Measuring Colombia's value added exports

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Preliminary and incomplete

Abstract

Global Value Chains (GVC) are becoming one of the main characteristics of the current stage of globalization. In this context, the role of Latin American countries in general, and Colombia in particular, has been secondary and there are relatively few studies that address this issue. Combining a national Input-Output table with international trade statistics, this article makes a characterization of Colombian exports according to the level of domestic value added they generate. Gross and net exports are then used as an indicator of the participation of Colombian exports into GVC. The results show that Colombia's participation in GVC is limited. Also, value added by exports can be interpreted from two perspectives: first, as the value added generated in a given sector as a result of total exports; and second, as the contribution of the exports of a given sector to the generation of value added in other sectors. Both perspectives contribute to assess the impacts of trade policies in the economy.

Keywords: Global Value Chains, Input-Output tables, Colombia.

JEL Codes: F10, F14, F62

1 Introduction

The current stage of globalization can be characterized by a second unbundling: if the first one was the globalization of consumption, the second one is the globalization of production (Baldwin, 2013). The fragmentation of production processes is increasingly a worldwide phenomenon. In this context, it is harder to determine the origin of manufactured goods and

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the “made in” label loses its explanatory power. This change implies that for understanding global production new tools and approaches have to be used. The amount of exports and imports of a given country, a gross measure of trade, are not the most adequate to reflect domestic productive efforts in presence of multiple country involvement in them. In this context, a recent literature has emerged, that of Global Value Chains (GVC).

This article has three main objectives: to contribute to the comprehension of the analysis of GVC, to characterize the role of Colombia in GVC by identifying economic sectors and their degree of integration to GVCs, and in a methodological ground, to present a relatively simple way to assess the effectiveness of some trade and industrial policies. To do that, we combine exports data with the productive structure as given by a domestic input-output table (IOT).

The analysis of GVCs has been conducted from two main perspectives. On one hand, there are some very illustrative case studies such as the analysis of the GVC of some well known mobile devices and phones (Dedrick et al., 2010). The authors identify the different components of those devices and they find that only 3% of the total value is generated in China, whereas the larger share go to the US and Japan which provide microprocessors, screens and other high-tech parts. Kraemer et al. (2011) refine the methodology to identify the value added in each step of the production process, this time taking the case of mobile phones and tablets. They arrive to similar conclusions relative to the importance of countries in the global value chain. Those results have become very rich evidence for the different role and relevance of countries in the world economy.

The second perspective of analysis looks to understand the phenomenon from a more aggregate stand. To do that, it combines IOT with trade information. The basic idea is that the IOT allows to determine economic sectors of origins and destination respectively for imports and exports, thus transforming trade statistics in a 5 dimensional variable: country of origin, sector of origin, destination country and sector, and time. (Johnson and Noguera (2012); Meng et al. (2012); Trefler and Zhu (2010); Stehrer (2012); Koopman et al. (2014)). This article is located into this second perspective. The majority of studies conducted up to now are based on international input output tables (IIOT), which connect sector production between countries. A good review to understand the design, scope and uselfuness of these matrices can be found in Timmer et al. (2012). Unfortunately, the role of Colombia has not been made explicit in any of such matrices, so alternative methods are called upon.

To overcome this lack of an IIOT, this paper relies on a domestic IOT, as it is mentioned by Meng et al. (2012). By addressing the problem with this approach, the domestic value added in exports is identified, but the foreign value added in it is not. This is the natural cost of not counting with the international links of production proportioned by IIOTs. The cost can be important for highly integrated to global value chains countries, but a minor one for the case of Latin American countries in general, and for Colombia in particular. Indeed, the empirical evidence for Colombia indicates this participation is limited as mentioned by Blyde (2014), and confirmed by Hernandez (2014) in a study of vertical specialization à la Hummels et al. (2001).

The final value of a good can be decomposed into the value added generated by its different stages of production. In this sense, we would expect that the unbundling of production implies that the relevance of single countries in the final value of a good has diminished. As Johnson and Noguera (2012) put it, the ratio of value added in exports to gross exports should decrease in the presence of GVC, meaning that each stage (i.e. country) involved in the production process has a lower weight into the final value of the good.

