VERTICAL SPECIALIZATION ACROSS THE WORLD: EVIDENCE FROM THE WORLD INPUT-OUTPUT TABLE

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1. Introduction

The current world economy is characterized by a strong economic interdependence among countries which ties them together, so that the production of a finished good involves the participation of many countries specialised in different stages of production. Indeed, a country imports goods from other countries, uses them as inputs in the production of its own good, which is then exported to the countries specialised in the next stage of production. This sequence continues until the good reaches its final consumers.

In literature this phenomenon known as "vertical specialization", "slicing the value chain", "international production sharing" or "outsourcing" is widely used to describe this kind of production process and the resulting trade pattern.

The phenomenon of vertical specialization has been extensively studied in literature and there is an increasing empirical documentation of the rising role of vertical specialization of the country economies. See for example but not limited to: Bridgman (2012), Dean and Lovely (2010), Dixit and Grossman (1982), Feenstra (1998); Feenstra and Hanson (1997), Goh and Henry (2005), Leung (2016), López (2014), Jones and Kierzkowski (2001), Hogan et al. (2005), Sanyal (1983), Yücer et al. (2014), Vechiu and Makhlouf (2014).

There are three standard methods to measure vertical specialization. While the first one uses firm surveys, the second method uses a fine industrial classification of trade, as in Athukorala and Yamashita (2006). The third and most popular method (Hummels et al., 2001) considers national input-output table (NIOT).

The measure proposed by Hummels et al. (2001) and generally used in the empirical analysis is the amount of imported inputs in domestic production embodied in goods that are later exported to other countries, either as a final product

(i.e. depend on the final demand of other countries) in the multi-country framework, whereas they are considered exogenous when using a national framework. Consequently, the index proposed by Hummels et al. (2001) is no longer sufficient to measure the degree of vertical specialization under multi-country IOT.

This paper, by means of the multi-country IOT derived from the World IOT (WIOT) database, furnishes a detailed analysis of the fragmentation degree of the world's economies applying a new measure, in the spirit of the Hummels et al. (2001) approach, that will be introduced in the next section.

The WIOT (www.wiod.org) is a multi-country IOT and is built in current U.S. dollars with a classification for 35 industries (sectors). The database covers 40 countries plus the Rest of the World and we are able to analyse the phenomena of the vertical specialization in three macro regions, the European Union (i.e. 27 countries that were members in 2011), NAFTA (Canada, Mexico and United States) and East Asia (China, Japan, South Korea and Taiwan) for the period from 1995 to 2011. The main results of this analysis show that the production chain of the countries has become increasingly fragmented since 1995. However, the degree and rates of change of international fragmentation vary considerably across the countries and economic sectors. Moreover, we find evidence that the global financial crises caused a structural break in the time evolution of the considered phenomena.

2. Methodology

Considering the following simplified pattern, in block matrix notation, of a NIOT:

Figure 1 – *Pattern of a NIOT.*

Z	**f**	**e**	**x**
M			
v′			
x′			

where:

- **M** is a *n*x*n* matrix whose entries (m_{ij}) are the imported flows, for intermediate use, from the i-th foreign sector to the j-th domestic sector;
- **v′** is *1*x*n* vector whose entries are the added value of the i-th sector (′ is the transposition symbol);
- **x** is a *n*x*1* vector whose entries (x_j) are the total production (gross output) of the j-th domestic sector.

As proposed by Hummels et al. (2001) a measure of the vertical specialization of an economic sector of a country R is the value of directly imported intermediates embodied in goods that are exported. Formally:

$$DVS_{Rj}=a_{M.j}e_j\left(\mathbf{i}'\mathbf{e}\right)^{-1} \text{ and } \quad a_{M.j}=\sum_{i=1}^{k} a_{Mij} \tag{1}$$

where, **i** is a vector of 1's, $a_{Mij} = m_{ij}/x_j$ is the generic entry of the $\mathbf{A}_M$ matrix of the direct imported coefficients. Thus, a_{Mij} is the total amount of i-th product imported and used as input for the production of one monetary unit of industry j's output.

For the economic system of a country, vertical specialization is simply the sum of DVS_j across all j. In matrix notation:

$$DVS_R=\mathbf{i}'\mathbf{A}_M\mathbf{e}\left(\mathbf{i}'\mathbf{e}\right)^{-1} \tag{2}$$

The DVS index is a weighted average of the direct import coefficients using the sectorial exports as weights.

