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REVISITING GROWTH ACCOUNTING FROM A TRADE IN VALUE-ADDED PERSPECTIVE

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Abstract: *Global Manufacturing and International Supply Chains changed the way trade and international economics are understood today. The present essay builds on recent statistical advances to suggest new ways of looking at the demand and supply side approaches when Global Value Chains (GVCs) —articulating supply and demand chains from an international perspective— are taken into consideration. This pilot case focuses on the G-20 countries, a group of leading developed and developing economies which took a prominent role in fostering and managing global economic governance. The paper is organised into two independent parts. The demand dynamics is first analysed through a growth-accounting decomposition, then through the long term determinants of income elasticity of imports. The second part looks at the implications of global manufacturing for our understanding of the supply-side growth dynamics, privileging a trade perspective: the definition of comparative advantages and the potential for value-chain up-grading.*

Keywords: Global value chains, trade and development, growth accounting, import elasticity, revealed comparative advantages, competitiveness benchmarking.
JEL: C18, C67, F14, F19, F43, F63, O11, O19, O41, O47, O57

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[1] Opinions are personal; in particular, they do not represent WTO's views. I thank L. Chang for her comments, Ch. Degain for doing the matrix calculations mentioned in Box 1, R. Inklaar for his advice concerning the use of the Penn World Table and N. Yamano for providing the set of harmonized input-output data. I also wish to thank the participants of the IIOA Conference in Mexico (June 2015) and a WTO-WB-IMF Geneva workshop (also in June 2015) for their comments to earlier drafts. Obviously, remaining errors and omissions are mine.

1 INTRODUCTION

Economic growth is usually measured as the variation in the Gross Domestic Product, calculated by national accountants either from the supply side (the sum of the value-added created by industrial activities) or the demand side (changes in aggregate demand). By virtue of the GDP identity, both measures should give the same result, at least in the short term. Analysing the long term dynamics requires referring (implicitly or explicitly) to a growth model. In the neoclassical tradition, the long run rate of growth is determined by exogenous factors affecting the supply-side of the identity, such as the increase in labour (working population), the stock of human and physical capital and technical progress. A Keynesian approach to growth, in contrast, focuses on the change in aggregate demand levels and composition and related constraints, following the Harrod trade multiplier tradition or, more recently, the "Thirlwall Law" (1979).

The emergence of Global Manufacturing and International Supply Chains has changed the way trade and international economics are understood today, compared to the time when those growth theories were first developed (mainly during the 30 years following the 1929 crisis. Some such as Grossman and Rossi-Hansberg (2006) predict that this change is of a paradigm nature and requires new theoretical modelling. Without entering into this epistemological debate (see Park, Nayyar and Low [2013] for a literature review), the present essay builds on recent statistical advances to suggest new ways of looking at the demand and supply side approaches when Global Value Chains (articulating supply and demand chains from an international perspective) are taken into consideration.

Theory cannot progress securely without data and statistics needs to be guided by theory. Thanks to recent research programs developed by a group of national and international organizations, we can now build on evidence that allows us to test the relevance of old theories and, if proven false, will provide stylized facts which should illuminate the path in search of new ones. This essay, which is still a work-in-progress, builds on the results of the 2015 release of the OECD-WTO Trade in Value Added data base (TiVA). It aims to investigate the statistical feasibility and the analytical usefulness of developing a series of new indicators on the "trade and growth" nexus based on these trade in value-added statistics. This pilot case focuses on the G-20 countries, a group of leading developed and developing economies which took a prominent role in fostering and managing global economic governance. In 2012, under the Mexican presidency, the G-20 identified GVCs as a priority area for research and policymaking.

The paper is organised into two main parts. The demand dynamics is first analysed through a growth-accounting decomposition using recent development of international input-output models, then put into a medium term perspective covering 1995-2011. The paper looks also into the long-term determinants of income elasticity of imports over the 1980-2011 period. The second part looks at some of the implications of the global value chain models for our understanding of the supply-side dynamics. Because global value chains are primarily conceived for optimizing the efficiency of each of the various steps involved in manufacturing, the paper concentrates on two approaches for measuring efficiency. The first approach revisits revealed comparative advantages through the new information provided by trade in value-added. The second approach benchmarks industrial sectors based on the information provided by the input-output accounting framework that backs the measure of trade in value-added. Conclusions summarize the main results.

2 THE DEMAND SIDE: SHORT AND LONG VIEWS

The first section presents a reformulation of the traditional demand-decomposition accounting; we will present a demand-side analysis that is more in line with the recent development of trade in task models and the progress made in measuring trade in value-added. The second section will present the results obtained using the OECD-WTO Trade in Value-Added (TiVA) database. A third section will look at some of the long term determinants that drive the evolution of demand aggregates.

2.1 The Basic Growth Accounting Framework

The decomposition of economic growth from the Demand Side is usually performed by analysing independently the short-term evolution of each of the Final Demand components. The GDP identity states that, in monetary terms, aggregate supply is always equal to demand. For a national economy, the value of aggregate supply is given by the Gross Domestic Product measured as the sum of the net output (or value-added) of domestic industries, plus the imported goods and services. The demand side (or expenditure accounts) tracks the uses of the economy's output. Aggregate demand is composed of domestic and external components: domestic demand relates to consumption by household and public sector (administration) and gross investment; external demand is satisfied through exports of goods and services. [2]

The established practice moves imports (part of the aggregated supply) to the right-hand side of the identity (with a minus sign) and merges it with exports to form net external demand (exports minus imports). It leads to the traditional formulation of the GDP identity:

$$GDP \equiv C + I + (X-M) \qquad [2.1]$$

GDP: Gross Domestic Product as the sum of sectoral value-added, at current price
C: Private and public consumption
I: Gross public and private investment (fixed capital formation and changes in inventories)
X-M: Net exports of goods and services

Economic growth is usually measured through changes in GDP. [3] Because the identity at current prices has to be maintained, any change in aggregate GDP from the supply side (ΔGDP) needs therefore to be balanced by a similar change in the demand side of the accounting identity [2.1].

$$\Delta GDP \equiv \Delta C + \Delta I + \Delta(X-M) \qquad [2.2]$$

In practice, the growth accounting identity [2.2] is usually employed when looking at the short term evolution of the economy. Nevertheless, the identity holds also for longer periods and has been used by long-term demand-driven growth models, especially heterodox approaches looking at balance of payments constraints (see Thirlwall, 1979, for a well-known example).

Yet, [2.2] may lead to misleading conclusions about the role of the external sector. Trade enters the GDP growth decomposition through the net exports of goods and services (X-M). This has, from a national account perspective, the merit of linking the GDP equation to the balance of payments trade balance. Unfortunately, the accounting elegance comes at an analytical cost, because it minimizes the importance of trade (imports have a negative impact, irrespective of their welfare effects on the consumer side or their positive implications on the supply side of the GDP) and overestimates the importance of domestic expenditures as drivers of growth. Had the 17th Century Mercantilists known about this identity, they would have exulted: according to [2.2], reducing imports leads mechanically to increasing domestic output and higher economic growth.

This mercantilist argument is analytically deceptive because the growth-accounting decomposition [2.2] is grossly misspecified when looking at the long run. This is due, inter alia, to the fact that in [2.2], all the "negative" impact of ΔM on ΔGDP is affected to ΔX when computing net exports, as if imports were independent of the change in the domestic production of the goods and services required to satisfy consumption and investment.

The 20th Century Mercantilists, who advocated import substitution industrial (ISI) policies in the 1950s, recognised that it was not always the case: for most developing countries, increasing investments (one of the engines of growth from the supply side perspective) required an increase in imports of capital goods.[4] Similarly, the first oil shocks in the early 1970s made clear that, for their economic development, industrialised countries required the importation of natural resources they could not produce. *Id est*, reducing imports of final or intermediate goods and services may well reduce GDP, contrary to the [2.2] formulation. The third industrial revolution, which marks the early years of the 21st Century, goes further by showing that "imports create exports" (Jara and Escaith, 2012), or, using a Sraffian perspective that "exports are produced by means of imports".

[2] Note that consumption by industries is not included in final demand but is deducted from gross output to calculate the industrial value-added in the left-hand side of the identity (its supply side).

[3] A sustainable growth accounting method would need to deduct the use of non-renewable resources.

[4] The two-gap model, for example, was an open economy Harrod-Domar model designed to show how a shortage of foreign exchange can reduce economic growth by constraining imports (Bacha, 1983).

To correct the misspecification of the [2.2] formulation, we follow and adapt Kranendonk and Verbruggen (2008) and reallocate imports to all expenditure categories.

$$GDP \equiv (C-M_c) + (G-M_g)+ (I-M_I) +(X-M_X) \qquad [2.3]$$

With M_c, M_g, M_I and M_X the import content of, respectively, public and private consumptions, investment and exports.

$$M = M_c + M_g + M_I + M_X \ ; \text{ with } M_n \geq 0 \text{ for } n=c, g, i \text{ or } x \qquad [2.4]$$

As long as ($M_c + M_g + M_I$) is different from 0, the traditional national account decomposition (X-M) in [2.1] underestimates the role of gross external demand [X] on economic growth.

The 'import-adjusted decomposition method' [2.3] provides a better understanding of the short term demand drivers of GDP growth fluctuations along the business cycle. Moreover, it has the considerable advantage of being better rooted in (i) development economic theory and (ii) recent trade in tasks models, reducing therefore the risk of "*measurement without theory*", an issue that should not be underestimated when doing growth accounting. As Kranendonk and Verbruggen (2008) mention, the traditional methodology for calculating the contribution of aggregate demand to GDP growth "can easily lead to misinterpretations about the expenditure categories that are really driving the (changes in) economic growth". From a trade perspective, this reformulation fits perfectly the recent work on *Trade in Value Added and Global Value Chains* being done in various academic centres and international organizations. [5] For example, M_X is closely related with the calculation of Hummels' vertical specialization (*VS*) index (intermediate imports embodied into exports, see Box 1).

One may go further and measure the imported component of final goods produced by the national industries and absorbed by the domestic markets. We can decompose M_C and M_I into imports of final goods for final demand C and I, plus imports of intermediate inputs required by the domestic industries to produce the output absorbed domestically by C and I. Following the progress made in measuring trade in value-added, investment and private or public consumption can be decomposed into three components: the share of domestic absorption satisfied from purely domestic inputs (intermediate and primary), the final goods imported to satisfy directly the final demand (direct imports), and the foreign inputs required for producing the domestic output which will be consumed domestically. Equation [2.3] becomes:

$$GDP = (C - M^d_C - M^i_C) + (G - M^d_G - M^i_G) + (I - M^d_I - M^i_I) +(X-M_X) \qquad [2.5]$$

Where the superscript (d, i) indicate that the imports are, respectively, direct (final goods and services) or indirect (intermediate goods and services required to produce domestic goods).

$$M^d_C + M^i_C = M_C$$
$$M^d_G + M^i_G = M_G$$
$$M^d_I + M^i_I = M_I$$
$$M = M_C + M_G + M_I + M_X$$

Note that, by definition, M_X does not have a direct imported component because all imports of final goods and services are absorbed for consumption or investment.

2.2 Growth in the G-20 countries: the demand side dynamics, 1995-2011

When trade is measured in value-added terms, as in the OECD-WTO TiVA (see Box 1), statisticians need to identify and measure all trade flows by country and industrial origin (the supply side) and country destination, further disaggregating for industrial and final demand uses (the demand side). As indicated in Box1, TiVA already provides the imported content of gross exports (the VS index).

[5] See Escaith (2014) for a review of the recent efforts in mapping and measuring trade along global value chains

Box 1: Decomposition of Gross Exports into their Domestic and Foreign Components

The foreign content of gross exports is measured as the imported content used as inputs during the production process. The decomposition requires the use of input-output tables. The basic relationship of trade in value added, from a single country perspective, can be described as follows (OECD-WTO, 2012):

$X = \mathbf{A}X + Y$ [B1.1]

Often written (after rearranging terms): $X = [\mathbf{I}-\mathbf{A}]^{-1} Y$ [B1.2]

Where:

X: is an n*1 vector of the output of n industries within an economy.

A: is an n*n technical coefficients matrix; where a_{ij} is the ratio of inputs from domestic industry *i* used in the output of industry *j*.

I: is the diagonal n*n identity matrix

Y: is an n*1 vector of final demand for domestically produced goods and services (final demand includes consumption, investment and exports) and $\mathbf{A}X$ results in a vector of direct and indirect intermediate inputs required for producing *Y*.

A country's total value added can be split in two parts: one is the VA embodied in goods and services absorbed domestically (consumption and investment), the other is the VA embodied in its exports. Assuming the homogeneity of products made for the domestic market and products made for exports, total imports embodied directly and indirectly within exports are given by:

Import content of exports $VS = M\,(\mathbf{I}-\mathbf{A})^{-1} E$ [B1.3]

Where:

M: is a 1*n vector with components m_j (the ratio of imports to output in industry *j*)

E: is a n*1 vector of exports by industry to the rest of the world.

In the same way, one can estimate the total indirect and direct contribution of exports to value-added by replacing the import vector *m* above with an equivalent vector that shows the ratio of value-added to output (*V*), with $V_j = [1 - \sum_i a_{ij}]$. So, the contribution of exports to total economy value-added is equal to:

VAE: $V\,(\mathrm{I}-\mathbf{A})^{-1}E$ [B1.4]

Deriving the [2.5] decomposition from the TiVA database is relatively straightforward once the TiVA indicators are available. This section presents the results of this decomposition applied to G-20 economies, between 1995 and 2011. [6] Due to extension constraints, the analysis does not enter into a description of particular country cases, and provides only an overall picture which hides important individual differences. Indeed, the G-20 is composed of developed and developing countries, each with different resource endowments, productive structures and institutional arrangements.

Additional words of cautions are required before we examine the results, which are approximates because we opted to simplify some calculations. [7] More fundamentally, the underlying input-output data are in nominal terms and the results (especially calculated across long periods) are affected by changes in relative prices, including exchange rates. This is particularly important when looking at commodity exporters, as the international price of primary goods increased notably after 2003.

[6] The G-20 includes the EU and 19 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russian Federation, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States.

[7] For example, the present analysis discards change of inventories and some minor components of final domestic demand while gross exports include the reflected VA imports --domestic value-added embodied in products being imported for intermediate or final use--).

Table 1 Growth rate and import content of main demand aggregates, 1995-2011

	Investment (fixed)		General Government		Household Consumption		Exports of Goods and Services	
	Mean	Var. Coef.	Mean	Var. Coef.	Mean	Var. Coef.	Mean	Var. Coef.
Growth (YoY, %) [a]	7.3	0.6	7.6	0.5	6.4	0.5	9.0	0.4
Imported component:								
- Total (var % pt) [b]	6.2	1.3	6.0	1.0	7.0	1.0	...	...
- Indirect (var % pt) [b]	5.3	1.0	6.1	1.0	5.2	1.1	6.1	1.0

Notes: a: Average annual growth rate of the aggregate over the 1995-2011 period at current prices; b: Average change in the imported content between 1995 and 2011, in percentage points. Unweighted (simple) average and coefficients of variation calculated on the G-20 countries (19 observations).
Source: Author's calculation based on WTO-OECD preliminary TiVA data, June 2015.

Exports have been the most dynamic component of the gross aggregate demand for the G-20 over the 1995-2011 period and the result is relatively stable across countries (the corresponding coefficient of variation is the lowest at 0.4). Counterbalancing partially this demand effect, the import content embodied in the production of exported goods and services increased by 6 percentage points between 1995 and 2011. This may be due to structural (real) factors, in particular an increase in the vertical specialization (importing to export) and/or changes in relative prices, in particular the price of primary commodities used in production, such as oil.

Household consumption, the largest demand aggregate, recorded the highest increase in direct import content. Total import content jumped by 7 percentage points (the highest in the table) while the indirect share increased only by 5.2 points. In contrast, the imported content of ***government consumption*** (the second most dynamic demand component after exports) increased largely due to its indirect component.

This is particularly interesting because countercyclical policies used by national governments usually favour public consumption because of its higher GDP multiplier (due to the lower import content). [8] But indirectly, the additional demand "filters-out" to other countries, thanks to the indirect imports required for producing domestic goods and services. Eventually, even the most "selfish" countercyclical policies have a favourable global impact. The coordinated public demand increase that G-20 implemented in April 2009 was very effective in limiting the depth of the 2008-2009 global crisis and accelerating recovery. Those indirect spill-over effects are probably to be commended for achieving the desired outcome.

Table 2 Participation of Final Demand Components to 1995-2011 Growth (billion USD[a] and percentages)

Variation 1995-2011 (bn USD)	Investment	Public Cons.	Private Cons.	Exports	Total Dom.	Imports
Gross	6,919	5,652	15,182	8,606	36,359	...
- Domestic VA	4,162	4,224	10,039	6,360	24,785	0
- Imported (Foreign VA) [b]	2,757	1,428	5,143	2,246	...	-11,574
Gross (%)	19.0	15.5	41.8	23.7	100.0	-31.8
Domestic VA (%)	11.4	11.6	27.6	17.5	68.2	0.0

Notes: a: Short scale billions (thousands of millions), current prices; b: direct and indirect imports, except for exports (indirect imports only). b: excluding domestic V-A embodied in imports (reflected V-A).
Source: Author's calculation based on [2.5] equation and WTO-OECD TiVA data (June 2015 release).