2 The method.

If we look at the demand side of production, we can express the value of production of a given sector i as the sum of intermediate inputs the sector sells to other sectors (z_{ij}) and the final demand (f_i) it faces,

$$x_i = \sum_j z_{ij} + f_i. \tag{1}$$

We can define the technical coefficient or direct requirement of input i in the production of good j as $a_{ij} = \frac{z_{ij}}{x_j}$ which allows us to rewrite equation (1) as

$$x_i = \sum_j a_{ij} x_j + f_i. \tag{2}$$

In matrix terms, the above equation writes $X = AX + F$, where A is a square matrix of dimension n which contains the a_{ij} coefficients, X is a $n \times 1$ vector of production and F is a $n \times 1$ vector of final demand. Solving for X, we get the familiar expression in input-output analysis:

$$X = (I - A)^{-1} F = LF. \tag{3}$$

The L matrix is called the "Leontief Inverse" and contains the indirect requirements coefficients. The typical element, l_{ij}, stands for the marginal effect in the production of good i as a result of an increase in the demand of good j. Now, define as well the ratio between value added (V_i) and gross production (X_i) in each sector as

$$v_i = \frac{V_i}{X_i}.$$

With that, and decomposing the final demand vector into domestic demand (F^d) and foreign demand (F^e) we can write equation (3) as:

$$v'X \equiv V = v'LF^d + v'LF^e, \tag{4}$$

where v' is a $1 \times n$ vector of value-added to gross production ratios, and V is a $n \times 1$ vector of sectors' value-added. Equation (4) decomposes total value-added generated in the economy in a domestic-generated part and a foreign-generated one. Of course, the vector F^e is the exports of the economy, composed by the sector level exports, f_j^e. For a given sector i, this equation writes:

$$V_i = v_i \sum_j l_{ij} f_j^d + v_i \sum_j l_{ij} f_j^e. \tag{5}$$

Note that an element of the second term of the sum above, $v_i l_{ij} f_j^e$, denotes the value added generated in domestic sector i as a result of sector j's exports. Then, the sum is the value added generated in sector i by the total exports of the economy, which we are going to call "value added in exports", and denote by VAiX(i),

$$\text{VAiX(i)} = v_i \sum_j l_{ij} f_j^e. \tag{6}$$

This indicator allows to identify those sectors which benefit more from the country's exports. In turn, it is possible to define a second indicator: the value added generated accross the economy as a result of the exports of the j-th sector, VAiX(j), as

$$\text{VAiX(j)} = f_j^e \sum_i v_i l_{ij}. \tag{7}$$

Of course, the information can be used to analyze the effects of any exports on any domestic economic sector –it is also possible to analyze the same, but in bilateral trade. Interesting results may arise, for example: "sector j's exports to country p generate x dollars of value added in domestic sector q", which can be really useful in evaluating the effects of trade policy in the context of Free Trade Agreements or similar. Moreover, taking into account that value added can be further decomposed into its principal components (remuneration to labor and capital, mixed income and subsidies and taxes) this can be used to evaluate effects on employment.

In addition, we can get rid of absolute values to get which exports produce more value added in the economy by simply writing $v_i l_{ij}$, which informs about the marginal value-added generated in sector i as a result of an increase in the exports of the j-th sector.

3 Data and results

We consider Colombian exports for 2013, taken from United Nations Trade Statistics (Comtrade). The original data is downloaded at 6 digits within the Harmonised System (HS). In order for this information to be in the same classification than Colombia's IOT, it is classified into the National Accounts Systems of Colombia using correspondence tables by Departamento Administrativo Nacional de Estadísticas (DANE).

We use the IOT constructed by DANE for the year 2010. Given that the economic structure only changes in the medium and long run, we think there are no big losses when we use an IOT for 2010 with trade data for 2013. The chosen IOT is composed by 61 sectors, of which we take the first 39 corresponding to goods, gas and electric energy. The remaining sectors are services, for which there is no trade data available. In sum, the analysis is representative of agriculture, mining, industry and public services.

The main result of the model is the value added generated by exports, which we call VAiX, given by equations (6) and (7). The results are shown in Table 1[1]. By rows, we have VAiX(i), i.e. the value added generated in row sector i as a result of the different sectors' exports. By columns, we get VAiX(j), i.e. the value added generated by sector j's exports in the rest of the economy. As an example, the value added generated in the agriculture sector as a result of total exports is 4030 USD million, whereas agriculture exports generated 2066 USD million of value added in the economy.

Table 1: VAiX matrix - in USD million

	Agriculture	Mining	Industry	Public Services	VAiX(i)
Agriculture	1946	11	2073	0	4030
Mining	9	30465	1742	2	32218
Industry	101	390	9428	1	9920
Public Services	10	75	342	78	505
VAiX(j)	2066	30941	13585	82	46673

Author's calculations.

