp, which indicates that axes F1 to F3 should be retained (see the appendix). Third, taking axes F1, F2 and F3 provided significant correlations (over 0.76) between axes and at least one of the variables. Had we taken only two, the variable SOCIAL_INDEX, would have been virtually uncorrelated with the axes while it is very strongly correlated (0.97) with axis F3.

No rotations were applied because the information concentrated in the first three axes showed virtually no increase when rotations where tested.

Regarding the clustering, we tested two methods. The first one is the agglomerative hierarchical clustering (AHC) method, which, when applied to the coordinates of each observation in the three axes retained, shows the number and (country) composition of classes for which classes can be considered homogeneous. The result obtained was that three classes was the best choice. We then tested the k-mean clustering method for purpose of robustness: That is, we performed a cluster analysis using the k-means method on the coordinates of the observations in axes F1, F2 and F3 of the PCA with an open range of classes from 1 to 5. Contrary to the AHC method, the k-mean clustering method implies choosing the number of classes beforehand to obtain their (country) composition. After having tried several number of classes, the conclusion was also that 3 classes is the most solid choice.

Table 8 shows the country composition of each class along with the number of countries in each, the sum of weights, within-class variance, and minimum, average and maximum distance to centroid for each class.

**Table 11: Eigenvalues, variability and cumulative variability for axes F1 to F4**

| | F1 | F2 | F3 | F4 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Eigenvalue | 1,225 | 1,097 | 1,004 | 0,674 |
| Variability (%) | 30,626 | 27,427 | 25,088 | 16,859 |
| Cumulative % | 30,626 | 58,053 | 83,141 | 100,000 |

**Table 12: Eigenvectors for each variable for axes F1 to F4**

| | F1 | F2 | F3 | F4 |
|---|---|---|---|---|
| PART_INDEX | 0,689 | 0,347 | 0,203 | -0,603 |
| VALCAPT_INDEX | 0,023 | 0,867 | -0,150 | 0,474 |
| INVESTMENT_INDEX | 0,705 | -0,349 | 0,037 | 0,616 |
| SOCIAL_INDEX | -0,168 | 0,075 | 0,967 | 0,177 |

**Table 13: Squared cosines of the variables for axes F1 to F4**

| | F1 | F2 | F3 | F4 |
|---|---|---|---|---|
| PART_INDEX | **0,581** | 0,132 | 0,041 | 0,246 |
| VALCAPT_INDEX | 0,001 | **0,825** | 0,023 | 0,152 |
| INVESTMENT_INDEX | **0,609** | 0,134 | 0,001 | 0,256 |
| SOCIAL_INDEX | 0,035 | 0,006 | **0,938** | 0,021 |

*Values in bold correspond for each variable to the factor for which the squared cosine is the largest*

**Table 14: Factor scores of each observation for axes F1 to F3**

| Observation | F1 | F2 | F3 |
|---|---|---|---|
| ARG | -0,033 | -0,562 | -0,428 |
| AUS | -1,148 | -2,651 | 0,300 |
| AUT | -0,416 | 1,263 | 0,818 |
| BEL | -0,096 | 0,020 | 0,873 |
| BRA | -0,867 | 0,046 | 0,006 |
| CAN | -1,045 | -0,584 | 0,355 |
| CHE | -0,046 | 1,914 | 1,046 |
| CHL | -0,541 | -1,800 | -0,306 |
| CHN | 2,477 | 0,573 | -0,763 |
| COL | -1,084 | -0,096 | -1,844 |
| CRI | 1,245 | 0,770 | -0,661 |
| CZE | 1,342 | -0,278 | 0,025 |
| DEU | -0,437 | 1,942 | 0,203 |
| DNK | -0,340 | -0,129 | 0,992 |
| ESP | -0,036 | -0,534 | 0,838 |
| EST | 0,603 | 0,279 | -0,093 |
| FIN | 0,086 | 0,255 | 0,457 |
| FRA | -0,704 | 0,367 | -0,066 |
| GBR | -2,051 | 1,132 | 0,360 |
| GRC | -0,901 | -1,134 | 0,179 |
| HRV | 1,565 | -0,790 | -0,871 |
| HUN | 0,752 | -0,090 | 0,305 |
| IDN | -0,082 | -1,583 | -0,388 |
| IND | 1,782 | -0,302 | -1,551 |
| IRL | 0,707 | 0,687 | 2,251 |
| ISL | -0,247 | -1,036 | 2,856 |