A more detailed index of a sector's vertical specialization is the following (3). Indeed, an intermediate good can be initially imported as input of one domestic sector and then used as an intermediate good in a second domestic sector and so on, until the imported product is finally embodied in a good that is exported:

$$VS_{Rj}=A'_{Mj}\mathbf{L}_j\frac{e_j}{\mathbf{i}'\mathbf{e}} \tag{3}$$

Where A'_{Mj} is the j-th column of the A_M matrix and $\mathbf{L}_j$ the j-th column of the Leontief inverse matrix $\mathbf{L}=(\mathbf{I}-\mathbf{A}_Z)^{-1}$. This last index includes both the directly and indirectly imported input content in exports of a sector. Indeed, equation (3) gives

The VS_R index, similarly to the DVS_R, is a weighted average of the import multipliers, with the sectorial exports as weights.

In general, a high value of the VS_R index indicates that imported intermediate goods make up a large proportion of the value of an economic sector (or country) exports and consequently indicate a country's greater degree of involvement in global production chains.

The application of the indices discussed earlier for measuring vertical specialization when a multi-country IOT is used is not completely suitable. In this regard let us consider the simplified pattern, in block matrix notation, of the WIOT depicted in Figure 2, where:

- $\mathbf{Z}_{R,R}$ (R=1,..,41) is a 35x35 matrix whose entries are the flows for intermediate use from the i-th sector of country R to the j-th sector of the same country;
- $\mathbf{Z}_{R,K}$ (R,K=1,..,41 and R≠K) is a 35x35 matrix whose entries are the exports for intermediate use from the i-th sector of country R to the j-th sector of country K;
- $\mathbf{C}_{R,R}$ (R=1,..,41) is a 35x5 matrix of the domestic final demand in country R;
- $\mathbf{E}_{R,K}$ (R,K=1,..,41 and R≠K) is a 35x5 matrix of the exports of country R for final demand purposes in country K;
- $\mathbf{x}_R$ (R=1,..,41) is a 35x1 vector whose entries are the sectorial output of country R;
- $\mathbf{v}_R$ (R=1,..,41) is a 35x1 vectors whose entries are the sectorial added-value of country R.

Figure 2 – *Pattern of a WIOT*

$\mathbf{Z}_{1,1}$	$\mathbf{Z}_{1,2}$	…	$\mathbf{Z}_{1,40}$	$\mathbf{Z}_{1,41}$	$\mathbf{C}_{1,1}$	$\mathbf{E}_{1,2}$	…	$\mathbf{E}_{1,41}$	$\mathbf{x}_1$
$\mathbf{Z}_{2,1}$	$\mathbf{Z}_{2,2}$	…	$\mathbf{Z}_{2,40}$	$\mathbf{Z}_{2,41}$	$\mathbf{E}_{2,1}$	$\mathbf{C}_{2,2}$	…	$\mathbf{E}_{2,41}$	$\mathbf{x}_2$
…	…	…	…	…	…	…	…	…	…
$\mathbf{Z}_{40,1}$	$\mathbf{Z}_{40,2}$	…	$\mathbf{Z}_{40,40}$	$\mathbf{Z}_{40,41}$	$\mathbf{E}_{40,1}$	…	$\mathbf{C}_{40,40}$	$\mathbf{E}_{40,41}$	$\mathbf{x}_{40}$
$\mathbf{Z}_{41,1}$	$\mathbf{Z}_{41,2}$	…	$\mathbf{Z}_{41,40}$	$\mathbf{Z}_{41,41}$	$\mathbf{E}_{41,1}$	…	$\mathbf{E}_{41,40}$	$\mathbf{C}_{41,41}$	$\mathbf{x}_{41}$
$\mathbf{v}_1'$	$\mathbf{v}_2'$	…	$\mathbf{v}_{40}'$	$\mathbf{v}_{41}'$					
$\mathbf{x}_1'$	$\mathbf{x}_2'$	…	$\mathbf{x}_{40}'$	$\mathbf{x}_{41}'$					

Legend: 41 is the Rest of World

the output of other countries ($\sum_{K=1}^{41} \mathbf{Z}_{R,K} = \sum_{K=1}^{41} \mathbf{A}_{R,K}\mathbf{x}_K$ and R≠K) and are thus endogenous to the economic system.