Table 2 presents the effective contribution of each of those final demand aggregates to the GDP growth in monetary terms, at current prices. The first line shows the gross contribution, as usually presented in growth accounting (equation [2.2]) and the second entry indicates the net effect, considering only domestic value-added after factoring-out both direct and indirect imports, as in [2.5]. Total imports, which are subtracted from total exports in the [2.2] presentation, are now imputed to the various domestic uses. While the [2.2] formula would have led to the conclusion

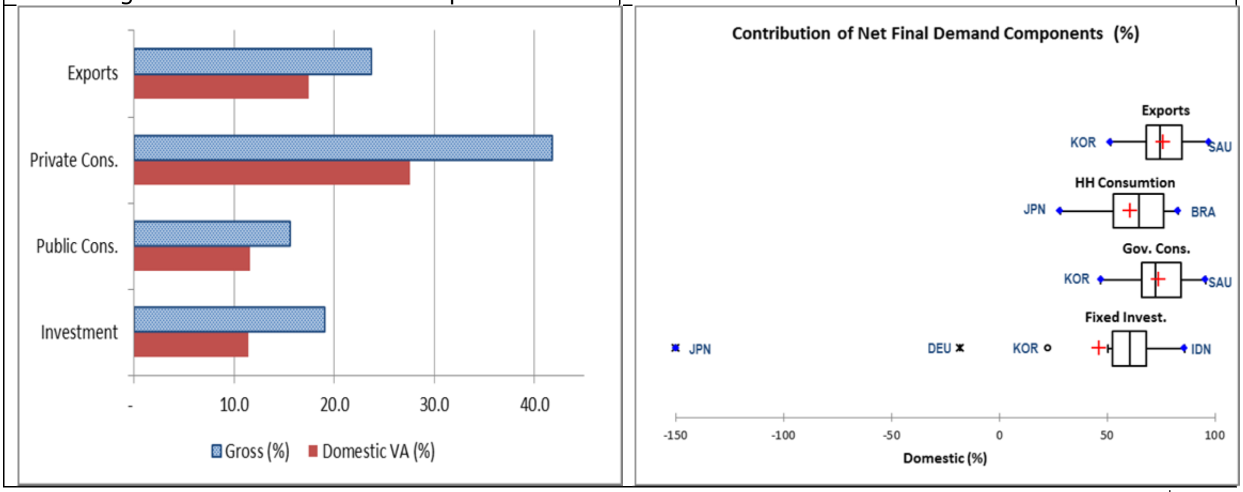
[8] Government purchases include the salaries paid to government employees such as soldiers or public civil servants and merchandise purchased by the government from private sector or imported (in practical terms, government is treated as the final purchaser of the portion of its services that is not sold to the public). Following the 1993 SNA method used in TiVA, public consumption excludes most investment goods. A new accounting framework (SNA2008) will also reclassify as investment some military expenditures considered as consumption under SNA1993.

that the external sector had a negative impact on 1995-2011 growth (the G-20 as a group had a negative variation of its trade balance), the [2.5] formula implemented in Table 2 indicates that the net contribution of exports was positive and contributed to 17.5% of the total growth.

At the contrary, the net contribution of household consumption is much lower than what is indicated by gross growth accounting (28% compared to 42%) because 34% of investment spending is imported, either directly as a final good, or indirectly as foreign inputs required to produce domestic output for private consumption. The share of foreign content is even higher for investment (40%), reducing the pull effect on GDP growth by almost 8 percentage points (from 19.0% to 11.4%). The reduction is lower for public consumption, with a drop of 4 percentage points.

Figure 1 Relative contribution of Final Demand Components to total growth, 1995-2011 (%)

a. Average effect for the G-20 Group | b. Distribution of individual G-20 countries

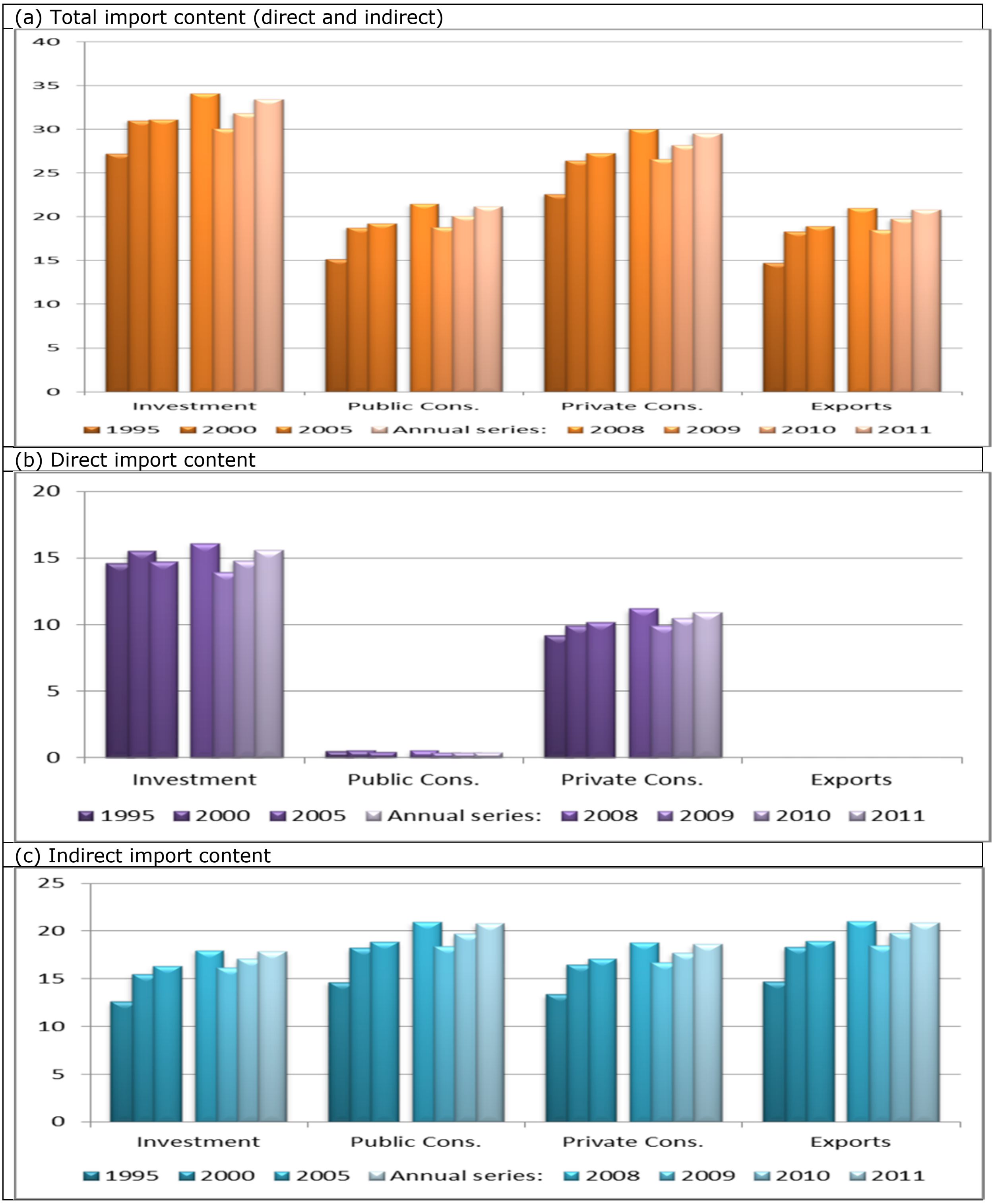


Note: The Box-Plot in panel b provides information on the data distribution. The box is defined by the 1st and 3rd Quartiles of the distribution, the Median is the line inside the box and the Mean the red cross. Whiskers show the Minimum and Maximum, within a limit calculated as a function of the interquartile interval [Q1 – 1.5 (Q3 – Q1)] and [Q3 + 1.5 (Q3 – Q1)]. Isolated points outside the whiskers limits indicate outliers, as in the case of investment.
Source: Table 2

The first panel in Figure 1 reflects the difference between gross and net accounting for the G-20 as a group. Panel b shows that those G-20 averages hide some heterogeneity between countries and between demand aggregates. Curiously, for the category of fixed capital investment, we have at the same time (i) more homogeneity in the core of the distribution (the inter-quartile interval is the smallest) and (ii) large outliers (Germany, Japan and Korea). Japan is the widest outlier: the nominal value of gross investment has dropped while the foreign component increased, leading to a strong negative contribution of the domestic value-added. Germany in 1995 had a relatively high investment rate, mostly domestic (more than 75% of fixed capital formation was domestic value-added); the import coefficient in 2011 rose to 39% in a situation where the increase in total investment was marginal (1.1% per year in average), leading to an absolute decrease in the domestic component. The low domestic contribution in the Korea case reflects the combination of a moderate growth in gross fixed investment and a significant increase of its foreign component.

Figure 2 shows the evolution of import content over the 1995-2011 period for the G-20 group. The graph includes three panels, showing the total import content, direct import content and indirect import contents by final demand aggregate. Each panel is subdivided into two time series: the first shows the three benchmark years 1995, 2000 and 2005 while the second is based on annual values from 2008 to 2011. Those values coincide with the Global Crisis and its recovery, providing important information on the evolution of globalization understood as a higher demand for products produced by foreign partners.

Figure 2 Direct and indirect import content by main demand aggregates, 1995-2011



Notes: Percentage of the corresponding gross aggregate (equal to domestic value-added plus direct and indirect imports). Simple average of the G-20 countries at current prices and market exchange rates.
Source: Author' s elaboration, based on WTO-OECD TiVA database, 2015 release.

Panel (a) of Figure 2 shows that the import component varies greatly between aggregates, being the highest for investment with a total foreign contribution of about 34%. Household consumption follows at about 30% while public consumption and exports stand much below, at about 20%. Globalization, as measured by the reliance on foreign goods and services to satisfy final demand, directly or indirectly, increased over the period and reached a maximum before the Global Crisis (2008 data-point). For all the demand aggregates, imports declined in both absolute and relative terms with the Great Trade Collapse of 2008-209 and did not recover the maximum content despite a strong recuperation in 2010 and 2011.

Panels (b) and (c) disaggregate those imports into direct and indirect content:

Panel (b) shows a great heterogeneity in terms of direct import content. By definition, it is nil for exports, but almost zero for public consumption. Moreover, its direct import content declined after 2008 without showing any sign of recuperation: in 2011, administration import only 0.4% of their needs, less than in 1995 (0.5% in average of the G-20 countries). In other terms, most if not all of the additional demand that a government will create will have a direct multiplier effect on the local economy. Except that the indirect imported content of public spending is the highest, together with the case of exports (panel c).

As mentioned previously, indirect content has been increasing rapidly over the 1995-2011 period, and the 2011 value is very close to the 2008 maximum of 21%. These findings confirm our previous hypothesis that, through indirect content, additional public demand filters out to other countries while its apparent low import intensity makes it particularly attractive for "selfish" counter-cyclical policies. It is therefore a good candidate for coordinated macro-policies, as policy making remains driven by domestic considerations, following the saying "*economics is global but policy making is local*".[9]

The four panels of Figure 3 provide more details on the diversity of individual country dynamics:

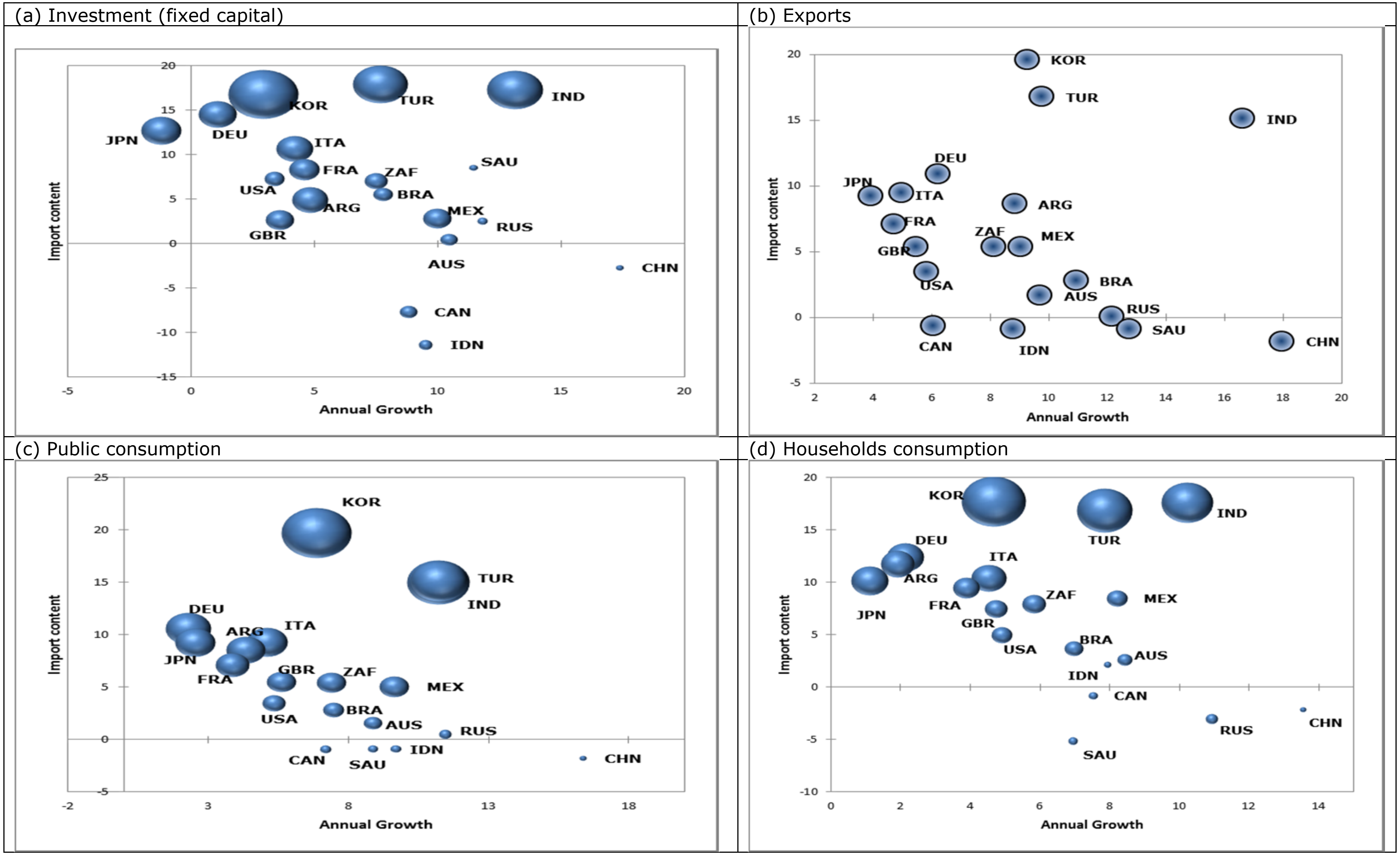
Panel (a) shows the relationship between the growth of investment (horizontal axis) and the change in imported content (vertical). There is a double and divergent tendency, with total imported content being negatively correlated with growth: the countries which rely more on their own domestic content were also those where the demand was more dynamic. However, the relationship is somewhat positive when indirect content is considered: a few high performers (e.g. India and Turkey) have also a high growth in indirect imported content (indicated by the size of the bubble in the scatter plot). Japan, Germany and Korea increased their direct and indirect import contents in a situation of low to moderate investment growth.

Exports (panel b) tell also a bimodal story about import reliance (or vertical specialization, in this case). A few countries increased their exports on the basis of increased import content (India, Turkey and Korea), while others did so on the basis of a reduction in their vertical specialization index. In this latter group, we find commodity exporters (products that typically include a high content of domestic value-added), such as Saudi Arabia, Russia, Australia, Brazil or Indonesia, which benefitted from the long cycle of high commodity prices (2003-2011). China is an exception in this cluster of countries benefitting from large natural resources endowments. This tends to support the hypothesis that China, a country which is very much inserted in GVCs, is increasingly substituting foreign inputs with domestic ones.

Panel (c) is somewhat similar to panel (a), with a negative correlation between the growth of public consumption and its import content, bar some outliers such as Korea, Turkey and India where indirect import content increased significantly. The pattern is similar when looking at household consumption (Panel d). The import content increased in some slow growing cases such as Japan, Argentina and Germany; it decreased in fast growing ones: commodity exporters (Saudi Arabia and Russia) but also in China. Here again, indirect import reliance is a discriminant factor, as it increased in the case of some fast growing demand growth (Turkey and Indonesia).

[9] This is a 21st Century version of Mandeville's 18th Century "Fable of The Bees" about "Private Vices" (or selfish objectives, in the present case) and "Public Benefits" (global macroeconomic governance).