| | | | |
|---|---|---|---|
| ISR | -1,295 | 1,526 | -0,925 |
| ITA | -1,009 | 0,531 | -0,183 |
| JPN | -0,061 | 2,160 | -1,243 |
| KHM | -0,150 | 2,064 | 0,317 |
| KOR | 1,325 | -0,189 | 0,395 |
| LUX | 1,648 | 0,404 | 1,069 |
| MEX | -0,056 | -0,628 | -1,726 |
| MYS | 1,853 | -0,324 | -0,131 |
| NLD | -1,539 | 1,512 | 0,810 |
| NOR | -1,189 | -1,617 | 0,505 |
| NZL | -1,506 | -0,958 | 0,801 |
| PHL | -1,114 | 1,257 | -1,490 |
| POL | 0,797 | 0,070 | -0,964 |
| PRT | -0,940 | -0,254 | 0,271 |
| ROU | 0,716 | -1,588 | -0,374 |
| RUS | -1,233 | -1,932 | 0,088 |
| SVK | 1,415 | -0,107 | 0,534 |
| SVN | 1,161 | 0,211 | 0,385 |
| SWE | -0,292 | 0,768 | 0,723 |
| THA | 1,605 | -0,210 | 0,334 |
| TUN | 0,176 | 0,270 | -0,951 |
| TUR | -1,047 | -0,138 | -1,571 |
| USA | -1,741 | 0,193 | -0,102 |
| VNM | 1,891 | -0,209 | 1,234 |
| ZAF | 0,101 | -0,491 | -2,697 |

**Table 15: Contributions of the observations to axes F1 to F3 (in percentage points)**

| | F1 | F2 | F3 |
|---|---|---|---|
| ARG | 0,002 | 0,565 | 0,358 |
| AUS | 2,111 | 12,560 | 0,176 |
| AUT | 0,277 | 2,853 | 1,307 |
| BEL | 0,015 | 0,001 | 1,489 |
| BRA | 1,202 | 0,004 | 0,000 |
| CAN | 1,747 | 0,609 | 0,246 |
| CHE | 0,003 | 6,550 | 2,137 |
| CHL | 0,468 | 5,792 | 0,183 |
| CHN | 9,817 | 0,587 | 1,137 |
| COL | 1,881 | 0,016 | 6,643 |
| CRI | 2,482 | 1,060 | 0,853 |
| CZE | 2,882 | 0,138 | 0,001 |
| DEU | 0,306 | 6,744 | 0,081 |
| DNK | 0,185 | 0,030 | 1,922 |
| ESP | 0,002 | 0,509 | 1,371 |
| EST | 0,581 | 0,139 | 0,017 |
| FIN | 0,012 | 0,116 | 0,409 |
| FRA | 0,793 | 0,241 | 0,008 |
| GBR | 6,732 | 2,291 | 0,253 |
| GRC | 1,300 | 2,300 | 0,063 |
| HRV | 3,918 | 1,115 | 1,483 |
| HUN | 0,906 | 0,014 | 0,182 |
| IDN | 0,011 | 4,479 | 0,294 |
| IND | 5,083 | 0,162 | 4,701 |
| IRL | 0,800 | 0,844 | 9,899 |
| ISL | 0,098 | 1,919 | 15,939 |