Consequently, in a multi-country input-output context theVS_R(VS_{Rj}) indices do not adequately measure the degree of specialization of a country because they consider all exports exogenous. The following fundamental relation is the starting point to solve this problem:

$$\begin{bmatrix} \mathbf{x}_1 \\ \vdots \\ \mathbf{x}_{41} \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{1,1} & \cdots & \mathbf{A}_{1,41} \\ \vdots & \ddots & \vdots \\ \mathbf{A}_{41,1} & \cdots & \mathbf{A}_{41,41} \end{bmatrix} \begin{bmatrix} \mathbf{x}_1 \\ \vdots \\ \mathbf{x}_{41} \end{bmatrix} + \begin{bmatrix} \mathbf{c}_1+\mathbf{e}_{1\bullet} \\ \vdots \\ \mathbf{c}_{41}+\mathbf{e}_{41\bullet} \end{bmatrix} \tag{5}$$

Where: $\mathbf{A}_{R,K} = \left[{}^{Z_{i,j,R,K}}/_{x_{j,K}} \right]$; $\mathbf{c}_R = \mathbf{C}_{R,R} \cdot \mathbf{i}$ (R=1,…,41); $\mathbf{e}_{R\bullet} = (\sum_{K=1}^{41} \mathbf{E}_{R,K}) \cdot \mathbf{i}$ (R=1,..,41).

Alternatively:

$$\begin{bmatrix} \mathbf{x}_1 \\ \vdots \\ \mathbf{x}_{41} \end{bmatrix} = \begin{bmatrix} \mathbf{I}-\mathbf{A}_{1,1} & \cdots & -\mathbf{A}_{1,41} \\ \vdots & \ddots & \vdots \\ -\mathbf{A}_{41,1} & \cdots & \mathbf{I}-\mathbf{A}_{41,41} \end{bmatrix}^{-1} \begin{bmatrix} \mathbf{c}_1+\mathbf{e}_{1\bullet} \\ \vdots \\ \mathbf{c}_{41}+\mathbf{e}_{41\bullet} \end{bmatrix} = \begin{bmatrix} \mathbf{L}_{1,1} & \cdots & \mathbf{L}_{1,41} \\ \vdots & \ddots & \vdots \\ \mathbf{L}_{41,1} & \cdots & \mathbf{L}_{41,41} \end{bmatrix} \begin{bmatrix} \mathbf{c}_1+\mathbf{e}_{1\bullet} \\ \vdots \\ \mathbf{c}_{41}+\mathbf{e}_{41\bullet} \end{bmatrix} \tag{6}$$

To determine the import content of exports of a generic country R, let us first consider the matrix of the total imports ($\mathbf{M}_{\bullet R}$):

$$\mathbf{M}_{\bullet R} = \sum_{K=1}^{41} \mathbf{Z}_{K,R} = \left(\sum_{K=1}^{41} \mathbf{A}_{K,R}\right)\mathbf{D}(\mathbf{x}_R) = \mathbf{A}_{\bullet R}\mathbf{D}(\mathbf{x}_R) \quad \text{for } R \neq K \tag{7}$$

Where $\mathbf{D}(\mathbf{x}_R)$ is the diagonal matrix whose entries, $d_{jj}(\mathbf{x}_R)=x_{jR}$, correspond to the total production of economic sectors in country R. Post-multiplying equation (7) by $\mathbf{i}$, the vector of the total sectorial imports ($\mathbf{m}_R$) is obtained:

$$\mathbf{M}_{\bullet R}\mathbf{i} = \mathbf{m}_R = \mathbf{A}_{\bullet R}\mathbf{D}(\mathbf{x}_R)\mathbf{i} = \mathbf{A}_{\bullet R}\mathbf{x}_R \tag{8}$$

Since (see Figure 2):

$$\mathbf{m}_R=\mathbf{A}_{\bullet R}\left(\mathbf{c}_R+\mathbf{e}_{R\bullet}+\mathbf{Z}_{R,R}\mathbf{i}+\sum_{\substack{K=1\\K\neq R}}^{41}\mathbf{A}_{R,K}\,\mathbf{x}_K\mathbf{i}\right) \tag{10}$$

By means of equation (6) the vector of the sectorial production $(\mathbf{x}_K)$ of country K can be rewritten in terms of production generated by the final demands of the other countries:

$$\mathbf{x}_K=\sum_{j=1}^{41}\mathbf{L}_{K,j}\left(\mathbf{c}_j+\mathbf{e}_{j\bullet}\right) \tag{11}$$