Figure 3 Relative evolution of demand-side growth and import content, 1995-2015



Notes: The horizontal axis shows the average annual growth of the demand aggregate over the period in percent. The vertical axis shows the change in total import content (direct --except for exports-- and indirect) in percentage points while the size of the sphere informs on the change in the relative share of the indirect component.
Source: Author's elaboration on the basis of WTO-OECD TiVA data, 2015 release.

3 LONG TERM DETERMINANTS OF THE DEMAND-SIDE DYNAMICS

The previous decomposition of GDP growth from the demand side is a descriptive methodology based on identities. A different analytical framework is required if we wish to deepen the analytical review of the factors which may explain the dynamics of each one of these sub-components. In particular, any longer term prospective or predictive analysis exercise should look at the role of the following set of relationships (semi-elasticities):

- Household income and consumer goods imports
- Investment in fixed capital and imports of capital goods
- Domestic output for export or domestic absorption and imports of intermediate goods (Vertical Specialization)

Over the longer term, the dynamic of demand for imports depends on many factors, some structural, others more contingent on macroeconomic factors or trade policies. Structural factors refer to the size of the economy, its level of industrial development, the international trade environment (cost of transportation, trade facilitation, etc.) and —as we saw in the previous section on short term dynamics— the origin of the demand for imports (final products for consumption, for investment or intermediate goods for further processing). Macro-economic variables relate, in the medium term, to the phase of the business cycle, binding financial and balance of payments constraints or changes in the relative prices between domestic and international products and, in the longer term, to the evolution of real national income and the closely related trend affecting tradable and non-tradable products.

3.1 Income, purchasing power and non-homothetic preferences

In most models used for analysing trade flows (e.g., the gravity equation), the higher the national income, the higher the demand for imports. In addition to affecting the *level* of imports, income growth over the long term also changes the *composition* of demand. Of particular interest in our case is the substitution effect between tradable and non-tradable products when household income increases. Two parallel effects play a role here. One is the familiar results of Balassa-Samuelson (1964), whereby the more developed an economy is (as measured by per capita income), the higher the prices for nontraded products will be. As non-traded products are mainly (labour intensive) services, their price evolution in the long run is a good proxy of changes in wages and household income. When household income rises over a threshold where basic necessities are fulfilled, another effect –Engel's law– predicts that additional consumption will favor superior products, in particular services like education, health and leisure activities. With the exception of tourism, most of those services are not (easily) tradable.

So, preferences are non-homothetic and consumers in poor countries will typically spend a higher share of their income on food and other tradable goods compared to consumers in rich countries (Engel’s law). As explained by Caron, Fally and Markusen (2014), the prevalence of non-homothetic preferences has also a negative impact on aggregate trade-to-GDP ratios. If high-income countries have a comparative advantage in income-elastic products (i.e. superior goods and services for which consumption is very sensitive to the level of income), both poor and rich countries tend to consume more of their own goods as opposed to what the gravity model would predict. [10] We should expect this negative bias due to non-homothetic preferences to lessen when differences in income are reduced, reinforcing the above-mentioned tendency for trade-income elasticity to overshoot its long term values when income converge.

Under the hypothesis of long term convergence between developed and developing countries, the net impact on trade of an increase in per capita income remains therefore ambiguous. We should expect a high elasticity when income is low but a smaller one when income increases over a certain threshold. Imports of final capital goods or imports of intermediate inputs for domestic production will intuitively follow a similar pattern, but for different reasons: low-income countries have limited technological capabilities and need to import most of their capital and complex intermediate goods; this dependency is expected to decrease when the economy develops, then stabilise.

[10] Non-homothetic preferences can therefore be one explanation for the “home bias” observed in trade.

After a certain threshold, this trend may be reversed. A supply-side effect (e.g., comparative advantages see p. 16) may induce higher income economies to specialize in a limited set of highly priced goods and services where they have a comparative advantage and to import other products. Overall, the traded component is expected to be higher for investment goods than for household consumption, if only because purchases of non-traded services (housing, health and education) constitute a high share of households' budget. [11]

3.2 An attempt at statistical modelling

Estimating the price and income elasticity of demand for imports is therefore a complex process, prone to the risks of omitted variables and misspecification. In addition to model specification, the estimation of the parameters faces several statistical issues. Not surprisingly, results vary widely according to authors. There is a vast literature (see Stern, Jonathan and Schmacher (1976) or Khan and Goldstein (1985) for earlier surveys) that contains empirical estimates of trade elasticities, but the magnitude of the estimates varies widely, and in some instances, the signs of the estimates are contrary to theories. For example, on price elasticity, Goldstein and Kahn (1985) report values ranging from −2.3 to −0.3 in the case of France; similar estimation intervals exist for Japan [−3.0 ; −0.5] or the USA [−2.3 ; −0.3]. Marquez (2002) reports values for the US price elasticity of imports varying from −4.8 to −0.3 and between 0.15 and −3.4 for Japan. The range for income elasticity (the object of interest here) is also large; for example, Bahmani-Oskooee and Kara (2005) report elasticities ranging from 3.8 (Switzerland) to 0.1 (Japan) over the 1973-1998 period.

- ***Our economic priors***

Household demand for imports may be approached through Engel's law, which states that, as income rises, the proportion of income spent on inferior goods (food, then manufactures) falls and demand of services and luxury goods increases. Because services are less tradable than goods (Escaith and Miroudot, 2015) and saving propensity increases with income, the income elasticity of demand of total imports is probably lower than 1 after some income threshold. With income convergence between North and South, demand for tradable products is expected to grow at a slower pace than GDP. On the other hand, with the rise of income, the relative price of tradable/non-tradable products will decrease: Engel's law may be somewhat offset by price effects. The exploration of those effects is a topic of investigation unto itself.

The long term evolution of import demand linked to investment and domestic production is another aspect to be investigated. In contrast to consumer theory, there is much less analytical research on the demand for intermediate goods and services by firms. For guidance, we should look into the "make or buy" models developed by business analysts or into the Armington elasticities used, for example in CGE modelling and related literature. Development levels also play a role here: as developing countries industrialise, some degree of substitution between imported and domestically produced machinery and equipment has to be expected. This may be directly related to the capacity of the home country to efficiently substitute imports (a supply-side consideration), *id est*, related to the size of the economy and its level of technological development. Parallel reasoning may also apply to the VS index, as the domestic content of exports is expected to increase when countries up-grade within the value chain (see below, p. 23).

Actually, those long-term results may lead to a re-interpretation of the Thirlwall's Law as stated in the original 1979 article. Thus, many factors are expected to influence the long term behaviour of import demand, and attempts at modelling it without considering, *inter alia*, the recent measurements of trade in value added or the rapid income and consumption convergence between developed and large developing G-20 countries, face serious misspecification issues.

In the following sections, we proceed in progressive steps, starting with an exploratory approach, taking into consideration the main structural variables, before delving deeper into the dynamic

[11] This trend may not hold for public consumption of imported goods and services, which is expected to remain relatively stable through time or even increase with the reduction of trade frictions (e.g., international agreements on public procurement).

characteristics of trade-income elasticity. A separate exercise will look at the demand for intermediate inputs used in exports. The rise in trade of intermediate parts and components is one of the most recent developments of international trade, given the international fragmentation of manufacturing and the rise of global value chains.

- ***Statistical explorations of long term relationships***

In order to capture long-term demand-side effects, an exploratory regression exercise estimated the coefficients of a simple equation linking imports of goods with domestic income (GDP at purchasing power parity) and the evolution of the PPP exchange rate compared to the US dollar. The latter variable captures two different effects: changes in the commercial exchange rate and relative price between tradable and non-tradable products. The statistical model also includes a lagged dependent variable, in an attempt to reduce the incidence of model misspecification.

Estimation was based on a recent release (April 2015) of the Penn Tables 8.1, for a selection of G-20 countries. An introduction to the main concepts behind this database, as well as a discussion on the Balassa-Samuelson effect can be found in Feenstra, Inklaar and Timmer (2015).

As mentioned above, we are interested in measuring from an international perspective the contribution of domestic demand, differentiated by its main aggregates (household and government consumption, investment and export) in explaining the demand for imports, while controlling for real income and price effects. The long-term evolution of the real exchange rate in an open economy is expected to be determined by purchasing power parity and the Balassa-Samuelson law. Both effects can be captured by the relative prices of tradable products (approximated by the deflator for imports) and non-tradable products (services being used here as a proxy). Note that the interpretation of the non-tradable index is complex, as it reflects the long term increase in real income (Balassa-Samuelson effect, with a positive effect on the demand for services) and, in the short term, the increase in the relative price of services (a negative effect).

The exploratory model is the following:[12]

$$logM_t = c + a1\, logM_{t-1} + a2 \log Yc_t + a3 \log Yc_t + a4 \log Yi_t + a5 \log Yg_t + a6 \log X_t + a7 \log Pm_t + a8 \log Ps_t + a9T + a10\, T^2 + a11\, Crisis\_Dummies \quad [3.6]$$

With:

M_t imports of goods and services at time t,
Yi_t i[th] component of the final domestic demand at year *t* ; *i* = *c*, *I and g* (respectively household and consumption and gross investment) obtained by multiplying the expenditure side of GDP by the corresponding share of "*i*" at current PPPs. and
X_t total exports, calculated like the Yi_t
(All above values are derived from national accounts and expressed in purchasing power parity at chained PPPs in 2005 US$)
And
Pm_t : price index of imports (price level of US GDP in 2005= 1)
Ps_t : price index of services (price level of US GDP in 2005= 1)[13]
T and T^2: time index and its squared value,
Crisis_Dummies: A set of dummy variables for major international crisis (1982-83; 1995-97; 2008)

The lagged dependent variable M_t was included for purely statistical reasons. Without it, equation [3.6] would register high serial correlation in its residual term, indicating, *inter alia*, that some important variables were missing. Introducing the lagged dependent variable reduces the misspecification issue, and can be interpreted as an instrument capturing the idiosyncratic variables that are not well represented by country-specific dummies (fixed effects). Nevertheless,

[12] The model is "exploratory" because its aim is purely descriptive and it does not attempt to estimate and test the parameters of a specific demand function (e.g., the CES function used by most trade economists).

[13] PSt (PL_SER in the table) is derived from the 2005 benchmarks from Inklaar and Timmer (2012) except for Saudi Arabia where the estimate was done by the author. Other years extrapolated using deflator for domestic absorption in the Penn World Tables 8.

this model remains purely exploratory and the estimates obtained for the semi-elasticity of demand are indicative only. [14]

A first exploration included all countries in our sample for the period 1980-2011 (Argentina; Australia; Brazil; Canada; China; Germany; France; India; Indonesia; Italy; Japan; Korea; Mexico; Russia; Saudi Arabia; South Africa; Turkey; United Kingdom; and United States).

Table 3 Exploratory regressions, all countries and developed vs developing; 1980-2011

	All G-20 [a]			Developed G-20 economies [b]			Developing G-20 economies [c]		
Variable	Coefficient	Std. Error	t-Statistic [d]	Coefficient	Std. Error	t-Statistic [d]	Coefficient	Std. Error	t-Statistic [d]
C	-1.55	0.45	-3.5	-1.15	0.72	-1.6	-1.40	0.65	-2.1
LOG(RGDP_M(-1))	0.54	0.03	20.5	0.46	0.04	11.4	0.53	0.04	14.9
LOG(RGDP_C)	0.13	0.05	2.6	0.15	0.07	2.0	0.12	0.07	1.7
LOG(RGDP_I)	0.16	0.03	5.4	0.20	0.04	5.6	0.19	0.04	4.6
LOG(RGDP_G)	0.12	0.03	4.6	0.00	0.04	0.0	0.10	0.04	2.9
LOG(RGDP_X)	0.23	0.03	8.6	0.33	0.03	9.3	0.20	0.04	5.4
LOG(PL_SER)	0.28	0.03	10.0	0.00	0.04	-0.1	0.35	0.04	8.8
LOG(PL_M)	-0.35	0.06	-6.2	-0.03	0.06	-0.6	-0.41	0.09	-4.8
TREND	-0.03	0.01	-4.6	-0.03	0.01	-5.2	-0.02	0.01	-2.0
$TREND^2$	0.00	0.00	5.0	0.00	0.00	6.5	0.00	0.00	2.3
CRISIS_82	-0.10	0.03	-3.4	-0.05	0.02	-2.2	-0.13	0.05	-2.7
CRISIS_83	-0.08	0.03	-2.9	-0.04	0.02	-1.9	-0.11	0.05	-2.3
CRISIS_09	-0.20	0.03	-6.8	-0.13	0.02	-5.6	-0.23	0.05	-4.5
R-squared	0.98			1.00			0.99		
D-W stat	1.18			1.46			1.23		

Notes: OLS; periods included: 32 years (including 1979 for the lagged dependent variable); a/cross-sections included: 18; total panel (balanced) observations: 576; b/ developed economies included: 8; total panel (balanced) observations: 256; c/ developing economies included: 10; total panel (balanced) observations: 320. c/ *t*-tests are indicative only as underlying normality assumptions may be violated (see text).
Source: Author's calculations, based on Penn World Tables

In order to keep a balanced panel of observations, the Russian Federation had to be excluded for lack of data for the pre-1990 period. As our statistical foundations are shaky, we opted for OLS in order to deal more efficiently with the probable specification and multicollinearity issues in a relatively small sample. For similar reasons, our preferred model includes fixed effects (country dummies) as the lagged dependent variable is expected to capture other idiosyncratic effects. As we look for long-term relationship, the model is specified in levels. This first exploration for G-20 members was compared with the results obtained by splitting the observations in two sub-samples: developed and developing G-20 economies.

Table 3 shows the results obtained for the panel estimates. The statistical model for all G-20 economies performs relatively well, with high R-squared (but this is quite spurious as most variables share common trends) and (moderately) acceptable residual correlation. [15] The lagged value of the dependent variable is always very significant; as mentioned earlier, this could be understood as the mark of a partial adjustment mechanism but may also capture the influence of excluded variables. Indeed, our tests reject the null hypothesis of "No cross-section dependence (correlation) in residuals" (with some doubts in the case of developing countries). This means that (i) the independence assumption of the error terms is most probably violated, implying that the results (coefficients and t-tests) may be biased and (ii) some relevant variables influencing the panel data may have been omitted.

[14] Statistical tests are tentative and the results should not be interpreted as confirmatory or falsification testing of pre-specified hypotheses.

[15] Actually, the statistician's assumption of serially uncorrelated disturbances in panel data model might be too restrictive in most economists' cases and the D-W statistics are presented here for information only. Unobserved (unspecified) shocks have probably an effect (i) on more than one period (as captured by the D-W statistics) and (ii) across countries (cross-section dependence tests). Once again, the results presented here are exploratory only and do not pretend satisfying the statistician's quality framework for best confirmatory practices.

An additional caveat resides in the high correlation of explanatory variables, leading to strong collinearity (Table 4). Correlation is particularly high between the three components of domestic absorption: private and public consumption (RGDP_C and RGDP_G) and investment (RGDP_I). This collinearity may explain some of the inconsistencies observed when the full sample is split between developed and developing and the aggregated coefficients are outside the range of the values calculated for the two sub-samples.

Table 4 Correlation between explanatory variables, 1980-2011

	RGDP_C	RGDP_I	RGDP_G	RGDP_X	PL_SER	PL_M
RGDP_C	1.00	0.83	0.84	0.67	0.39	0.37
RGDP_I	0.83	1.00	0.94	0.78	0.34	0.38
RGDP_G	0.84	0.94	1.00	0.77	0.34	0.44
RGDP_X	0.67	0.78	0.77	1.00	0.62	0.56
PL_SER	0.39	0.34	0.34	0.62	1.00	0.81
PL_M	0.37	0.38	0.44	0.56	0.81	1.00

Note: all G-20 countries, except Russia.
Source: Author's calculations, based on Penn World Tables

Exports show the highest semi-elasticity registered for a demand component. To paraphrase P. Sraffa (1898-1983), it seems that we are in presence of a "*Production of Exports by Means of Imports*". Although this is fully consistent with the TiVA results showing that "*Imports Make Exports*", this remains surprising, considering that global manufacturing and the increasing reliance on imported inputs to produce exports became globally significant in the mid-1990s and only for some countries (China, Europe, Mexico and the USA in particular). An additional effect is possibly at work here, and relates to the heterodox tradition of export-led growth in developing countries. Higher exports relax the balance of payments constraint and lead to higher domestic demand. There is therefore, according to this structuralist tradition, a potential pro-cyclical effect of exports on domestic absorption through the financial constraint, which reinforces the more recent trend that exports are intensive in imports of intermediate inputs. Nevertheless, the semi-elasticity observed for developing countries (the countries most subjected to external constraints) is lower than for industrialised countries, so this theoretical option remains to be investigated.