| | | | |
|---|---|---|---|
| ISR | 2,683 | 4,162 | 1,673 |
| ITA | 1,630 | 0,503 | 0,066 |
| JPN | 0,006 | 8,340 | 3,020 |
| KHM | 0,036 | 7,611 | 0,196 |
| KOR | 2,810 | 0,064 | 0,305 |
| LUX | 4,347 | 0,291 | 2,232 |
| MEX | 0,005 | 0,706 | 5,821 |
| MYS | 5,497 | 0,188 | 0,034 |
| NLD | 3,790 | 4,084 | 1,281 |
| NOR | 2,262 | 4,674 | 0,499 |
| NZL | 3,630 | 1,640 | 1,252 |
| PHL | 1,985 | 2,822 | 4,339 |
| POL | 1,017 | 0,009 | 1,814 |
| PRT | 1,415 | 0,116 | 0,143 |
| ROU | 0,821 | 4,504 | 0,273 |
| RUS | 2,435 | 6,674 | 0,015 |
| SVK | 3,205 | 0,021 | 0,558 |
| SVN | 2,157 | 0,080 | 0,289 |
| SWE | 0,136 | 1,054 | 1,022 |
| THA | 4,123 | 0,079 | 0,217 |
| TUN | 0,050 | 0,130 | 1,766 |
| TUR | 1,754 | 0,034 | 4,825 |
| USA | 4,852 | 0,066 | 0,020 |
| VNM | 5,722 | 0,078 | 2,973 |
| ZAF | 0,016 | 0,432 | 14,214 |

**Table 16: Squared cosines of the observations for axes F1 to F4**

| | F1 | F2 | F3 | F4 |
|---|---|---|---|---|
| ARG | 0,001 | 0,146 | 0,085 | **0,768** |
| AUS | 0,153 | **0,816** | 0,010 | 0,021 |
| AUT | 0,068 | **0,627** | 0,263 | 0,042 |
| BEL | 0,012 | 0,001 | **0,986** | 0,002 |
| BRA | **0,830** | **0,002** | **0,000** | 0,168 |
| CAN | **0,622** | 0,194 | 0,072 | 0,112 |
| CHE | 0,000 | **0,728** | 0,217 | 0,055 |
| CHL | 0,070 | **0,780** | 0,022 | 0,127 |
| CHN | **0,563** | 0,030 | 0,053 | 0,354 |
| COL | 0,255 | 0,002 | **0,737** | 0,006 |
| CRI | **0,525** | 0,201 | 0,148 | 0,127 |
| CZE | **0,906** | 0,039 | 0,000 | 0,055 |
| DEU | 0,045 | **0,893** | 0,010 | 0,052 |
| DNK | 0,094 | 0,014 | **0,796** | 0,096 |
| ESP | 0,001 | 0,147 | 0,363 | **0,488** |
| EST | **0,497** | 0,107 | 0,012 | 0,385 |
| FIN | 0,015 | 0,130 | 0,420 | **0,435** |
| FRA | **0,581** | 0,158 | 0,005 | 0,256 |
| GBR | **0,748** | 0,228 | 0,023 | 0,001 |
| GRC | 0,370 | **0,586** | 0,015 | 0,029 |
| HRV | 0,355 | 0,091 | 0,110 | **0,444** |
| HUN | 0,175 | 0,002 | 0,029 | **0,794** |
| IDN | 0,002 | **0,696** | 0,042 | 0,261 |
| IND | **0,551** | 0,016 | 0,418 | 0,015 |
| IRL | 0,079 | 0,075 | **0,801** | 0,045 |
| ISL | 0,006 | 0,112 | **0,850** | 0,032 |