Finally, substituting the equation (11) into (10), we have:

$$\mathbf{m}_R=\mathbf{A}_{\bullet R}\left[\mathbf{c}_R+\mathbf{e}_{R\bullet}+\mathbf{Z}_{R,R}\mathbf{i}+\sum_{K=1}^{41}\mathbf{A}_{R,K}\left(\sum_{j=1}^{41}\mathbf{L}_{K,j}\left(\mathbf{c}_j+\mathbf{e}_{j\bullet}\right)\mathbf{i}\right)\right] \quad \text{for } R\neq K \tag{12}$$

At this point, consider the following quantities:

– The *exogenous exports* of country R (i.e. final exports): the j-th entry of this vector gives the exogenous exports of the j-th economic sector: $\mathbf{exp}_1=\mathbf{e}_{R\bullet}$;

– The *imports content of the exogenous export* of country R: from equation (11), the vector $\mathbf{L}_{R,R}\mathbf{e}_{R\bullet}$ gives the domestic output necessary for the exogenous exports. Consequently, the generic entry of following vector gives the imports of sector j embodied directly and indirectly in the exogenous exports of the same sector: $\mathbf{imp}_1=\mathbf{A}_{\bullet R}\mathbf{L}_{R,R}\mathbf{e}_{R\bullet}$;

– The *endogenous exports* of country R (i.e. exports that are used as inputs in the production process of the other countries): the j-th entry of the following vector gives the endogenous exports of the j-th economic sector: $\mathbf{exp}_2=\sum_{K=1}^{41}\mathbf{Z}_{R,K}\,\mathbf{i}=\sum_{K=1}^{41}\mathbf{A}_{R,K}\,\mathbf{x}_K=\sum_{K=1}^{41}\mathbf{A}_{R,K}\left(\sum_{j=1}^{41}\mathbf{L}_{K,j}\left(\mathbf{c}_j+\mathbf{e}_{j\bullet}\right)\right)$ for $R\neq K$.;

– The *imports content of endogenous exports* of country R: this quantity is given by the vector $\mathbf{imp}_2=\mathbf{A}_{\bullet R}\sum_{K=1}^{41}\mathbf{A}_{R,K}\left(\sum_{j=1}^{41}\mathbf{L}_{K,j}\left(\mathbf{c}_j+\mathbf{e}_{j\bullet}\right)\right)$ for $R\neq K$ whose entries give the imports of sector j embodied directly and indirectly in the endogenous exports of the same sector.

Consequently, the following index is adopted to measure the degree of vertical specialization of the j-th economic sector:

$$VS1_R=\frac{\mathbf{i}'(\mathbf{imp}_1+\mathbf{imp}_2')}{\mathbf{i}'(\mathbf{exp}_1+\mathbf{exp}_2)}=\frac{\mathbf{i}'\left(\mathbf{A}_{\bullet R}\mathbf{L}_{R,R}\mathbf{e}_{R\bullet}+\mathbf{A}_{\bullet R}\sum_{K=1}^{41}\mathbf{A}_{R,K}\left(\sum_{j=1}^{41}\mathbf{L}_{K,j}(\mathbf{c}_j+\mathbf{e}_{j\bullet})\right)\right)}{\mathbf{i}'\left(\mathbf{e}_{R\bullet}+\sum_{K=1}^{41}\mathbf{A}_{R,K}\left(\sum_{j=1}^{41}\mathbf{L}_{K,j}(\mathbf{c}_j+\mathbf{e}_{j\bullet})\right)\right)} \text{ for } R\neq K \quad (14)$$

If only NIOT is available, the endogenous exports, $\sum_{K=1}^{41}\mathbf{Z}_{R,K}$ (for R≠K), belong to the final exportations of the country R and are considered exogenous. Thus, equations (11) and (12) become respectively:

$$\mathbf{x}_R=\mathbf{L}_{R,R}\left(\mathbf{c}_R+\mathbf{e}_{R\bullet}+\sum_{K=1}^{41}\mathbf{Z}_{R,K}\right) \text{ for } R\neq K \quad (15)$$

and:

$$\mathbf{m}_R=\mathbf{A}_{\bullet R}\left[\mathbf{L}_{R,R}\left(\mathbf{c}_R+\mathbf{e}_{R\bullet}+\sum_{K=1}^{41}\mathbf{Z}_{R,K}\right)\right] \text{ for } R\neq K \quad (16)$$

Consequently, the $VS1_R$ index becomes:

$$\overline{\overline{VS1}}_R=\frac{\mathbf{i}'\left(\mathbf{A}_{\bullet R}\mathbf{L}_{R,R}\left(\mathbf{e}_{R\bullet}+\sum_{K=1}^{41}\mathbf{Z}_{R,K}\right)\right)}{\mathbf{i}'\left(\mathbf{e}_{R\bullet}+\sum_{K=1}^{41}\mathbf{Z}_{R,K}\right)} \quad (17)$$

that is the original index proposed by Hummels et al. (2001).