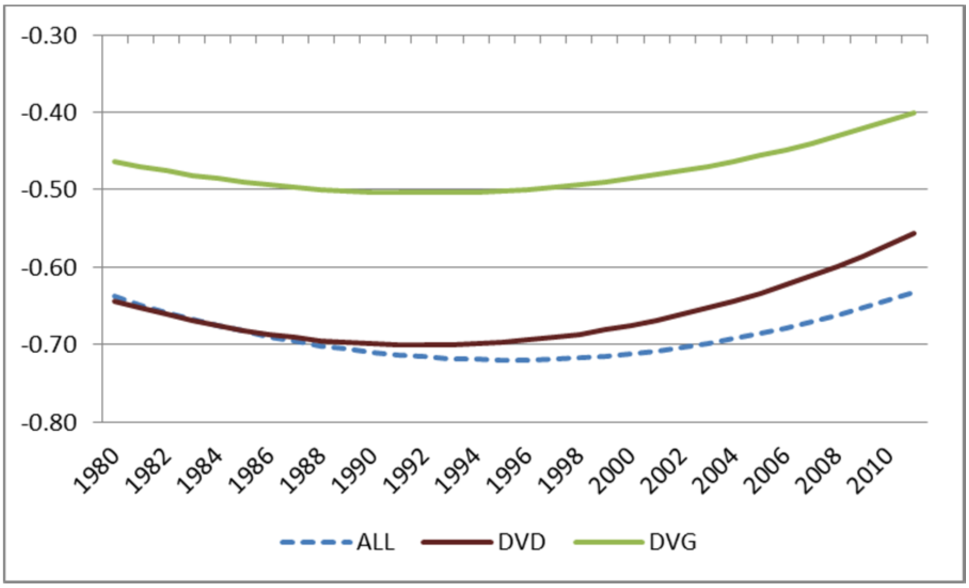
As expected, investments are also import intensive. Household consumption, on the contrary, is relatively non-intensive in imports at the margin, for both developed and developing countries. Moreover, the semi-elasticity is lower in developing countries contradicting the prior inference based on Engel's law that high-income households spend more on (non-tradable) services. However, the standard errors on the related coefficients are relatively high (especially for developing countries), so no definitive conclusion should be derived at this point. Public consumption, as expected, has low import intensity and it is probably nil in the case of developed economies. This is consistent with national accounting conventions that exclude most final (capital) goods from public consumption.

The price elasticity of imports has the expected negative coefficient; nevertheless, it is not significantly different from zero in the case of developed economies. Actually, developed economies appear, on the basis of the results, to be much less sensitive to prices than developing countries.

The positive coefficient associated with the price of non-tradable products may reflect two different effects. One is the traditional relative price effect: if the relative price of non-tradable products increases, demand will tend to favour tradable goods, and therefore boost imports. The second effect is linked to the Balassa-Samuelson effect: the price of services (in PPP$, which means relative to the USA taken as a benchmark) reflects the increase in households' per capita income, leading to increased consumption of tradable goods even if non-tradable goods are superior goods under Engel's law. The fact that the coefficient is not significantly different from zero in the case of developed economies tends to favour the hypothesis of a structural Balassa-Samuelson effect over the short-term price arbitraging effect.

The trend effects are statistically significant and indicate a non-linear effect (see Figure 4). During most of the 1980-2011 period, the resulting trend was negative, even if this effect slowed down in the early 1990s. It is only after the mid-1990s that there is a positive "globalization" effect, once other factors have been taken into consideration. When considering the two sub-groups, developed and developing economies, the net effect in 2011 is higher than at the beginning of the period, indicating a positive effect on globalized demand.

Figure 4 Net Trend Effect on import propensity.



Note and Source: the net effect is calculated on the basis of results in Table 3, the time index being calculated on the entire 1950-2011 time sample and based on the value t(1950)=0.

The negative trend observed through the early 1990s for the G-20 economies is consistent with the general observation that world trade-income elasticity remained below its long-term value up through the mid-1990s at the global level (Escaith and Miroudot, 2015). As these authors discussed, the trade-income elasticity reached a high value in the early 2000s and then returned to its long-term average of 1.5, with a faster regression to mean after the global 2008-2009 crisis. However, when testing for this possibility of a third degree polynomial trend structure with two inflection points, the results obtained on the individual G-20 data were not statistically significant, even if they had the expected sign (negative for the first and third polynomial terms, positive for the second). [16]

4 THE SUPPLY SIDE DYNAMICS

As mentioned in the introduction, long-term growth in the mainstream tradition is determined outside the GDP identity by exogenous factors affecting the supply-side of the identity, such as stocks of human and physical capital and technical progress. Technical progress, in turn, is a residual estimated by applying growth accounting techniques introduced by Solow in the late 1950s. From this perspective, trade promotes long term growth by accelerating the transmission of technical progress and —in particular when trade takes place along global value chains— by facilitating the adoption of modern management techniques and best practices in terms of industrial norms. In addition to these effects of trade on total factor productivity (TFP), GVCs are characterized by their strong "trade-investment" nexus. Foreign Direct Investment is also a driver of growth (i) through TFP when technical progress is embodied in new generations of capital and (ii) by removing some of the balance of payment constraints that many developing countries face.

Escaith and Miroudot (2015) show that in the hyper-globalised world that emerged in the late 1980s, trade grew more rapidly in the phases of GDP absolute convergence. Ideally, it would reach a maximum when all economies are of similar size, but convergence slowed down in the 2010s.

[16] Absence of statistical significance does not mean that the trend does not exist, following the statistical adage "absence of proof is not proof of absence". In this case, individual country behaviours are too diverse for concluding to a common set of coefficients.

Because trade is also a driver of growth, a virtuous cycle will sustain convergence, up to a certain level.

When looking at the supply-side, trade analysts –true to their Ricardian tradition– focus on the export specialization of each country. Specialization is usually measured through Revealed Comparative Advantages (RCA). RCA looks at the competitiveness position of an exporting country by comparing its export structure with the overall trade composition. As countries are expected to specialize in products where they have comparative advantages, this comparison reflects their RCA. Because this analysis uses relative market shares, it is also closely related to the shift-share type of growth analysis. [17] The calculation RCAs is associated to Balassa (1965) while Shift-Share Analysis (known as "Constant Market Share Analysis" by trade analysts) can be traced back to Tyszynski (1951).

During the 19th Century and most of the 20th Century, RCAs were expected to show a distribution of comparative advantages closely related to the degree of industrialization, with developed countries specializing in complex manufacturing and least-advanced countries exporting commodities. This pattern was supported by neoclassic growth theory (e.g., Solow models and the relatively slow path of convergence) and the trade models based on the product life-cycle. More recently, RCAs were also seen as *predictors* of the development potential. In particular, export specialization as observed through trade flows was seen as a reliable indicator of a country's underlying technology competencies, conveying important information on countries' latent capabilities (Hausmann, Hwang and Rodrik, 2007).

This approach of dynamic comparative advantages "revealed" by export flows in the product-space is valid when trade is composed of commodities and final goods. With the rise of GVCs, inter-industrial trade in intermediate inputs has taken much more importance, as GVCs allowed less advanced countries to leap-frog the industrialization ladder by specializing in some of the tasks required for the manufacturing of the final products. As a result, the export structure may not reflect anymore the relative situation of the exporting country with respect to the technology frontier.

As mentioned by Ferrarini and Scaramozzino (2011), today, a measure of comparative advantage that actually looks at supply capabilities should be based on net trade flows at the sectoral level. The analysis of RCAs on the basis of net trade flows is particularly relevant in the presence of global production sharing and vertical specialization. Understanding the reality of today's trade in global manufacturing networks provides important information regarding the capacity for any given country to upgrade and "capture" a larger share of the value-added generated in the international supply chain. [18] Trade in Value Added data presents the opportunity to move the analysis one step further and include domestic inter-industrial relationships in the analysis of comparative advantages and industrial competitiveness.

The purpose of this section is to look at the changes in comparative advantage that occurred during the 1995-2011 period, providing a few stylized facts and exploring the role of global value chains from a trade in value-added perspective.

4.1 Trade in Value Added and Revealed Comparative Advantages

The TiVA database is particularly well suited for analysing RCAs as it is organized not according to products, like most trade databases, but according to industries. Moreover, building on the suggestion of Ferrarini and Scaramozzino (2011) by using an industry perspective rather than a product-by-product approach, it is possible to subtract imports of intermediate inputs from exports. This is easily done in the OECD-WTO TiVA database by taking into consideration the value of the vertical specialization (VS) index (see equation [B1.3] in Box 1).

[17] When applied to trade, Shift-Share Analysis aims at explaining (decomposing) export growth through the initial distribution of market shares and their own dynamics, plus a residual supposed to measure changes in competitiveness.

[18] "Capture" is not the right word when referring to GVCs, which are mainly about net value creation and more in tune with the positive/cooperative view of the Physiocrats school than the Mercantilists' negative/confrontational vision of the world. But this zero-sum game anachronism is now firmly installed in the specialised literature, so...

The calculation of RCAs is based on the comparison of export structures relative to the Rest of the World. In Table 5, RCAs are obtained by comparing individual export structures with the G-20 average. The calculation was done for all industries (goods and services) for years 1995 and 2011. We also differentiated exports according to their use (final demand or intermediate use). This may provide interesting information on the comparative advantages relative to an upstream or downstream position in the global value chain. Actually, according to the industry, less advanced developing countries may join either as an upstream supplier (agriculture or mining) or as downstream suppliers (e.g., final product assembly in electronics); conversely, being downstream is a sign of market power in agriculture (brand reputation associated to geographical appellations) while being upstream in electronics or automobile indicates a strong position in R&D.

In order not to extend an already long paper, we will not look into the situation of each sector and each country, but focus on a few stylized facts. Our first interest is to observe the changes in RCAs, and see if the initial situation in 1995 is a good predictor of achieving similar results in 2011.

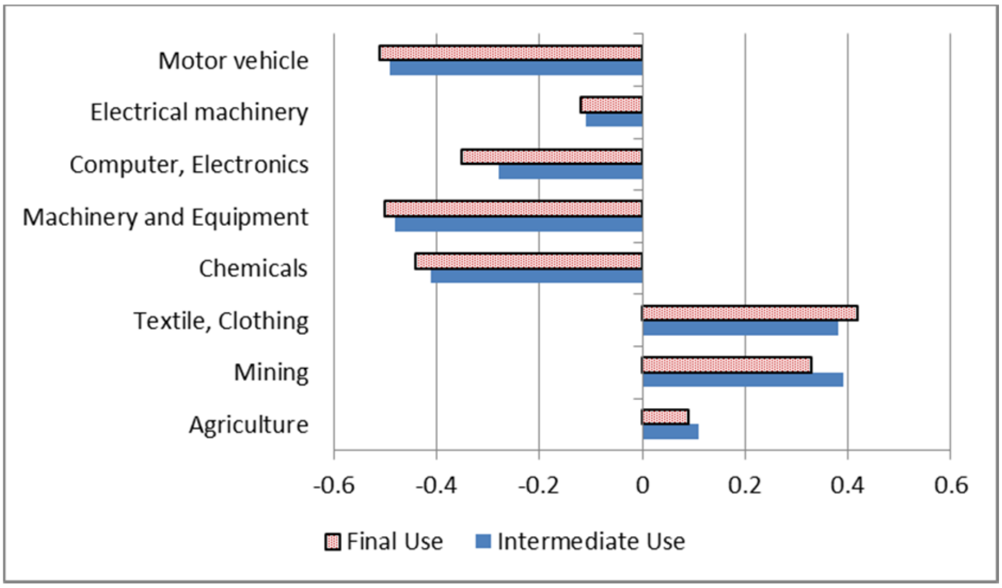
Table 5 Correlation between sectoral comparative advantages in 1995 and in 2011

All Sectors	RCA Final Goods and Services 2011	RCA Intermediate Products 2011
RCA Final Goods and Services 1995	0.7	0.6
RCA Intermediate Products 1995	0.6	0.7

Source: Based on OECD-WTO TiVA database 2015 (preliminary).

The results in Table 5 can be read as a kind of transition matrix, indicating the probability of maintaining the initial status over the 1995-2011 period. Overall, the odds are clearly in favour of a conservative situation and most exporters retain their relative strengths and weaknesses, but the results vary from sector to sector.

Figure 5 Sectoral correlation between shares in exports, 1995 and export growth from 1995-2011.



Source: Based on OECD-WTO TiVA database (preliminary).

Figure 5 shows the results obtained for a selection of goods-producing sectors, some identified as low technology, others more highly industrialized. The figure compares the initial strength in the base year with the subsequent growth of exports. Not surprisingly, natural-resource rich countries maintained their competitive advantage during the period under review, recording relatively high export growth. This is in contrast to industries strongly affected by the global fragmentation of production. With the exception of textile and apparel, all other manufacturing sectors recorded a reversion to the mean: the dominant countries in 1995 recorded, on average, lower export growth. However, in the case of textile and apparel, we observe a consolidation of dominant positions (at least within the G-20 group, where China is a clear outlier, as shown in the next section, in Figure 11). This may indicate that this sector, which was among the first one to be internationalised, had achieved its structural mutation in 1995, while new players in the other industries arrived after this date.

4.2 Global Value Chains and Upgrading

For many developing countries, particularly in East Asia, incorporation into Global Value Chains has been a great opportunity for export diversification (WTO and IDE-JETRO, 2011). By creating much needed low-skilled employment opportunities required to absorb the excess labour resulting from rural-urban migration, GVCs contributed in lowering the incidence of poverty and are credited for making possible the achievement of the related Millennium Development Goals. But joining GVCs at the low-skill entry level is only a first step, and the objective of many firms and policy makers is to up-grade by performing increasingly complex tasks and functions. This type of upgrading is in line with the export diversification policy understood in Hausmann, Hwang and Rodrik (2007).

Looking at export diversification from a GVC perspective opens also new options: up-grading can be achieved by including more and more domestic value added in the final export through deeper inter-industrial linkages. What the TiVA data tell us is that an industry exports not only directly (either final or intermediate products), but also by supplying other exporting industries with inputs (indirect VA exports). This role of second-tier supplier is particularly important for services, and half of service exports are indirect exports through service inputs embodied in merchandise goods. It is also often the best avenue for increasing small and medium firms' contribution to national exports. Up-grading through deepening ties with GVCs is closely related to Hirschman's views of economic development. [19]

Table 6 Revealed Comparative Advantage: Difference between Gross and Value-Added Exports, 2008 (in %)

Country	Average [a]	Food	Textiles	Wood products	Chemicals	Metal products	Machinery	Electrical equipment	Transport equipment	Other manufactur
Argentina	-7.5	-5.0	-6.4	-12.0	1.2	-6.1	-8.7	-4.5	-21.0	-5.3
Australia	-0.5	-1.5	1.0	-0.9	6.2	-6.5	-10.8	11.7	1.5	-5.2
Brazil	-3.0	-8.2	-3.8	-7.6	0.9	-0.8	-6.1	3.6	-2.2	-2.5
Canada	1.0	4.1	0.3	7.5	6.8	-6.1	-3.5	6.7	-11.4	4.9
China	0.5	2.0	11.9	-14.6	0.9	-0.6	-3.9	-8.0	3.9	13.0
France	1.7	1.9	-5.5	3.8	-1.1	0.0	1.5	13.1	-7.9	9.7
Germany	-0.5	-5.1	-6.8	-0.8	-1.8	-8.8	1.8	17.5	-4.3	4.0
India	3.8	8.7	6.8	4.3	2.6	8.8	2.5	21.4	9.5	-30.5
Indonesia	-6.3	-3.1	-18.6	-11.7	12.6	-1.4	-30.0	-3.9	2.6	-3.3
Italy	-1.6	-4.4	1.8	-6.4	-8.3	-5.6	-1.4	8.8	0.4	0.6
Japan	-1.6	-5.5	-4.5	-3.1	-6.1	-4.5	1.1	8.6	4.0	-4.7
Korea	9.3	10.4	12.3	17.4	-28.8	-3.8	16.1	11.4	19.8	28.6
Mexico	9.6	15.6	11.4	14.1	44.7	18.9	3.6	-24.8	2.2	0.6
Russian Federation	-6.6	-12.9	-13.5	-12.1	12.1	-0.8	-10.9	6.3	-18.6	-9.0
Saudi Arabia	-25.0	-24.8	-27.3	-30.9	13.0	-44.8	-28.4	-13.7	-37.1	-31.4
South Africa	-0.3	1.2	1.5	-3.0	13.1	-3.9	0.0	6.6	-19.8	2.0
Turkey	-1.2	5.8	7.2	-4.1	-8.5	-10.9	-2.5	10.5	1.5	-9.9
United Kingdom	0.5	0.8	0.8	1.7	5.1	-2.9	-4.8	10.4	-6.0	-0.9
United States	-0.9	-10.2	-8.8	-2.4	-3.0	6.8	-5.2	19.6	-4.7	-0.7

Note: a: simple average of industrial sectors. All sectorial results are in percentage of the RCA calculated for Gross Exports of goods producing sectors.
Source: Based on OECD-WTO TiVA, May 2013 release

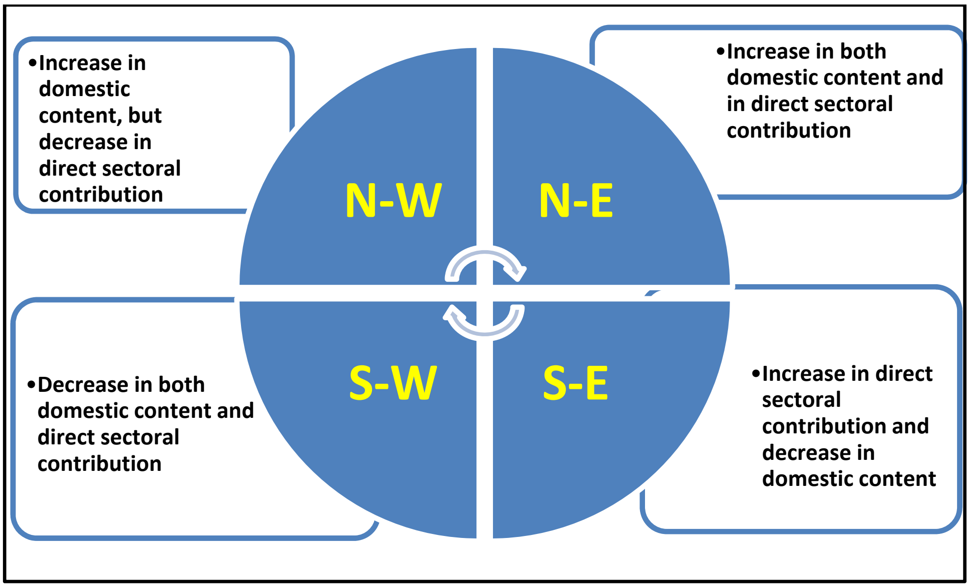
[19] Hirschman (1958) was not much optimistic about spontaneous and autonomous outcomes and favoured the role of "binding agents" and "inducement mechanisms" in economic development. Actually, GVC trade is a kind of "inducement mechanism" which makes decisions "induced" by lead-firms and first-tier suppliers. For Hirschman, spotting the most interesting inducement channels was to be done using the input-output tables, in particular backward and forward linkages. He thought that backward linkages were more compulsive, an opinion many GVC analysts would share.