| | | | | |
|---|---|---|---|---|
| ISR | 0,345 | **0,479** | 0,176 | 0,000 |
| ITA | **0,762** | 0,211 | 0,025 | 0,002 |
| JPN | 0,001 | **0,749** | 0,248 | 0,003 |
| KHM | 0,005 | **0,964** | 0,023 | 0,008 |
| KOR | **0,729** | 0,015 | 0,065 | 0,191 |
| LUX | 0,196 | 0,012 | 0,082 | **0,710** |
| MEX | 0,001 | 0,112 | **0,844** | 0,044 |
| MYS | **0,795** | 0,024 | 0,004 | 0,176 |
| NLD | **0,358** | 0,346 | 0,099 | 0,197 |
| NOR | 0,328 | **0,607** | 0,059 | 0,006 |
| NZL | **0,591** | 0,239 | 0,167 | 0,003 |
| PHL | 0,238 | 0,303 | **0,426** | 0,033 |
| POL | 0,283 | 0,002 | **0,413** | 0,302 |
| PRT | **0,831** | 0,061 | 0,069 | 0,040 |
| ROU | 0,151 | **0,740** | 0,041 | 0,068 |
| RUS | 0,267 | **0,655** | 0,001 | 0,077 |
| SVK | **0,541** | 0,003 | 0,077 | 0,379 |
| SVN | **0,677** | 0,022 | 0,074 | 0,226 |
| SWE | 0,066 | **0,456** | 0,405 | 0,073 |
| THA | **0,942** | 0,016 | 0,041 | 0,001 |
| TUN | 0,029 | 0,067 | **0,832** | 0,073 |
| TUR | 0,285 | 0,005 | **0,642** | 0,068 |
| USA | **0,979** | 0,012 | 0,003 | 0,005 |
| VNM | **0,661** | 0,008 | 0,281 | 0,049 |
| ZAF | 0,001 | 0,029 | **0,867** | 0,103 |

*Values in bold correspond for each observation to the factor for which the squared cosine is the largest*

**Table 17: Country composition of the classes found using the k-clustering and statistical results by class (World Bank country abbreviations)**

| Class | 1 | 2 | 3 |
|---|---|---|---|
| Objects | 14 | 16 | 21 |
| Sum of weights | 14 | 16 | 21 |
| Within-class variance | 1,559 | 1,886 | 1,995 |
| Minimum distance to centroid | 0,402 | 0,517 | 0,371 |
| Average distance to centroid | 1,109 | 1,272 | 1,225 |
| Maximum distance to centroid | 2,398 | 2,006 | 2,740 |
| | Argentina | Austria | China |
| | Australia | Brazil | Costa Rica |
| | Belgium | Switzerland | Czech Republic |
| | Canada | Colombia | Estonia |
| | Chile | Germany | Finland |
| | Denmark | France | Croatia |
| | Spain | United Kingdom | Hungary |
| | Greece | Israel | India |
| | Indonesia | Italy | Ireland |
| | Iceland | Japan | South Korea |
| | Norway | Cambodia | Luxembourg |
| | New Zealand | Netherlands | Mexico |
| | Portugal | Philippines | Malaysia |
| | Russian Federation | Sweden | Poland |
| | | Turkey | Romania |
| | | United States | Slovakia |

| |
|---|
| Slovenia |
| Thailand |
| Tunisia |
| Viet Nam |
| South Africa |

# 3. MEASURING THE IMPACT OF AUTHOR'S METHODOLOGICAL CHOICES IN GVC PARTICIPATION AND VALUE CAPTURE INDICATORS

In Section 3 of the paper we proposed new indicators to measure GVC participation and value capture. Each of these indicators presents a series of methodological differences in their construction in respect to traditional ones. The objective of this Annex is to measure, for each indicator, the impact each methodological change had on the different results we obtain when compared to those of traditional indicators.

We will measure this impact in three ways. Firstly, we will look at how much each methodological change affected the country ranking of GVC participation and value capture respectively. Secondly, we will calculate how each methodological change separately affected the correlation between the author's indicators and the traditional ones. Finally, we will do the PCA and cluster analyses we had carried on in Section 4 using the traditional GVC participation and value capture indicators in order to show the impact our methodological innovations in calculating these two indicators affect the conclusions that can be reached regarding the link between GVC participation and developmental outcomes.

## 3.1 GVC participation

As shown in Table 2, the author's GVC participation indicator presents three methodological differences compared to the traditional indicator:

1. While the traditional indicator includes primary commodities, the author's does not
2. The denominator of the traditional indicator is gross exports, while the denominator of the author's indicator is GDP
3. The traditional indicator applies the 'two borders rule', while the author's does not.