3. Results and discussion

In this section, the vertical specialization of the world economy between 1995 and 2011 is examined by means of the $VS1_R$ index.

Table 1 depicts the values of the $VS1_R$ index by countries and for same years. The detailed values are available from the authors upon request.

Analysis of this index over time highlights that vertical specialization increases in all countries with two exceptions: (i) Bulgaria, Cyprus and Indonesia, where the values remain almost constant over time, and (ii) Canada, Estonia, Malta, Portugal and Russia, where the vertical specialization decreases.

value in the 2009 is identical to the one of 2008, the rest of the countries show an average decrease amounting to 5.5%. Bulgaria (-29%), India (-6%) and Taiwan (-6%) realized the highest decrease in the sample.

Table 1 – *$VS1_R$ index by countries and same years.*

	1995	2000	2005	2010	2011		1995	2000	2005	2010	2011
AUS	0.08	0.09	0.10	0.09	0.10	IRL	0.35	0.41	0.37	0.37	0.38
AUT	0.20	0.24	0.27	0.27	0.29	ITA	0.15	0.17	0.18	0.21	0.22
BEL	0.34	0.36	0.36	0.38	0.41	JPN	0.04	0.06	0.08	0.10	0.11
BGR	0.25	0.29	0.25	0.25	0.25	KOR	0.17	0.22	0.23	0.25	0.27
BRA	0.05	0.09	0.08	0.07	0.09	LTU	0.26	0.29	0.32	0.30	0.30
CAN	0.22	0.24	0.20	0.16	0.16	LUX	0.39	0.47	0.47	0.50	0.50
CHN	0.12	0.13	0.20	0.15	0.15	LVA	0.20	0.20	0.24	0.20	0.19
CYP	0.24	0.28	0.20	0.23	0.23	MEX	0.23	0.28	0.27	0.28	0.28
CZE	0.22	0.30	0.35	0.38	0.39	MLT	0.40	0.44	0.35	0.33	0.33
DEU	0.15	0.20	0.22	0.23	0.24	NLD	0.28	0.31	0.30	0.34	0.35
DNK	0.24	0.27	0.29	0.32	0.33	POL	0.13	0.21	0.25	0.27	0.28
ESP	0.17	0.23	0.21	0.22	0.24	PRT	0.24	0.25	0.26	0.22	0.22
EST	0.29	0.35	0.31	0.26	0.26	ROM	0.16	0.21	0.23	0.19	0.19
FIN	0.18	0.21	0.24	0.25	0.26	RUS	0.05	0.07	0.05	0.03	0.04
FRA	0.16	0.21	0.21	0.22	0.24	SVK	0.23	0.35	0.40	0.36	0.36
GBR	0.16	0.16	0.15	0.18	0.19	SVN	0.28	0.31	0.35	0.31	0.31
GRC	0.15	0.26	0.22	0.21	0.22	SWE	0.21	0.25	0.25	0.26	0.26
HUN	0.22	0.42	0.39	0.40	0.40	TUR	0.12	0.16	0.22	0.16	0.18
IDN	0.12	0.16	0.15	0.11	0.12	TWN	0.27	0.30	0.35	0.36	0.37
IND	0.08	0.11	0.16	0.18	0.19	USA	0.08	0.09	0.10	0.11	0.12

The mean value of the $VS1_R$ index varies across countries from 0.05$ (Russia) to 0.47$ (Luxemburg). Accordingly, countries were classified into four groups based on the mean level of the index:

1) Countries with low value (i.e. $VS1_R$<0.10$): Australia, Brazil, Japan, Russia, and USA;
2) Countries with mean-low vertical specialization (i.e. 0.10$<$VS1_R$\leq$0.20$): China, Germany, France, Great Britain, India, Indonesia, Italy, and Turkey;
3) Countries with mean-high (i.e. 0.20$<$VS1_R$\leq$0.30$): Austria, Bulgaria, Canada, Cyprus, Denmark, Estonia, Finland, Greece, Korea, Lithuania,

presented a value not exceeding 0.20$. The lowest value is recorded for Japan (0.05$) and the highest value for Malta (0.40$), as illustrated in Table A5.