Table 6 above shows, for a selection of industrial sectors, the difference between RCA calculated using gross export statistics (direct exports from the industrial sector, including domestic and foreign contents), and RCA calculated based on the value-added, directly and indirectly, exported by the same industry (domestic content of the direct export plus sectoral value-added embodied in exports from other national industries). A positive value indicates that the sector is indirectly exporting by supplying inputs to exporting firms; a negative value indicates that the sector is relying on imported inputs for its exports. This, using Hirschman's view, would signal potential for encouraging more backward linkages to domestic suppliers, provided that the domestic suppliers are sufficiently close to the international efficiency frontier (see page 24).

For some sectors, the difference can be quite important. In the case of Chemical industries, for example, Mexico and Korea present a very contrasting situation. Measured in Value Added, the comparative advantage of Mexico is 45% higher than what would imply its gross exports. At the contrary, Korea drops by almost 30% due to its high reliance on imported inputs.

This said, a higher domestic value-added content might not be the sole industrial objective from an upgrading perspective. In the previous example, Korea's gross exports relied on imports of inputs not because the country is not able to produce the required inputs, but because it focused in part, where it has the higher competitive advantage. Thus, for more advanced economies, upgrading may also mean gaining overall competitiveness by shortening the upstream domestic linkages and outsourcing non-core inputs (similar to the "make or buy" decision at firm level). Escaith and Miroudot (2015) mention the non-homothetic relationship between income levels and product diversification; Cadot, Carrère and Strauss-Khan (2011) point out that when GDP per capita increases, there is first a diversification in exports up to some threshold of USD 25,000 PPP; above this income, concentration takes place again.

Figure 6 Upgrading and stylised patterns of changes in the domestic value-added content of exports



Note: The matrix crosses, on the vertical axis the change in the domestic content of exports and on the horizontal axis the change in the contribution of direct value-added created by the exporting sector in relation to the total (direct and indirect) domestic content

Figure 6 helps illustrate some of the hypothetical upgrading trajectories that will be analysed in Figure 7. The graph is based on changes over a given period affecting three components: (i) gross exports, as the sum of domestic value-added plus the value of imported intermediate inputs required for the production of the products (foreign value-added); (ii) domestic value-added generated by the exporting industry (value of export minus purchase of imported and domestic inputs); (iii) domestic value-added generated by the various national sectors that supply inputs to the exporting industry. It presents on the vertical axis the change in the domestic content of exports (Δ Domestic VA / Gross Exports); the horizontal axis presents the change in the contribution of direct value-added created by the exporting sector in relation to the total (direct and indirect) domestic content (Δ Sectoral VA/Domestic VA).

A first phase in upgrading would be to increase the domestic content of exports (upper-right *North-East quadrant*) by increasing the direct contribution of the exporting sector (intensive upgrading) and by increasing the indirect contribution of other sectors (horizontal upgrading à la Hirschman). This corresponds to a reduction in vertical specialization in concordance with traditional ISI policies, albeit in practice (modalities are very different as we shall see later).

Quadrant North-West corresponds to a situation where the increase in indirect domestic content is at least partially based on some outsourcing by the exporting industry to other domestic sectors.

The *South-East quadrant* corresponds to a mature industry which outsources non-core activities and concentrates on the most profitable segment of the value-chain: sectoral contribution increases but the share of other domestic suppliers decreases. This is the typical position of a post-industrial developed economy during the Third Industrial Revolution. Such outsourcing behaviour fuels the upgrading trajectories of less advanced countries in the northern quadrants.

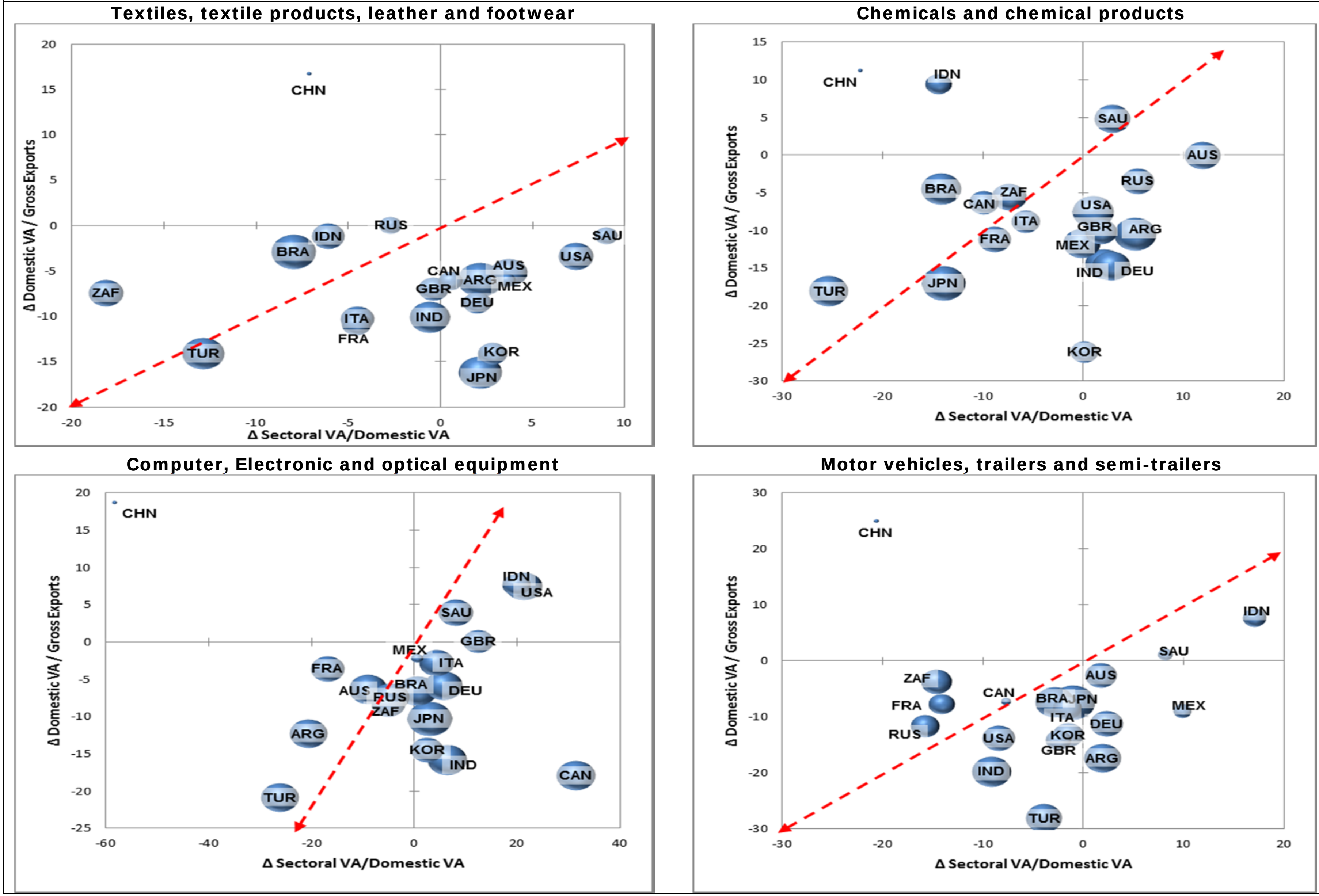
The *South-West* quadrant corresponds to a situation where both direct and indirect domestic contributions are retreating. It may not be seen forcibly as a negative outcome when it is the result of shifting productive resources in order to exploit comparative advantages. Actually, it may characterise a phase of rapid structural transformation in developing countries from a structuralist perspective "*à la Lewis*." For example, resources shifting from agriculture to manufacture. In fact, the sectorial results analysed with the help of matrix in Figure 6 should not be considered in isolation of the behaviour of other sectors. It should also be noted that, in practice, TiVA results analysed through this matrix are affected by changes in exchange rates. So, after devaluating its currency, a country may be located in the S-W quadrant just because the value of foreign inputs increased.

Applying this analytical matrix, Figure 7 shows the results obtained by comparing the 1995-2011 evolution of domestic content (Δ Domestic VA / Gross Exports) and the direct sectoral content of exports (Δ Sectoral VA/Domestic VA) for four products: i) Textiles, textile products, leather and footwear; (ii) Chemicals and chemical products; (iii) Computer, Electronic and optical equipment; (iv) Motor vehicles, trailers and semi-trailers. All results are based on OECD-WTO TiVA database at current prices, converted in USD at market exchange rates.[20] Calculations are based on the Leontief inverse (as mentioned in Box 1) and include all direct and indirect linkages. The size of the spheres indicates the share of domestic content in the initial year 1995 (percentage of direct and indirect domestic value-added embodied in gross exports). As we shall see below, overall domestic content (contribution of the entire economy through inter-industrial linkages) may vary in a different direction than the sectoral content (contribution of the exporting industry.

Before we examine individual sectors, three stylized facts emerge from the four panels. First, most observations are located in the Southern quadrants, indicating an increase in vertical specialization (*id est*, a decrease in the domestic content of exports due to a higher reliance on imported inputs). Secondly, China in the North-West quadrant (increase in domestic content principally due to an increase in the proportion of indirect value-added) is an outlier. It should be kept in mind that the Chinese situation in 1995 was very specific as most export-oriented activities were functioning as industrial enclaves. The domestic content of computer and electronic equipment exports was only 26% (vs. a 64% average of the G-20 group) while direct value-added represented 97% of this domestic value-added (vs. a G-20 average of 57%). The third observation is the scarcity of N-E cases (direct and indirect growth of the domestic value-added content based on a drop in vertical specialization).

[20] As we saw in previous sections page 11, measuring non-tradable intermediate and primary factors in $PPP may alter the results and probably reduce the incidence of commercial exchange rate variations on the results, especially for developing countries where PPP$ tend to "anticipate" future exchange rate appreciations due to the Balassa-Samuelson effect.

Figure 7 Foreign and domestic outsourcing: domestic content of exports and direct contribution of the exporting sector, 1995-2011



Notes: Change over 1995-2011 in percentage points; 45° line of balanced variation in dotted red.
Source: OECD-WTO TiVA database, June 2015 release

In the case of Textiles, all G-20 countries are located in the bottom quadrants, indicating decreasing domestic content in gross exports (increased vertical specialization), except China, which started with very low domestic content. In this case, the increase in domestic VA may reflect more domestic integration or/and higher prices of non-tradable intermediate and primary inputs, including wages.

Few countries, all developing ones, are above the 45° line in the South-West quadrant, where the decrease in the sectoral share of domestic VA was larger than the decrease in the domestic content of gross exports. The results being in percentage of total value, this result may relect different trends. Either the wages and profits in this sector dropped relative to the rest of the economy, or there was a process of internal outsourcing, with an increase in inter-industrial linkages. All other countries, except Turkey, Italy, France, India and UK, are in a situation where sectoral content increased in a situation of overall decrease in domestic content. This is possibly a sign of foreign outsourcing and/or increase in sectoral wages and profit (both options being compatible).[21]

In Chemicals, Saudi Arabia is the sole country that increased its share of domestic content and its share of sectoral value-added, Australia being a borderline-case. Here, the surge of commodity prices after 2003 may have played a role as these two countries have large endowments of natural resources (the situation of Russia, not far from Australia, is an argument in favour). With regards to countries which increased their domestic content but lowered their sectoral participation, we find China, which started with a very low domestic content, and Indonesia. An increase in domestic content may reflect more domestic integration or a higher rate of value-added (wages, profits) in domestic suppliers (exchange rate appreciation, due for example to the Belassa-Samuelson effect). Few countries, (Brazil, Canada, South Africa and Turkey) are above the 45° line in the South-West quadrant where the decrease in the sectoral share of domestic VA was larger than the decrease in the domestic content of gross exports. All other countries, except Italy, France and Japan, are in a situation where sectoral content increased in a situation of overall decrease in domestic content: sign of large foreign outsourcing and/or increase in sectoral wages and profit (both options being compatible)?

Computer and Electronic equipment is probably the most illustrative sector when looking at the geographical fragmentation of production. Indonesia, Saudi Arabia and the USA are in the positive North-East quadrant, with the UK on the border. The situation of these two industrialised economies is particularly interesting in view of the current debate on globalization, outsourcing and deindustrialization. It appears that the USA (and the UK in a lower proportion) was able to specialize in high and dynamic value-added segments of the industry. Few countries (Argentina, Australia, France and Turkey) are above the 45° line in the South-West quadrant (larger decrease in the sectoral share of domestic VA compared to the overall reduction in the domestic content of gross exports), All other countries except Russia and South-Africa are in a situation where sectoral content increased in a situation of overall decrease in domestic content. Sectoral content increased in an environment of decreasing domestic content for all other countries, except Russia nd South Africa. This may be the sign of foreign outsourcing of non-core activity and/or increase in sectoral wages and profit (both options being compatible).

In Transport equipment, Indonesia and Saudi Arabia are the sole countries that increased both domestic and direct sectoral contents. China is alone in the N-W quadrant: starting from a very low domestic content in 1995, it increased the contribution of domestic suppliers while lowering, in proportion, the direct contribution of the sectoral value-added. Few G-20 countries (Canada, France, Russia and South Africa) are above the 45° line in the South-West quadrant where the decrease in

[21] The sectoral analysis presented here is for illustration only. As a first approximation based on macro-estimates, it should be completed by an in-depth sectoral and microanalysis before attempting a more elaborated diagnostic.

the sectoral share of domestic value-added was larger than the decrease in the domestic content of gross exports. Either the wages and profits in this sector dropped relative to the rest of the economy, or there was a double process of international and internal outsourcing, with an increase in foreign content and in domestic inter-industrial linkages. All other countries are in a situation where direct sectoral content increased its share in a situation of overall decrease in domestic content.

As mentioned, most observations are located in the Southern quadrants, indicating an increase in vertical specialization over the period 1995-2011 for all sectors. To confirm this possible stylised fact for a larger sample, Table 7 presents the result of a correlation analysis on all economies included in the TiVA database (62, including Rest of World).

Table 7 Correlation between initial trade in value-added indicators and 1995-2011 changes (*all TiVA economies*)

	Domestic VA / Gross Exports	Sectoral VA/Domestic VA	Domestic VA / Gross Exports	Sectoral VA/Domestic VA
	Textile		**Chemical**	
Domestic VA/Gross Exports (1995)	**1**	**-0.3**	**1**	**-0.3**
Sectoral VA/Domestic VA (1995)	**-0.3**	**1**	**-0.3**	**1**
∆Domestic VA / Gross Exports	**-0.4**	-0.0	**-0.3**	0.1
∆Sectoral VA/Domestic VA	0.0	-0.1	-0.1	-0.2
	Computers		**Vehicles**	
Domestic VA/Gross Exports (1995)	**1**	**-0.4**	**1**	-0.0
Sectoral VA/Domestic VA (1995)	**-0.4**	**1**	-0.0	**1**
∆Domestic VA / Gross Exports	**-0.5**	**0.3**	**-0.5**	0.1
∆Sectoral VA/Domestic VA	**0.3**	**-0.5**	-0.1	**-0.4**

Note: 62 observations. Values in bold are different from 0 with a significance level alpha=0.05
Source: OECD-WTO TiVA database, June 2015.