Difference number 3 means that, when calculating the traditional GVC participation indicator, only if a good has been exported from a country A to a country B and then to a third country C (i.e. only when the good has crossed two borders) that trade is considered to be GVC-related and therefore measured in the traditional GVC participation indicator. In terms of measurement, this implies that in order to measure a country's GVC participation, the numerator of the indicator considers only the imports of re-exported intermediate inputs (VS) and the exports of intermediate inputs that are re-exported by the importer (VS1). For the reasons detailed in subsection 3.1, the author's indicator does not follow the two borders rule. Therefore, in order to measure the GVC participation of a given country, it considers the imports of all intermediate inputs regardless of the fact that they are re-exported or not, while it excludes the imports of finished products. Regarding exports, it includes both the exports of all intermediate inputs and final products.

In order to measure the impact each of these changes had on the country ranking of GVC participation in respect to the traditional indicator, we calculated this ranking for a series of 'intermediate indicators' in which we introduce only one of the methodological changes into the traditional indicator at a time. Then we measure the average absolute difference in terms of rankings with the traditional indicator in order to quantify the impact each of the three above-mentioned methodological changes had in terms of country rankings.

Another way to measure the impact each methodological change had in respect to the traditional GVC participation indicator is to calculate the Pearson correlation coefficient between each intermediate indicator and the traditional indicator. Lower correlations would indicate a larger departure from the results expected from the traditional indicator, which translates into a higher impact of the methodological change in question.

The results are presented in Tables 8 and 9.

**Table 18: Absolute difference in country rankings between author's GVC participation indicator, intermediate indicators and the traditional GVC participation indicator for 1995 and 2011**

| Year | Author's GVC participation indicator | Standard GVC participation indicator without commodities | Standard GVC participation indicator with GDP in the denominator | Standard GVC participation indicator without the two borders rule |
|---|---|---|---|---|
| 1995 | 7.8 | 9.3 | 7.1 | 17.2 |
| 2011 | 9.2 | 9.9 | 7.0 | 16.9 |

NB: All comparison are made in respect to the traditional GVC participation indicator

Table 8 shows that, among the three methodological differences the author's GVC participation presents in respect to the traditional one, the non-inclusion of the two borders rule is the one that has the higher impact regarding the changes in the ranking. In effect, when the author's indicators is used in 1995, a country shifts in average 7.8 positions in the country ranking of GVC participation in comparison to the ranking that would be obtained using the traditional indicator. If only the two borders rule was lifted from the traditional indicator, each country would switch in average 17.2 positions in 1995.

**Table 19 : Pearson correlation coefficient between author's value capture indicator with and without commodities and the traditional value capture indicator for 1995 and 2011**

| Year | Author's GVC participation indicator | Standard GVC participation indicator without commodities | Standard participation indicator with GDP in the denominator | Standard GVC participation indicator without the two borders rule |
|---|---|---|---|---|
| 1995 | 0.81 | 0.58 | 0.83 | 0.12 |
| 2011 | 0.72 | 0.53 | 0.77 | 0.21 |

NB: All correlations are calculated with the traditional GVC participation indicator

The results of Table 9 go in the same direction as those of Table 8. When only the two borders rule is lifted from the traditional indicator, its correlation with the traditional indicator drops to 0.12 in 1995 and 0.21 in 2011. Moreover, when only commodities are removed from the traditional indicator the correlation with the latter drops to 0.58 and 0.53 in 1995 and 2011 respectively, while in other cases they remain above 0.7. This shows that the elimination of the two border rules is the methodological change that has the higher impact in changing the results obtained with the traditional GVC participation indicator both in terms of country ranking and correlation.

## 3.2 Value capture

As explained in subsection 3.2 of the article, two methodological changes were introduced in the author's value capture indicator in respect to the traditional one (domestic value added content of gross exports), namely:

1. While the traditional value capture indicator considers commodities, the authors' does not

2. While the traditional value capture indicator has gross exports in the denominator, the author's has what we consider 'GVC related trade': domestic value added in exports and imports of all intermediate inputs.