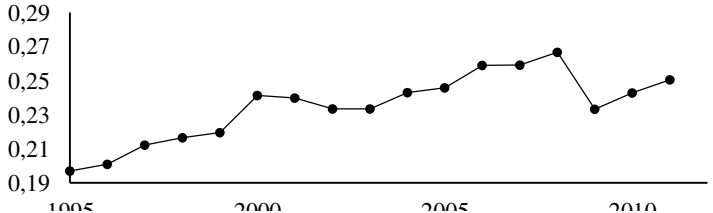
The mean value increased to 0.25$ in 2011, when Luxemburg was the country with the highest value (0.50$), while Russia had the lowest value (0.04$). The mean value of the index increased by 0.05$ during 1995-2011 (Figure 3).

The first quartile grows from 0.15$ to 0.19$. The median changes from 0.20$ to 0.25$ and the third quartile from 0.24$ to 0.32$. This confirms that the degree of specialization of the world economy has grown markedly during 1995-2011.

Table 2 – *Descriptive statistics of the $VS1_R$ index by year.*

Year	Mean	Std. Dev.	1° Quart.	Median	3° Quart.	Min	Max
1995	0.20	0.09	0.15	0.20	0.24	0.04	0.40
1996	0.20	0.09	0.14	0.21	0.26	0.04	0.40
1997	0.21	0.09	0.15	0.22	0.28	0.05	0.44
1998	0.22	0.09	0.17	0.23	0.28	0.06	0.45
1999	0.22	0.09	0.15	0.22	0.28	0.05	0.45
2000	0.24	0.10	0.17	0.24	0.30	0.06	0.47
2001	0.24	0.10	0.18	0.24	0.30	0.06	0.47
2002	0.23	0.10	0.18	0.24	0.28	0.06	0.48
2003	0.23	0.09	0.18	0.24	0.30	0.06	0.46
2004	0.24	0.10	0.20	0.24	0.30	0.05	0.48
2005	0.25	0.09	0.20	0.24	0.31	0.05	0.47
2006	0.26	0.10	0.21	0.26	0.33	0.05	0.48
2007	0.26	0.10	0.20	0.26	0.34	0.04	0.48
2008	0.27	0.10	0.21	0.27	0.35	0.04	0.50
2009	0.23	0.10	0.18	0.23	0.30	0.03	0.50
2010	0.24	0.10	0.18	0.24	0.31	0.03	0.50
2011	0.25	0.10	0.19	0.25	0.32	0.04	0.50

Figura 3 – *Time series of the mean value of $VS1_R$ index between 1995 and 2011.*



more dependent on imported inputs for their production than larger countries, which are more self-supporting.

4. Conclusions

With the global economic systems becoming more integrated, production processes, previously carried out in one site, are now split up into stages (or fragments), each to be performed in a different location and often beyond national boundaries.

These changes have been extensively studied under different names, such as "disintegration of production", "vertical specialization", "fragmentation", "outsourcing", "offshoring", among others. Thus, one important feature of the new international and globalized economy is the significant increase of intermediate goods trade, crossing several borders along the supply chains.

At the same time, fragmentation of production processes plays a role in societal well-being, improving living conditions and wealth of resident population.

Using the measure proposed by Hummels *et al*. (2001) and modified to be used in a multi-country IOT, this study has analysed the degree and evolution of vertical specialization of the world economy in the period 1995-2011.

Our main data source has been the World Input Output Table, which covers 40 countries with a classification for 35 economic sectors.

Empirical results confirm the growth of foreign intermediate goods content of exports in all economies. The positive trend declined slightly at the beginning of the financial crisis.

The degree of specialization is greatly diversified across countries. In this regard, four distinct groups of countries were identified.

Moreover, the analysis identified a negative correlation between the vertical specialization index and the size of country's economies: small countries have the highest degree of specialization and are concentrated in Europe.

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SUMMARY

Vertical specialization across the world: evidence from the world input-output table

Fragmentation of vertically integrated production processes (known also as vertical specialization) implies that production blocks are located in different countries and geographical areas across the world countries. This study extends the quantitative measure of vertical specialization, originally proposed by Hummels et al. (2001), into a multi-country framework. Based on this approach, vertical specialization in the world economy was studied between 1995 and 2011. Empirical evidence supports a significant increase in the vertical specialization of the world economy during the study period.