For all sectors, the correlation is negative and significant between (i) the value of domestic content and the share of direct value added in 1995; and (ii) the value of domestic content in 1995 and the change between 1995-2001. The countries that sourced most of their inputs domestically in 1995 were those that also outsourced more actively to other domestic suppliers in 1995 (large domestic content positively associated with strong inter-industry linkages); the same industries outsourced more to international suppliers over the 1995-2011 period. The trend is particularly strong for 'computers and electronics': because of this international outsourcing substituting domestic inputs for foreign ones, the direct sectoral content increased (the correlation coefficient of 0.3 is positive and significant).

4.3 Sectoral Efficiency and Inefficiency Spillovers

Gains in sectoral efficiency when using intermediate inputs translates into higher value-added, and therefore support GDP growth. Public policies have increasingly adopted a GVC approach to economic development, in particular for the manufacture sector. [22] Adopting a value-chain perspective and developing industrial clusters, as encouraged by M. Porter (1985), has been the back-bone of many new "smart" industrial policies since the early 1990s. Value is not about

[22] And increasingly also in services. The Value Chain concept is also used in agricultural and rural development projects, but it generally refers to a wider sociological and environmental definition of "value" that differs from the original business approach of M. Porter. In particular, external competitiveness is not always the main decision criteria but sustainable income creation for poor farmers (sustainability meaning also long term economic rationality, the extended value chain concept does not ignore competitiveness issues).

output, it is about (consumer, shareholder, worker and stakeholder) satisfaction. Translating this approach to an inter-industrial dimension, a value-chain perspective assesses and optimizes the contribution of various industries —upstream and downstream— to the overall economic value. Here, "value" should not only be interpreted as an enterprise's profit or shareholders' income, but should also include income generation and long-term industrial sustainability objectives (which increasingly include corporate social and environmental sustainability).

Many low-income developing countries join global value chains by performing only one of the various tasks required in the global value chain. The objective of most industrial policies, old style or new style, is to incorporate more value-added by promoting domestic inter-industrial linkages. Increasing the length of domestic supply chains and deepening backward linkages by substituting imported inputs seems very similar to the older Import Substitution Industrialization (ISI) policy pursued by many developing countries in the 1950s and still in force in some areas. Yet, there are deep differences both in the conception and in the implementation of these policies.

This approach is often called "smart industrial policy" to differentiate them from previous import substitution strategies. One of the main guiding principles of these "smart policies" is to avoid inefficient allocation of (public and private) resources; efficiency is best benchmarked by the capacity of national industries to export, which in turns refers to the issue of "competitiveness", both in terms of process and prices.

The TiVA data help us to understand the relationship between nominal (price) competitiveness and productive efficiency. The technical coefficients of the IO matrix reflect the industry's production function under the domestic price structure. If input prices were similar across the world, higher efficiency would translate into higher international competitiveness. This is not the case in practice, and domestic prices differ from country to country. The domestic price of internationally tradable inputs is affected by a series of costs (freight costs, tariffs and other trade hurdles) while the price of non-tradable inputs reflects (more or less) the level of development of a country and its per capita income. Moreover, when trade is not frictionless and some inputs are not tradable, the inefficiency of some domestic sectors may in turn affect the international competitiveness of the industries that depend from them for their inputs. This section will review how the information derived from TiVA can help establish a diagnostic relative to sectoral efficiency and its down-stream spillovers. The following examples are based on the results obtained for two industries where GVCs are prevalent: Textile and Clothing, a buyer-driven GVC, and Automobile (motor vehicles and trailers), an industry-driven GVC.

➢ Sectoral efficiency

There are many definitions of productivity and efficiency. The business approach to measuring performance indicators relies generally on financial indicators such as return on assets, gross margin, etc. Often, key performance indicators take the form of a ratio between an output and an input (Bogetoft and Otto, 2011). If we have input-output data for all industries, we can use this information to determine which is doing best according to a specific dimension of efficiency. When we have several inputs and outputs, the comparison between different industries is more difficult, some being more effective than others in the use of some inputs.

Setting aside for now the distinction between effectiveness and efficiency, we approximate productive efficiency by the ratio, sectoral Value-Added per unit of Output. The ratio derives directly from the national input-output data and at this stage we do not take into consideration turnover and scale effects. [23] Comparing sectoral ratio with other foreign producers, nevertheless, does not reflect just differences in gross return per unit due to technology as reflected by the (IO matrix) technical coefficients, but also the difference in the purchase price of inputs and output. Even under the assumption of a unique international price for tradable goods, domestic prices are affected by trade costs, while the price of non-tradable inputs (services and primary inputs) is affected –inter alia– by the Balassa-Samuelson effect (Feenstra, Inklaar and Timmer, 2015).

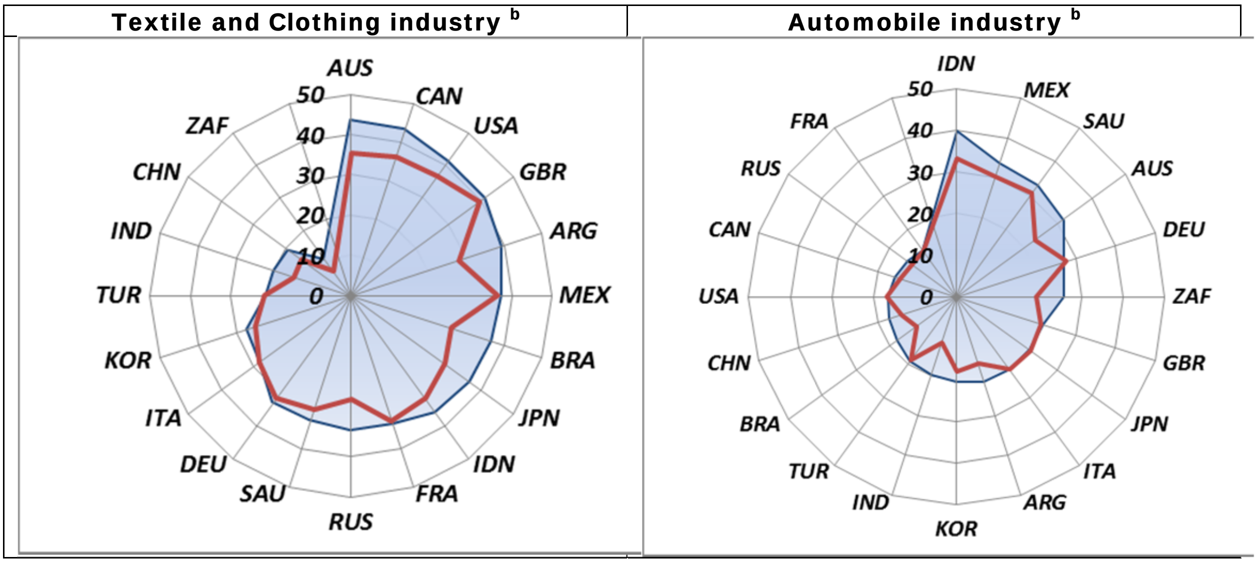
[23] This is a clear restriction on the use of this indicator for inter-enterprise comparison, as a small-sized industry may generate high value added per unit, but be less profitable (eg., in terms of return to investment or total wages per worker) than a high-volume/low-margin industry. Ideally, this indicator would be best used when input-output data are split by firm size, but this disaggregation –envisaged by TiVA promotors– is still a long term objective.

Diakantoni and Escaith (2014) explore the impact of tariff policies on the domestic price of inputs and their cascading effect on costs of production. They show that measuring trade in value-added reveals that, in a GVC context, transaction costs (border and behind the border cost of trade) on both imported inputs and exports are a crucial part of the competitiveness of firms and determine in part their ability to participate in production networks. In particular, tariffs have an accumulative effect with important implications on effective protection and competitiveness. Moreover, they show that domestic service producers do pay the cost of customs duties when purchasing intermediates required for their functioning; their international competitiveness and the competitiveness of the firms they supply with their services are reduced, inducing a negative spill-over.

A high VA ratio may therefore reflect a situation where the industry benefits from a high nominal protection on its output, while the intermediate goods required by the production process are subject to lower tariffs. [24] The net effect of this difference in nominal protection between output and input, relative to a situation of free trade, is known as Effective Protection Rate, a concept from the late 1960s that takes a new relevance when trade is in value-added (Diakantoni and Escaith, 2014). The value-added of sectors benefiting from a high positive EPR will be artificially inflated, while those suffering from negative effective protection will generate less VA than would have been the case in a free trade situation.

Overpriced inputs may be due to technical inefficiencies affecting the upstream industrial sectors or the effect of distorting trade policies. As observed by Cella and Pica (2001), sectoral inefficiencies in the OECD were largely due to inefficiencies imported from other sectors via intermediate input prices, rather than internal factors. Inefficient sectors producing tradable goods are often beneficiaries of effective protection through high tariffs, resulting in final domestic prices much higher in the home market than international ones. So, correcting for the artificial bias induced by tariff escalation allows for a more transparent international comparison of sectoral efficiency.

Figure 8 Textile and Automobile: Sectoral Value-Added at current domestic prices and correcting for tariffs, 2011[a]



Notes: a/ Effective Protection Rates are calculated on 2008 tariff data, including preferences and ad-valorem equivalents.

b/ The blue area shows the sectoral value-added in per cent of total production; the red line indicates the unit value-added after adjusting for effective protection due to tariff policy.

Source: OECD-WTO TiVA database (June 2015) and Diakantoni and Escaith (2014).

Incidentally, the graph illustrates a stylised fact that is often forgotten when discussing industrial policy: industrial upgrading means lowering the rate of value added. Here, textile, a low-

[24] In the following section, we will not consider differences in transportation costs, which may also play the role of differentiated trade barriers and affect the degree of sectoral effective protection. Shiozawa (2012) presents a neo-Ricardian model accounting for differences in production techniques and labour costs that provides further insights on the issue.

technology/low-skills industry, generates on average 32% of value added vs only 23% for the more complex automobile industry. This lower profitability must be compensated by higher production volumes that are not always easy to obtain in highly competitive or saturated markets.

Developed G-20 countries top the ranks of gross return per unit in the textile industry while developing G-20 members do so for the automobile industry. France, Canada and the USA have very low gross rate of return per dollar of automobile produced; as for textiles, the lowest returns are found for South Africa, China Indonesia or Turkey. But low rate of return per unit may actually show competitiveness in the high-volume segments, while high rates of value-added may be the characteristics of niche markets (luxury or specialised products). This indicates that the indicator is probably not a good one for international comparison.

Using the same notation as in Box 1, EPR for sector "j" is the difference between the nominal protection enjoyed on the output (t_j) minus the "weighted average" of tariff paid on the required inputs ($\sum t_i . a_{ij}$). [25] The measure, as in the numerator of equation [5.1] is divided by what would have been the net benefits if all prices had been equal to their international process (without tariff). It is given by:

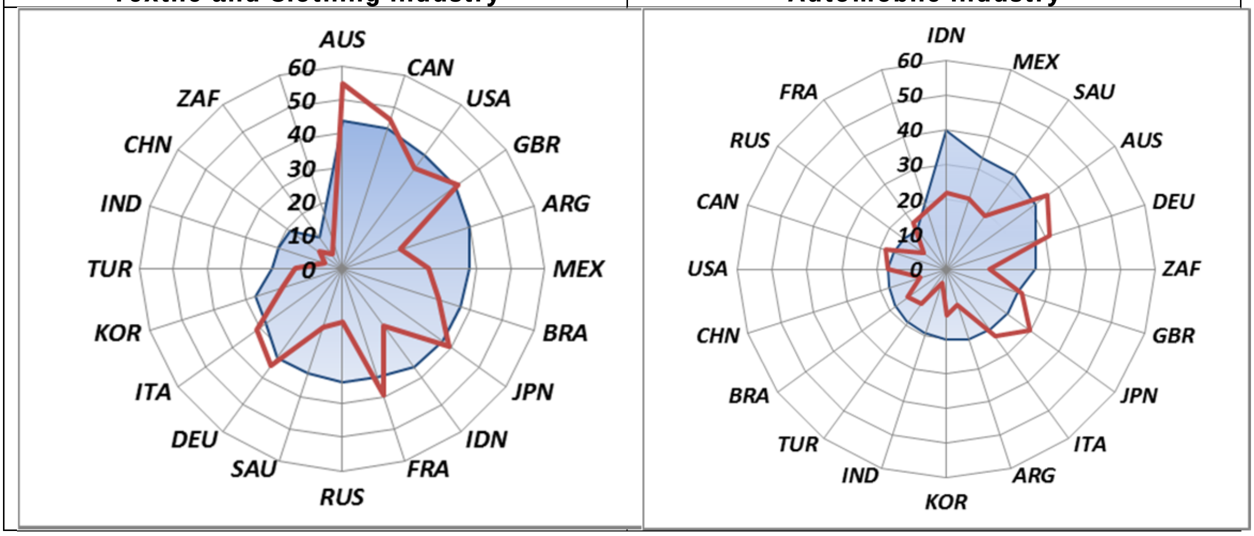
$$EPR_j = \frac{t_j - (\sum_i t_i \cdot a_{ij})}{1 - \sum_i a_{ij}} \qquad [5.1]$$

With $[1 - \sum_i a_{ij}] > 0$

Correcting for effective tariff protection provides, nevertheless, an indication on the extent of genuine vs. policy-induced competitiveness. The red line in Figure 9 corrects the rate of value added for the bias introduced by the differences in nominal tariff protection between output in a two sector example (textile and clothing or automobiles) and the various inputs required for their production.

Figure 9 Textile and Automobile: Sectoral Value-Added at current domestic prices, and correcting for tariffs and purchasing power parities, 2011[a]

Textile and Clothing industry [b]	Automobile industry [b]



Notes: a/ Effective Protection Rates are calculated on 2008 tariff data, including preferences and ad-valorem equivalents. Purchasing power parity US-PPP =1 in 2011.

b/ The blue area shows the sectoral value-added in per cent of total production; the red line indicates the unit value-added after adjusting for tariff policy and exchange rate misalignments.

Source: OECD-WTO TiVA database (June 2015), PWT8 and Diakantoni and Escaith (2014).

[25] It is not strictly a weighted average, as by EPR definition, the weights cannot sum up to 1 (services and primary inputs are excluded from the formulation).

The automobile industry in developed countries (barring Australia) does not benefit from a significant effective protection, and its gross profitability (per unit) is genuine; this is also the case for Turkey. In many developing G-20 countries, part of the profitability of the automobile industry relies on the difference between the nominal protection received and the additional cost paid on inputs due to tariffs. EPR in [5.1] is the ratio of value-added generated dues to this difference in nominal protection relative to the VA that would have been generated in a situation without tariff duties. The difference is particularly high for Indonesia (41%) and Brazil (32%). Australia and South Africa provide 25% effective protection to their automobile industry, inflating by a similar margin its profitability.

When it comes to textile and clothing, a more labour-intensive industry, many developed countries also provide effective protection, even if in a lower proportion than developing countries. 21% of value-added generated by textile and clothing activities in Japan, 19% in Australia and 17% in Canada can be attributed to the tariff structure. The profitability of these industries would therefore be affected by a flattening and reduction of the tariff schedules. It would also be the case in South Africa (32%), Brazil (29%), Argentina (28%), China, Indonesia and Russia (between 21 and 25% of additional return due to trade policy).Some developing countries do not provide much protection to their domestic industry, relying on their own capacity for international competitiveness as is the case for Mexico (3%) and especially Turkey, where the protection is negative (its textile and clothing industry would generate more value-added in absence of effective protection).

A second filter consists in correcting the price of value-added (remuneration of employees and entrepreneurs, assumed non-tradable) for variations in costs of living. Low costs of living imply lower monetary wages for a given bundle of final goods and services, thus a gain in international competitiveness for the firms established in low-cost countries (in general, low-income developing countries). Purchasing Power Parities ($PPP) relate the cost of living in a given country with the USA, a value of 1 means that the commercial exchange rate is aligned with the cost of living (one USD will buy the same amount of goods and services in both countries); a value above/below one indicate that the country is more/less expensive than in the US (overvalued/undervalued). Nevertheless, when countries develop, the cost of living tends to increase (Belassa-Samuelson). Some analysts profess that market exchange rates tend to converge towards their $PPP value in the long term, albeit this claim is debated. [26] The simulation shows the change of competitiveness per unit of output if the remuneration of primary factors (value-added) adjusts to a purchasing power situation where $PPP=1. Australia, Brazil or Canada (commodity exporters which suffered from an episode of "Dutch Disease" during the commodity super-cycle of 2003-2011) would benefit from a devaluation of their currency; it would also be the case for Europe and Japan, albeit for different reasons. Most of the other countries, at the contrary, would have to appreciate their commercial exchange rate increase in order to align purchasing power parities with the USD. Were it the case, Indonesia, China, Saudi Arabia or Russia would see their competitiveness eroded.