In order to calculate the impact the change of the denominator we introduced (difference number 2) had in terms of country ranking and correlation with the traditional indicator, we calculate an intermediate indicator in which only the denominator is changed in respect to the traditional one. The same could not be done regarding difference number 1 because, in order to exclude primary commodities from both the numerator and the denominator of the original indicator, we would have to multiply both by the share of non-primary-commodities in exports of the country, which would result in the indicator remaining unchanged. Therefore, the separate effect of having removed primary commodities from the traditional value capture indicator is to be assessed by comparing overall changes between the traditional and the author's indicator and change between the traditional and the intermediate value capture indicator mentioned above.

The results of the same calculations done in subsection 3.1 of this Appendix are presented in Tables 10 and 11 regarding value capture indicators.

**Table 20: Absolute difference in country rankings between author's value capture indicator with and without commodities and the traditional value capture indicator for 1995 and 2011**

| Year | Traditional value capture indicator with author's GVC-related trade in the denominator | Author's value capture indicator (excluding commodities) |
|---|---|---|
| 1995 | 10.4 | 21.1 |
| 2011 | 6.8 | 20.6 |

NB: comparison are made with the traditional value capture indicator: domestic value added content of gross exports

Table 10 shows that the difference in terms of country ranking when the author's indicator is used is considerable. In average, countries switch 21.1 positions in 1995 and 20.6 positions in 2011 in comparison with the positions they would occupy in the ranking if the traditional value capture indicator was used. This difference drops to 10.4 and 6.8 for 1995 and 2011 respectively if only the change of the denominator is introduced. This shows that both of the changes introduced in respect to the traditional value capture indicator are relevant to explain the shifts in country rankings, although the relevance of having excluded commodities seems to grow over time, which is consistent with the timing of the commodity boom.

**Table 21: Pearson correlation coefficient between author's value capture indicator, the traditional value capture indicator with author's GVC-related trade in the denominator and the traditional value capture indicator for 1995 and 2011**

| Year | Traditional value capture indicator with author's GVC-related trade in the | Author's value capture indicator (excluding primary commodities) |
|---|---|---|

| | denominator | |
|---|---|---|
| 1995 | 0.73 | -0.09 |
| 2011 | 0.82 | -0.18 |

When analyzing the impact of the two above-mentioned methodological changes in respect to the traditional value capture indicator in terms of correlation with the latter, the exclusion of primary commodities appears as having an enormous impact. Indeed, when only the denominator is changed from gross exports to author's GVC-related trade, the correlation of that indicator and the traditional value capture indicator remains high (0.73 and 0.82 in 1995 and 2011, respectively). On the contrary, if the author's indicator is used, the correlation is insignificantly negative for both 1995 and 2011. Therefore, of the two changes introduced, the exclusion of primary commodities is the one that had the higher impact.

## 3.3 PCA and cluster analysis using traditional indicators of GVC participation and value capture

We have seen in subsections 3.1 and 3.2 of the article that using authors' GVC participation and value capture indicators instead of the traditional ones alters considerably country rankings. In subsections 3.1 and 3.2 we have analyzed, for each of the authors' indicators, the separate effect each methodological change in respect to the traditional indicator had in terms of country ranking and correlation with the traditional indicator. Nevertheless, one could think that, although there are considerable variations in terms of country ranking when the authors' indicators are used, the effect of using the authors' indicators instead of the traditional ones would be minor in the PCA and cluster analysis carried on in the article, since correlations between authors' and the traditional GVC participation and value capture indicator remain reasonably high.

In order to see if the use of alternative GVC participation and value capture indicators had an important effect on the PCA and the cluster analysis carried on in the article, we present in this subsection of the Appendix the results of the same analyses using the

traditional GVC participation and value capture indicators, while keeping the other variables and parameters intact.

### 3.3.1 PCA USING TRADITIONAL GVC PARTICIPATION AND VALUE CAPTURE INDICATORS

In this subsection we will compare the factor loadings of each variable on axes F1, F2 and F3 and the square cosines of each variable in each axes when traditional and authors' GVC participation and value capture are used.