By comparing VAiX(i) and VAiX(j) we can classify sectors according to how much they benefit from exports in terms of value added. In particular, the difference between these two measures indicates, when it is positive, that the sector is a net receiver of VA, whereas when it is negative, the sector is responsible of generating VA which is later absorbed in

[1]We show here a summarized presentation of results. The full matrix with results for the 39 sectors is available upon request.

other sectors. See Table 2.

Table 2: Net benefit - in USD million

Sector	VAiX(i) − VAiX(j)
Agriculture	1964
Mining	1277
Industry	-3665
Public Services	423

Author's calculations.

From the results, it is clear the role of the industrial sector as a generator of value added in the economy, something that is in line with the educated guess about multiplier analysis and the degree of connections of the industry to the other economic sectors.

It is sometimes worthy to distinguish between the different components of value added. Consider for example the case of the oil sector. In the past decade, Colombia, as well as the rest of oil producer countries, has benefitted from high prices of oil. Foreign direct investment in the sector exploded, and this was on the pillars of the outstanding performance of the economy. Exports of oil and the value added generated by them represented more than half of their corresponding total. A summary of results is shown in Table 3, where there can be seen the low level of the remuneration to labor in mining as compared to the industry sector: for mining to generate the same remunerations it has to create roughly three times the value added the industry generates.

Table 3: VAiX - in USD million

Sector	Labor	Taxes & subs.	Mixed income	Gross op. surplus	VAiX
Agriculture	1329	81	1527	1094	4030
Mining	2899	454	39	28826	32218
Industry	2608	266	563	6026	9920
Public services	153	17	32	303	505
Total	6989	818	2161	36248	46673

Author's calculations.

Table 4 shows value added, total exports (X) and the corresponding value added to exports (VAX) ratio. This is, first, a comparison between a net and a gross measure of exports; and second a measure of how global is the production chain. We expect manufactures to have lower VAX ratios compared to other sectors, since they participate more in global production than for example agriculture.

Table 4: VAiX, X and VAX ratio

	VAiX(i)	X	VAX ratio
Agriculture	4030	2665	1,5121
Mining	32218	34311	0,9390
Industry	9920	21734	0,4564
Public Services	505	103	4,8948

Author's calculations.

4 Conclusions

The role of Latin American countries in general and of Colombia in particular in GVCs is limited. In this paper we have proposed an easy-to-use methodology to assess on the importance of global value chains. Results indicate that the industrial sector activity benefits the rest of the economy in terms of value added generation. Exports by the mining sector are responsible for a large majority of value added generation, while this value added is mainly composed by gross operation surplus (i.e. remuneration to capital).

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5 Appendix

We present in Table 5 the decomposition of value added generated by total exports according to the sectors that benefit.

Table 5: VAiX - in USD million

Sector	Labor	Taxes & Subs.	Mixed Inc.	Gross Op. S.	VAiX
Oil and gas	2115	373	17	24925	27429
Mineral Coal	784	81	23	3901	4789
Oil products	199	63	24	2679	2965
Agriculture (ex coffee crops)	679	18	1096	193	1986
Coffee crops	504	53	135	852	1545
Chemical	523	48	48	793	1412
Metallurgic products	404	28	18	901	1350
Waste	101	8	7	195	311
Metallic minerals	168	12	10	375	564
Electric energy	140	16	29	285	471
Live animals	129	8	265	36	439
Textile, garment	149	11	63	37	261
Non-metallic minerals prod	78	8	25	134	245
Coffe products	80	8	21	135	244
Rubber and plastic	100	11	33	76	220
Non-metallic minerals	58	2	61	80	201
Machinery	99	9	5	84	196
Other machinery	88	8	7	79	183
Paper products	62	6	7	79	154
Other manufactures	38	3	52	48	140
Sugar	36	4	12	82	134
Textile, not garment	44	2	8	48	103
Animal and vegetable oils	36	3	2	54	96
Leather products	49	2	34	7	93
Cacao	71	6	9	3	90
Printing	38	3	13	35	89
Mill products	31	2	35	20	88
Textile fibres	43	4	8	16	70
Alimentary	23	1	4	19	48
Transport equipment	23	5	8	10	46
Meet and fish products	19	1	22	3	45
Silviculture	11	1	19	11	41
Furniture	19	1	15	5	40
Wood products	12	1	12	10	35
Home gas	13	1	2	18	35
Beverages	7	1	1	16	25
Fishery	6	0	12	2	20
Dairy products	7	1	1	3	12
Tobacco products	3	0	0	1	4
TOTAL	**6989**	**818**	**2161**	**36248**	**46673**

Author's calculations.