Extreme caution needs to be applied here, as this simulation is done under the "*ceteris paribus*" hypothesis, something highly unlikely were the relative prices to change so drastically. Indeed, the static input-output framework used here is not appropriate for large shocks in relative prices and a general or partial equilibrium approach would be much more appropriate Figure 9 shows the results of this (very hypothetical) simulation, after considering both the EPR and the exchange rate adjustments. The competitiveness gap would be much higher in developing countries, which usually have a more protectionist policy and benefit from lower costs of living than the US. The size of the gap provides some indication of the productive shift that the sector would require to maintain its profitability if domestic prices were to align with international ones. On the contrary, most developed economies would benefit from a price situation (including exchange rate) closer to its "pure free market" ideal (e.g., Australia in the case of textiles and Japan for automobiles).

- **Benchmarking inefficiencies**

A productive chain is as strong as its weakest link. This is particularly important when the policy makers' objective is to improve the quality of their GVC specialization by deepening backward and forward domestic linkages. At the difference of traditional Import Substitution Industrialization that

[26] Many other factors than purchasing parity influence exchange rate markets, in particular financial considerations (covered interest rate parity).

relied on explicit or implicit subsidies, this upgrading strategy is sustainable only when domestic suppliers can efficiently substitute imported inputs. To be successful, such a GVC approach to industrialization must look –inter alia– at value creation by identifying and reducing industrial inefficiencies. [27] Because (international) efficiency is only relative to (international) industrial standards, this implies comparing national industries against international benchmarks.

Following the work of Cella and Pica (2001) on 5 OECD countries, International Input-Output matrices offer a novel source of data for a worldwide efficiency benchmarking analysis, comparing domestic inter-industrial linkages for a given country against its main trade partners. [28]Accounting for inter-industry linkages via the IO relationship allows tracking sectoral inefficiency spillovers over the upstream and downstream domestic and international segments of the value-chain.

This section applies frontier analysis to identify those sectors that effectively convert intermediate inputs into maximum achievements from an economic growth perspective (production and domestic value-added). To this purpose, we use the benchmarking technique of data envelopment analysis (DEA), which has been used extensively in the last 30 years in the estimation of production frontiers for private and public entities.

Observations (firms) in DEA are often referred to as decision-making units (DMU); this name reflects the hypothesis that the DMU can discretionarily decide on the bundle of input required to produce outputs. This bundle may be optimal or not; if optimal, the DMU is deemed "efficient". Efficiency, in a multiple input-output setting is measured as the maximum Output/Input ratio, obtained either by minimizing inputs for a given level of output (primal) or maximizing output for a given level of inputs (dual).

DEA uses the input-output data of a sample of industries to identify a production frontier and determine the location of each observation. A DMU is a frontier point in an input-oriented optimization (primal) if its current input levels cannot be reduced (proportionally) to obtain the same value of outputs. On-frontier industries are ascribed an "efficiency rating" of 100%; less efficient "off-frontier" observations are characterised by a "distance" from the frontier which measures a potential for enhanced performance.

The method derives from Operational Research programs and looks at the minimum bundle of inputs required for producing the given level of output or, in a dual approach, the maximum production obtainable for the observed combination of inputs (see Koopmans, 1951, for an early review of optimizing resources allocation). This (relatively) simple linear programming technique has been progressively enriched to account for differing production technologies, for example constant vs. variable return to scale, stochastic frontiers, logarithmic preference and cost functions, etc. DEA has been extensively applied to benchmark profit and non-profit maximizing enterprises. Because it allows consideration of not only multiple inputs, but also multiple outputs, it is increasingly used to gauge development projects that have several concomitant objectives (economic, social and environmental). For example, Thore and Taverdyan (2015) explore this technique of providing diagnostics to support policymaking aimed at achieving sustainable development goals (SDGs).

Applying DEA to input-output data in order to benchmark industries against their international competitors seems a natural extension of this technique to identify the existence of inefficient sectors that may jeopardise the competitiveness of downstream domestic value chains. Nevertheless, a closer look reveals several caveats that require attention and may, if not attended, limit the analytical value of the results or their robustness. On the analytical side, the main issue is the international comparability of highly aggregated sectors as those presented in the TiVA database. Because DEA is best applied as a benchmarking device when the units are homogeneous (in their inputs, outputs and operating environment), the aggregation biases present in national accounts is a tangible issue. Comparing the agricultural sector of India and of Japan on the implicit assumption that the "representative" Indian and Japanese farmer face the same environment and

[27] The present paper does not formally look at the systemic sources of inefficiency, such as the institutional environment and formal rules analysed by the New Institutional Economics. Nevertheless, any international benchmarking exercise of firms must take into account the diversity of business and social environments.

[28] Cella and Pica (2001) use also the "price" dimension, which allows refining the analysis and examine allocative efficiency. In our case, TiVA data come from accounting sources and are "values" (cost and revenues); therefore, quantity and prices are missing.

can use the same productive technologies is at best heroic. [29] There exist several options for controlling heterogeneity and calculate meta-frontiers that consider the different environmental constraints in which the industries operate, but these techniques demand a large number of observations.

The limited number of observations in our G-20 case study is already a constraint, even considering the standard DEA approach. A small sample not only reduces the robustness of the results, as in most empirical analysis, but DEA also loses discriminatory power and may flag too many observations as "efficient". There are in practice several rules of thumb for selecting the sample size (Avkiran, 2006): larger than the product of number of inputs and number of outputs or larger than three times the sum of the number on inputs and outputs. If the sample size is large enough, the number of fully efficient observations (industries, in our case) should not exceed one-third of the sample. In the case of the G-20, the sample size is fixed (19 countries). We kept 2 outputs (total production and value-added) and aggregated the various sectoral inputs (domestic and imported) in order to reduce them to five: three domestic inputs, sourced from the primary, secondary and tertiary sectors of the economy, and two imported ones (intermediate goods imported from primary and secondary foreign sectors). [30]

The argument of considering value-added as an output of the optimization system is not straightforward and requires some attention. Indeed, from a public industrial policy perspective, the objective is to create as much value-added as possible as it is the source of factorial income (wages, profits, indirect net taxes on production) and economic growth (a country's GDP is equal to the sum of its sectorial value-added). Yet, from a value-chain perspective, high value-added in an upstream industry also reflects higher prices for its output and inflated production costs for the other down-stream industries. So, from an efficiency spill-over perspective, value-added may also be treated as a primary input, as it is the case in standard production function. Moreover, Koopmans mentions when reviewing earlier research that Leontieff and von Newmann treat labour as an output, even if himself prefers integrating it as a fixed primary input (Koopmans, 1951). [31] The results presented here adopt the policy-makers perspective by considering value-added as part of the objective function.

All calculations were made using the "Benchmarking" package implemented in "R" (Bogetoft and Otto, 2015). Following Avkiran (2006), the data were normalized by dividing all inputs and outputs by their sample mean; this does not affect the results but facilitates calculations. More importantly, this transversal normalization across countries breaksdown the accounting identity linking the sum of inputs and the sum of production and value-added in a national account framework. This transformation is necessary if the researcher wants to avoid collinearity issues when implementing stochastic frontier analysis (not performed here).

The results presented here are for illustration only as they only scrape the surface of the analytical power of modern DEA analysis and, more importantly, were not submitted to robustness tests (the results are based on a relatively small sample). To be more rigorous, the DEA methodology would require a full TiVA sample (62 economies) or an even larger collection of national Input-Output or Supply Use Tables, provided they were harmonized. This remains a work in progress.

➢ A simple benchmarking of the automobile industry

The data in Table 8 correspond to TiVA sector "Motor vehicle including trailers" collected for the nineteen G-20 countries in 2011. The analysis considers two outputs (production and value-added) and 5 aggregated inputs (three domestic, two imported). A first exploration of the data set relies on simple correlation coefficients between inputs (three classes of domestic inputs and two imported ones). With the exception of primary domestic inputs, all correlations are significant.

[29] Not to mention the "representativeness" of the input-output sectoral average, when firms are highly heterogeneous, which is one of the limitation of the present TiVA estimates. In the 2015 version of TiVA, this aggregation bias is reduced in the case of China and Mexico, by separating export-oriented from domestic oriented firms. Future work, differentiating firms by size and ownership based on the compilation of Extended Supply Use Tables should reduce the TiVA aggregation biases.

[30] Food was considered as "Primary" in our aggregation, even if it includes agro-industrial products.

[31] The treatment of non-discretionary inputs such as "labour" in Koopmans' case falls beyond the scope of this essay. In our cases, all inputs are deemed to be flexible and can be discretionarily adjusted (within limits set by production technologies) by the industry managers.

Interestingly, and in accordance to the GVC axiom that "Imports Make Exports", value-added and production are highly correlated with the use of imported industrial inputs (6th column of Table 8).

Table 8 Automobile industry: Correlation coefficients between inputs, output and value-added, 2011

Variables	Primary_D	Secondary_D	Tertiary_D	Primary_I	Secondary_I
Primary_D	**1.0**	**0.6**	**0.7**	**0.9**	**0.8**
Secondary_D	**0.6**	**1.0**	**0.9**	0.4	**0.6**
Tertiary_D	**0.7**	**0.9**	**1.0**	0.4	**0.7**
Primary_I	**0.9**	0.4	0.4	**1.0**	**0.8**
Secondary_I	**0.8**	**0.6**	**0.7**	**0.8**	**1.0**
Value_Added	**0.8**	**0.7**	**0.8**	**0.6**	**0.9**
Production	**0.8**	**0.7**	**0.8**	**0.7**	**1.0**

Note: Pearson coefficients calculated on 19 observations, values in bold are different from 0 with a significance level alpha=0.05. Input suffixes "_D" and "_I" stand, respectively, for "domestically sourced" and "imported".
Source: Author's calculations, based on TiVA data.

Industry benchmarking between countries is based on the optimal use of inputs (the primal model). Table 9 presents the results obtained under two alternative technologies: variable and constant return to scale. More countries are classified as efficient under the variable returns hypothesis, and many countries are very close to the efficiency frontier (id est, a more flexible approach integrating random measurement errors would have probably classified them as efficient). Following Avkiran (2006), we can conclude from the high number of efficient DMUs that the sample size is probably too small to discriminate correctly between them.[32]

Table 9 Automobile sector: Frontier efficiency scores under variable (VRS) and constant (CRS) returns to scale, 2011.

ISO3	**ARG**	**AUS**	**BRA**	**CAN**	**CHN**	**DEU**	**FRA**	**GBR**	**IDN**	**IND**
VRS	0.89	1.00	1.00	0.87	1.00	1.00	0.96	0.96	1.00	0.93
CRS	0.88	1.00	1.00	0.83	0.82	0.85	0.82	0.83	1.00	0.91
ISO3	ITA	JPN	KOR	MEX	RUS	SAU	TUR	USA	ZAF	
VRS	1.00	1.00	1.00	1.00	0.95	1.00	0.87	1.00	0.94	
CRS	0.91	1.00	0.99	1.00	0.85	0.96	0.86	0.82	0.91	

Source: Author's calculations, based on TiVA data and 'Benchmarking' R package.

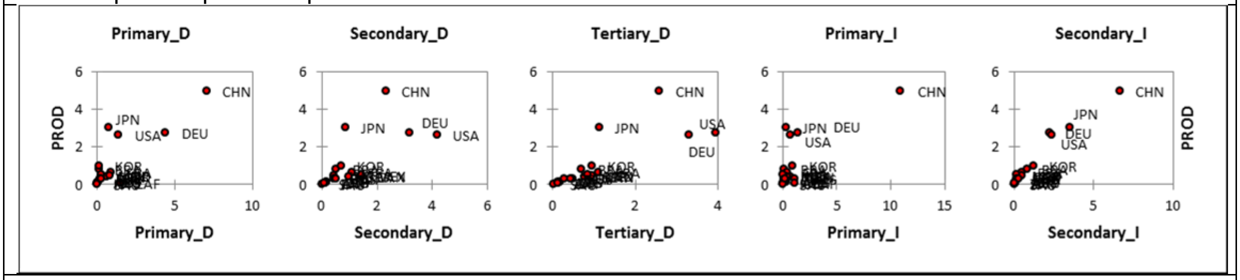
As mentioned previously, the results may not represent international competitiveness because the value of inputs and outputs used in the benchmarking exercise are based on domestic prices. Those prices may differ widely, at least for the output price, from the international conditions that exporting firms face when they are price takers. [33] A more thorough analysis should correct for the biases introduced by trade and tariff policy, as was done in the previous section in Figure 8.

One may gain additional information by considering inputs or outputs separately (Figure 10). The four leaders (China, Germany, Japan and USA) differ in their use of inputs. For example, China's automobile industry is particularly intensive in the use of primary inputs, especially imported ones.

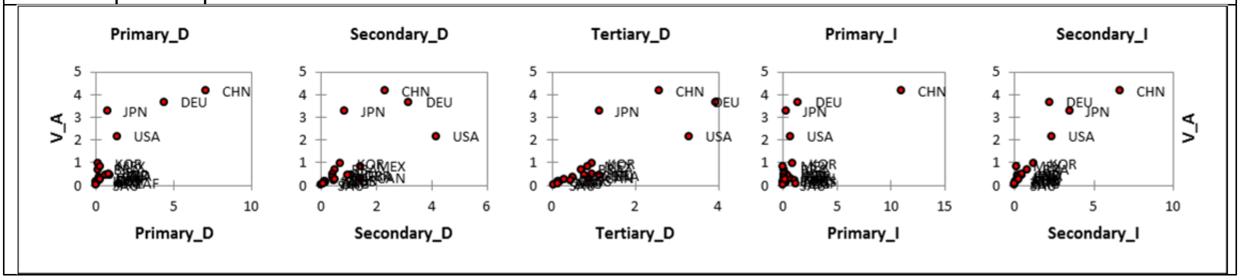
[32] Under standard DEA, a DMU may be classified as efficient only for the use of one particular input, even if it is inefficient for all others. Other benchmarking methods (e.g., Stochastic Frontier Analysis) may correct for this bias, but at the cost of introducing assumptions that are more demanding.
[33] Benchmarking loses analytical relevance when firms are price makers from a position of monopoly, at least from an international perspective. The DEA technique remains valid for the managers who may use it to identify margins of improvement in the use of inputs. Actually, the technique has been extensively used to improve public services management, despite the fact that they do not operate according to market pricing.

Figure 10 Automobile sector: Input use vs Production and Value-Added

Scatter plots inputs vs. production



Scatter plots inputs vs. value-added



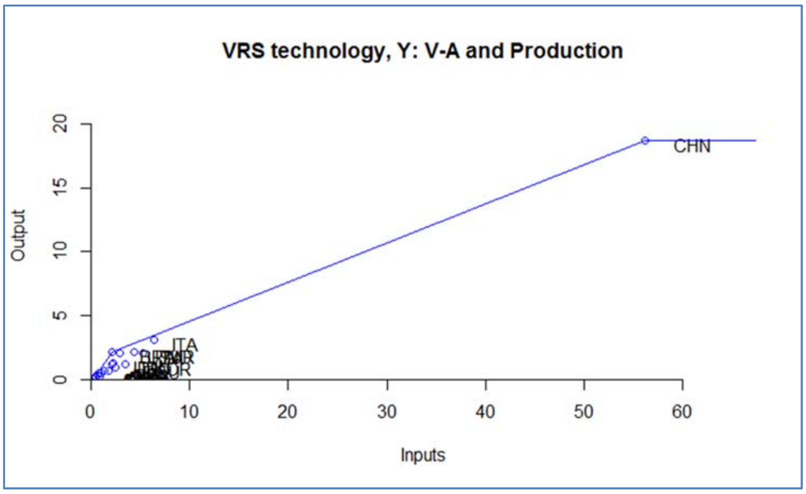
Note: Input suffixes "_D" and "_I" stand, respectively, for "domestically sourced" and "imported".
Source: Author's calculations, based on TiVA data.

Some industries are also clear outliers and weigh too much on the sample, distorting the analysis. An example is provided in the following section on textile and clothing.

➢ Benchmarking various dimensions of the textile and apparel industry

In Figure 11, China is clearly an outlier. The large scale of its production overshadows the results obtained for other G-20 countries. Moreover, by construction of a convex frontier, as an outlier alone in its class, it also defines the frontier for this mix of input and output; in other words, China is classified automatically as efficient under the variable returns to scale technology. In order to gain analytical insights for the other G-20 economies, we drop the Chinese textile industry from the sample.