**Table 22: Factor loadings of each variable for axes F1, F2 and F3 using authors' GVC participation and value capture indicators**

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | **0.76** | 0.36 | 0.20 |
| VALCAPT_INDEX | 0.03 | **0.91** | -0.15 |
| INVESTMENT_INDEX | **0.78** | -0.37 | 0.04 |
| SOCIAL_INDEX | -0.19 | 0.08 | **0.97** |

NB: the highest factor loading of each variable is presented in bold

**Table 23: Factor loadings of each variable for axes F1, F2 and F3 traditional GVC participation and value capture indicators**

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | 0.534 | **0.590** | 0.273 |
| VALCAPT_INDEX | 0.424 | -0.516 | **0.719** |
| INVESTMENT_INDEX | -0.425 | **0.637** | 0.466 |
| SOCIAL_INDEX | **0.710** | 0.246 | -0.356 |

NB: the highest factor loading of each variable is presented in bold

When comparing tables 12 and 13 we can see that in both PCAs the association between variables remains the same: GVC participation and investment seem to be correlated, while value capture and social index seem to be independent, each being located at the extremes of separate axes. Nevertheless, it should be noted that correlations with the axes are in all cases higher when authors' indicators are used, which indicates that the conclusions to be drawn from that PCA are more trustworthy than those obtained with a PCA that uses traditional GVC and value capture indicators.

**Table 24: Squared cosines of the variables for axes F1, F2 and F3 using authors' GVC participation and value capture indicators**

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | **0.581** | 0.132 | 0.041 |
| VALCAPT_INDEX | 0.001 | **0.825** | 0.023 |
| INVESTMENT_INDEX | **0.609** | 0.134 | 0.001 |
| SOCIAL_INDEX | 0.035 | 0.006 | **0.938** |

**Table 25: Squared cosines of the variables for axes F1, F2 and F3 using traditional GVC participation and value capture indicators**

| | F1 | F2 | F3 |
|---|---|---|---|
| PART_INDEX | 0.286 | **0.348** | 0.075 |
| VALCAPT_INDEX | 0.180 | 0.266 | **0.517** |
| INVESTMENT_INDEX | 0.181 | **0.406** | 0.217 |
| SOCIAL_INDEX | **0.503** | 0.061 | 0.127 |

When we examine the squared cosines of the variables for axes F1, F2 and F3 for both PCAs, the differences between the two widen. In the PCA that uses authors' GVC participation indicator, the share of information of each variable contained in the axis to which it is associated is considerable, never below 58% (cf. Table 13). On the contrary, in the PCA that uses traditional GVC and value capture indicators that share of information never goes *beyond* 52%. Therefore, the conclusions to be drawn from the PCA that uses the traditional GVC participation and value capture are to be interpreted with cautiousness, while those of the authors' PCA are robust.

### 3.3.2 CLUSTER ANALYSIS USING TRADITIONAL GVC PARTICIPATION AND VALUE CAPTURE INDICATORS

We now compare the country composition of the three classes that arise from the k-means cluster analyses in both PCAs.

**Table 26: Comparison of country composition of the classes using the author's and the standard GVC participation and value capture indicators**

| Class 1 of the authors' grouping | Class 2 of the authors' grouping | Class 3 of the authors' grouping |
|---|---|---|
| Argentina | Brazil | Czech Republic |
| Canada | Philippines | Finland |
| Greece | United States | Hungary |
| Indonesia | **Colombia** | Ireland |