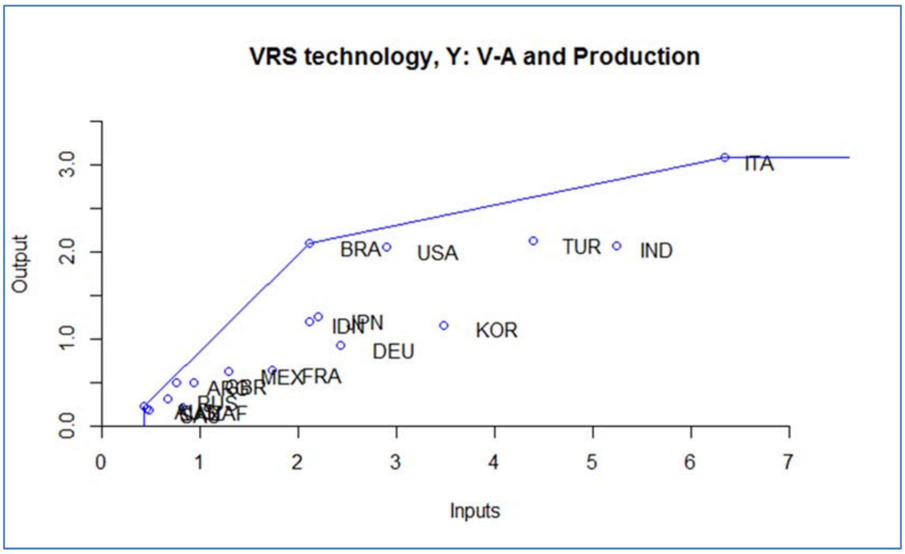
Figure 11 Textile and Clothing sector: Frontier efficiency graph under variable returns to scale, G-20 (2011).



Note: Due to the projection of 5 inputs and 2 outputs on a 2 x 2 graph, the position of each point relative to the frontier is approximated.
Source: Author's calculations, based on TiVA data and 'Benchmarking' R package.

Taking China out of the sample provides a clearer view of the relative efficiency of other G-20 textile and apparel industries (Figure 12).

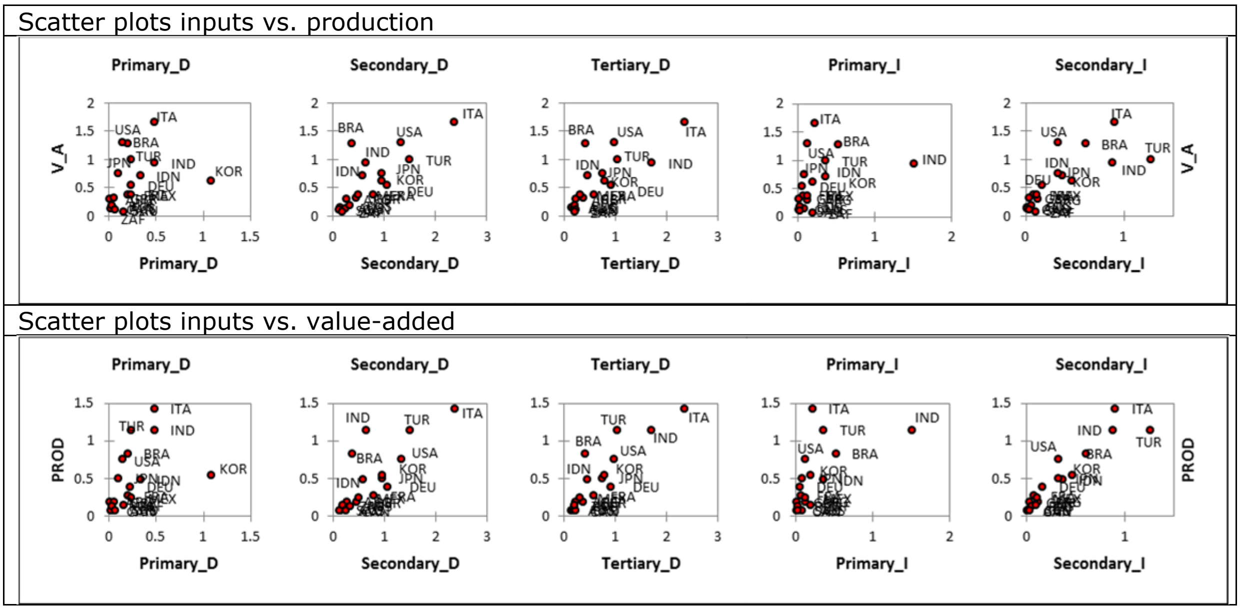
Figure 12 Textile and Clothing sector: Frontier efficiency graph under variable returns to scale, G-20 less China (2011).



Note: Due to the projection of 5 inputs and 2 outputs on a 2 x 2 graph, the position of each point relative to the frontier is approximated and some efficient DMUs may be plotted inside the frontier.
Source: Author's calculations, based on TiVA data and 'Benchmarking' R package.

The frontier analysis considers a weighted sum of all inputs on the one hand, and all outputs on the other. As Figure 13 shows, countries differ widely in the mix of domestic and imported inputs used in the production process. Table 10 tells us also that primary inputs (domestic or imported) may play a lesser role in "producing" value-added than in determining turnovers.

Figure 13 Textile and Clothing sector: Input use vs Production and Value-Added



Note: G-20 countries, excluding China. . Input suffixes "_D" and "_I" stand, respectively, for "domestically sourced" and "imported".
Source: Author's calculations, based on TiVA data.

Table 10 Textile and Clothing industry: Correlation coefficients between inputs, output and value-added, 2011

Variables	Primary_D	Secondary_D	Tertiary_D	Primary_I	Secondary_I
Primary_D	**1.0**	0.4	**0.5**	0.4	**0.5**
Secondary_D	0.4	**1.0**	**0.9**	0.1	**0.7**
Tertiary_D	**0.5**	**0.9**	**1.0**	**0.5**	**0.7**
Primary_I	0.4	0.1	**0.5**	**1.0**	**0.6**
Secondary_I	**0.5**	**0.7**	**0.7**	**0.6**	**1.0**
V_A	0.4	**0.8**	**0.8**	0.4	**0.8**
PROD	**0.5**	**0.8**	**0.9**	**0.6**	**0.9**

Note: Excluding China. Pearson coefficients calculated on 18 observations, values in bold are different from 0 with a significance level alpha=0.05. Input suffixes "_D" and "_I" stand, respectively, for "domestically sourced" and "imported".
Source: Author's calculations, based on TiVA data.

In order to analyse more precisely the efficient use of some factor of particular interest, DEA analysis can focus on particular inputs or outputs. Figure 14 provides an example of the differences in efficiency observed in the G-20 textile and clothing industries (minus China) for their use of domestic and foreign intermediary goods. For example, the graphs show that the use of imported inputs is in general more efficient (more countries are on the frontier or close to it).

Some countries in Figure 14 are always on the efficiency frontier for each individual category of inputs (Italy, for example), others may be in some cases (e.g., Japan), others are always inside the efficiency frontier (Korea). Once again, we should keep in mind that this comparison is based on domestic prices for outputs and inputs, and an industry benefitting from a high effective protection may be efficient due to inflated output or value-added prices but may not be competitive at international prices (see section 5.1 for a discussion).

A full DEA analysis would deliver additional information on how the actual performance of sub-optimal industries could be improved, for example by comparing them to their peers located at the frontier. [34] Korea, for example, lies relatively far from the frontier in Figure 12 and has up to five peers (one for each of the inputs). Among the Textile and Clothing industries, five of them could improve the efficiency of one or several inputs. Slacks (i.e., the possibility of reducing the use of some input without increasing the need for other inputs or reducing the production of outputs) are more frequent in the use of domestic primary inputs and nonexistent in the use of imported secondary inputs (Table 11).

Table 11 Textile and Clothing: DEA "VRS-Efficient" industries with Slack in inputs

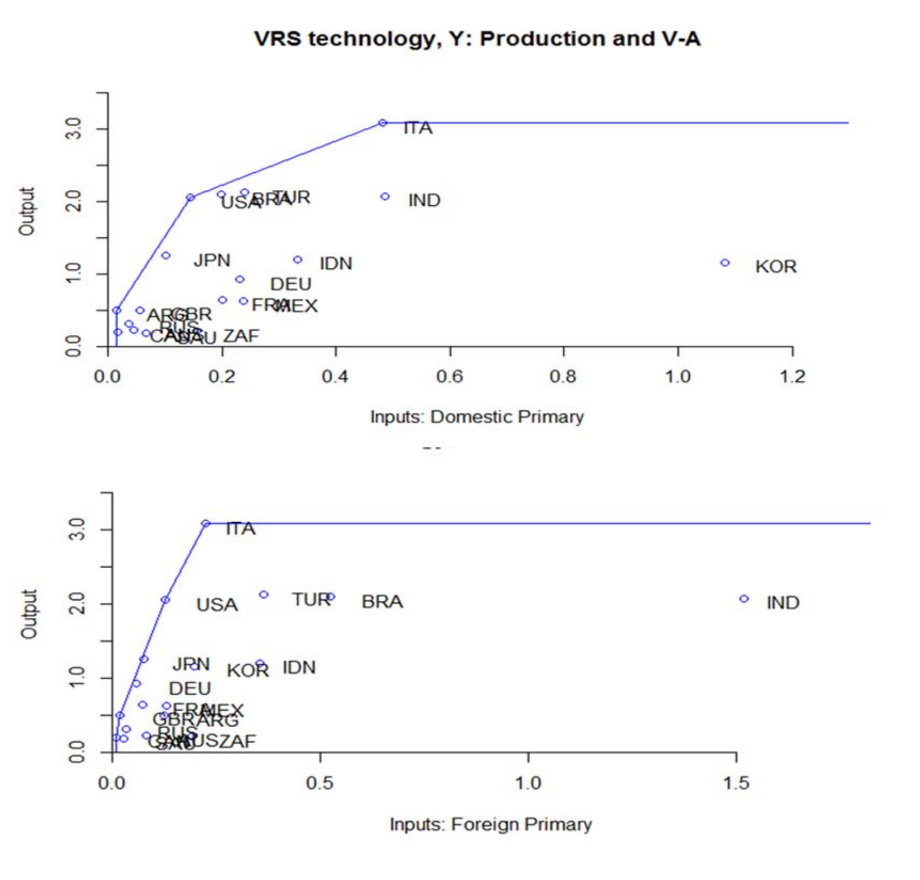
	Primary_D	Secondary_D	Tertiary_D	Primary_I	Secondary_I
DEU	0.12	0.27	0.27	0.00	0.00
IDN	0.19	0.05	0.00	0.05	0.00
KOR	0.92	0.00	0.00	0.00	0.00
MEX	0.16	0.11	0.00	0.02	0.00
ZAF	0.09	0.00	0.02	0.05	0.00

Note: Input suffixes "_D" and "_I" stand, respectively, for "domestically sourced" and "imported".
Source: Author's calculations, based on TiVA data and 'Benchmarking' R package.

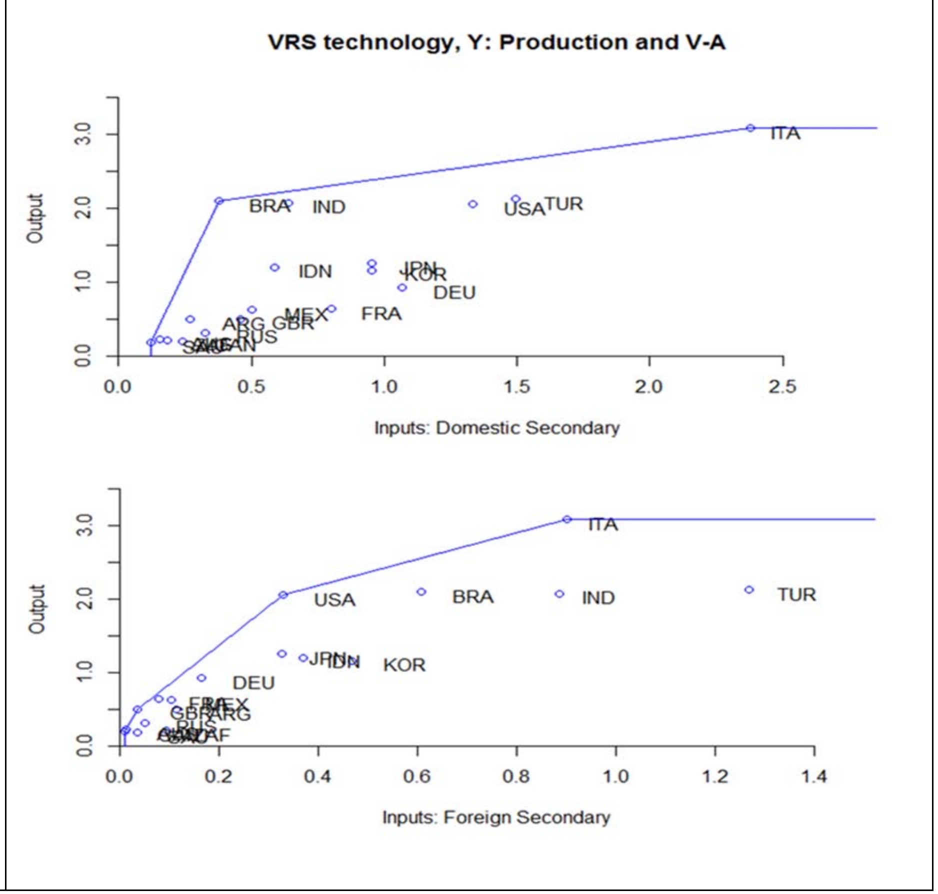
[34] Because efficient firms according to DEA may still be Koopmans inefficient, some inputs can still be reduced by efficient DMUs without affecting the need for other inputs (Bogetoft and Otto, 2011).

Figure 14 Textile and Clothing: Frontier efficiency for different domestic and imported inputs, G-20 less China (2011)

Frontier using domestic and imported inputs from primary sectors



Frontier using domestic and imported inputs from secondary sectors



Source: Author's calculations, based on TiVA data and 'Benchmarking' R package.

The results here are purely illustrative of the type of supply-side analysis which could be done on harmonized and interlinked input-output data. More comprehensive research would need to consider and overcome the limitation of DEA when applied to an international context. In particular, such an analysis would have to consider that the industries to be benchmarked are located in different countries, facing different external constraints that affect their efficiency.

Assessing the performance of industries in different countries would require separating sub-frontiers (or meta-frontiers), something which falls outside the objectives of the present essay. In traditional DEA, environment variables that are not controllable under the discretionary power of the industry (e.g., business environment) can be treated as fixed inputs and excluded from the optimization program. The deterministic approach of DEA can also be relaxed by incorporating a stochastic dimension and take into account, for example, random measurement errors. As an alternative to DEA, a Stochastic Frontier Analysis could specify formally the environment variables (e.g., macroeconomic stability, business environment, exchange rate under/over valuation) which affect industrial performance but which are not under the direct control of the industries as other variables of the production function are. Such a treatment requires a sample larger than the nineteen countries of the G-20 group and will not be treated here.

5 CONCLUSIONS

The stylised facts derived from the new OECD-WTO Trade in Value-Added (TiVA) database suggest new trade-and-growth accounting techniques derived from the GVC perspective. The paper explores, using the G-20 group as case study, new ways of looking at the demand and supply side growth models when Global Value Chains (GVCs) —articulating supply and demand chains from an international perspective—are taken into consideration.

On the demand side, TiVA is used to allocate total imports on the right side of the GDP identity to their respective use (final and intermediate demand). The demand for intermediate imported inputs used to produce domestic goods and services has been increasing rapidly over the 1995-2011 period. An interesting result of this demand decomposition is that, through its indirect content, additional public sector consumption filters out to other countries while is apparent low import intensity makes it particularly attractive for "selfish" counter-cyclical policies. It is therefore a good candidate for coordinated macro-policies, as policy making remains driven by domestic considerations, following the saying "economics is global but policy making is local". In the longer term, demand-driven trade-and-growth dynamics is expected to slow-down under the force of its own success while other factors like demand switching towards less-tradable services may work in lowering trade-income elasticity. Even if the Trade-GDP ratio stabilizes, it will do so at higher levels, increasing global interdependence and the need for policy coordination.

The supply side emphasised the difference in perception that the global value chain perspective brings when looking at GVC-specific export-led growth strategies (joining GVC then up-grading by incorporating more domestic value-added). Even if they may look very similar to industrialization strategies that A. Hirschman promoted in the late 1950s, it is not old wine in new bottles. The main difference in our view is the constant search for micro-efficiency that drives GVCs worldwide. This quest for efficiency applies also at the national level and is a condition for the long-term sustainability of GVC upgrading strategies. The paper uses the TiVA data to offer new perspectives for analysing the international competitiveness of domestic industries. Revealed Comparative Advantages are revisited through the Trade in Value-Added angle. Because internaitoanl competitiveness in trade in task relates to the cost of primary factors (value-added), we adjust industrial competitiveness and correct the nominal bias on profitability induced, for example, by tariff policies.

GVC up-grading strategies imply often increasing domestic inter-industrial linkages. This strategy is sustainable in the long term only if the new domestic suppliers can efficiently substitute foreign ones. If not, an inefficient upstream provider will increase the production costs of the rest of the domestic chain; inefficiency spillovers reduce the competitiveness of the entire domestic cluster. The paper shows how benchmarking techniques applied to international input-output data could help identifying industrial inefficiencies.

The results presented in this essay are only illustrative of the new dimensions of growth accounting that can be derived from the trade in value-added data. If the G-20 example offered a balanced group of developed and developing countries, the small size of the sample limits the robustness of our results. But this should not limit the researchers' ambition: the present version of TiVA includes already more than 60 economies and its coverage is expected to increase in the future.

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