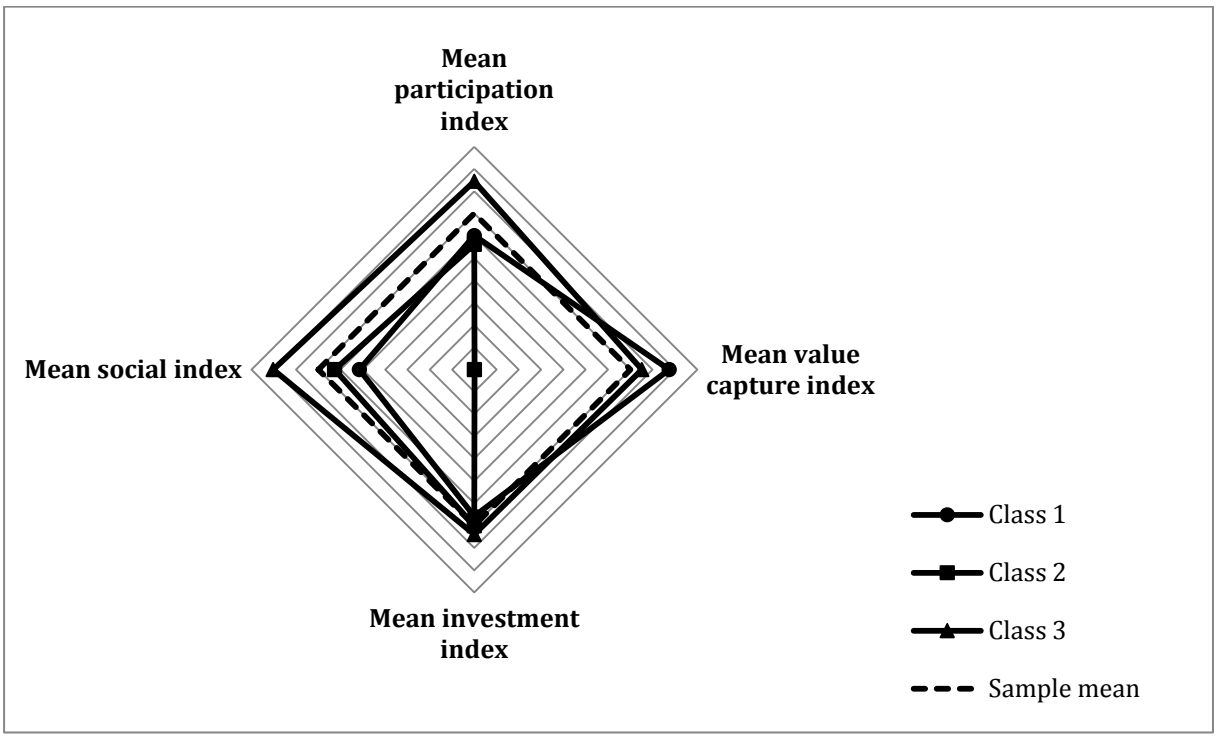
| | | | |
|---|---|---|---|
| | Portugal | **Germany** | South Korea |
| | Russian Federation | **France** | Luxembourg |
| | **Australia** | **United Kingdom** | Malaysia |
| | **New Zealand** | **Israel** | Slovakia |
| | **Belgium** | **Italy** | Slovenia |
| | **Chile** | **Japan** | Thailand |
| | **Denmark** | **Turkey** | Viet Nam |
| | **Spain** | **Austria** | **Costa Rica** |
| | **Iceland** | **Switzerland** | **Estonia** |
| | **Norway** | **Cambodia** | **Croatia** |
| | | **Netherlands** | **India** |
| | | **Sweden** | **Mexico** |
| | | | **Poland** |
| | | | **South Africa** |
| | | | **China** |
| | | | **Romania** |
| | | | **Tunisia** |
| Percentage of countries having switched classes | 57% | 81% | 48% |
| Number of countries added/subtracted from the authors' original class | 7 | -8 | 1 |

NB: Countries in bold are those that switched classes when traditional GVC participation and value capture indicators were used to perform the PCA and the cluster analysis

As Table 16 shows, when the cluster analysis is performed using the PCA that includes the standard GVC participation and value capture indicators the country composition of the three classes, as well as the length of classes 1 and 2, are considerably altered.

Finally, if we analyze the characteristics of each class in terms of the values each variable take for each of them we find a profile very different to that found when the authors' GVC participation and value capture indicators were used.

**Figure 5: Mean value of each variable by class and for the sample when traditional GVC participation and value capture indicators are used**




As shown in Figure 1, when traditional GVC participation and value capture indicators are used the profiles of each group differ radically from those obtained using the authors' indicators. Class 1 and class 3 have no distinct profile. All the variables are close to the sample mean. The same applies to class 2, with the exception of value capture, which takes a very low value, making this the only distinctive trait to be found in the profile of the three classes.

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