Value added and participation in Global Value Chains: the case of Spain

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Introduction (I)

- Changes in the nature of production and international trade:
  - Growing **international fragmentation of production** and emergence of **global value chains (GVCs)**:
    - The production of a single good takes place across several countries.
    - Inputs cross borders many times.
  - Key problem with standard trade statistics: international trade data record the gross value of goods as they cross borders.
    - Substantial **double-counting**: gross exports overstate the amount of domestic value-added in exports.
    - **Statistical bias**: standard trade measures attribute the total value to the last country in the chain.
    - Sectors of **origin of value-added**.
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Need for new statistics to complement traditional trade data: **global input-output tables.**

- Initiatives: WIOD, TiVA (WTO-OECD), GTAP, IDE-JETRO, EORA.

- Global IOT describe input shipments across sectors and countries and enable to trace the VA in final goods back to its source.

Why do we have to care about value-added (VA)? It’s VA what generates benefits to the producing economy!

- A certain amount of exports does not generate an equivalent amount of benefits to the producing economy.

- Difficult to **identify the real contribution** a given export may make to an economy.
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In this paper:

- We analyze the production and trade patterns of the Spanish economy from the perspective of:
  - trade in value-added and vertical specialization over the period 1995-2011.

This paper addresses:

1. Participation of the Spanish economy and its sectors in GVCs.
2. Contribution of sectors to VA.
3. Sectoral interdependencies: services as an input for manufacturing production and exports.

Questions:

- ¿What’s the degree of integration of Spain and its sectors into GVCs?
- ¿What’s the value added content of Spanish exports?
Introduction (III)

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Outline

- Introduction.
- Related literature.
- Methodology.
  - Input-output framework.
  - Concepts:
    - Value-added exports.
    - Vertical specialization.
- Results.
- Summary and conclusions.
Related literature

- **Vertical specialization**
  - Hummels, Ishi & Yi (2001):
    - Definition of VS (import content of exports) and VS1 (exports that are used as inputs in a second country’s production of exports).
    - Mathematical definition for the VS index.
  - Daudin, Rifflart & Schweisguth (2011):
    - Mathematical definition for the indices VS1 and VS1*

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Methodology

- We estimate the sectoral interdependencies in international trade using a **multi-regional IO model (MRIO)**.

- Decomposition of gross exports following KWW (2014), a conceptual framework that integrates the literature of vertical specialization and value-added trade:
  - Value-added exports.
  - Measures of vertical specialization ($VS$, $VS_1$ and $VS_1^*$).

- Database: World Input-Output Database (WIOD).
  - Time series of world input-output tables from 1995 to 2011.
  - 35 sectors x 40 countries + “rest of the world (RoW)” = 1435x1435
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## Methodology

<table>
<thead>
<tr>
<th></th>
<th>Country A</th>
<th>Country B</th>
<th>Rest of World (RoW)</th>
<th>Country A</th>
<th>Country B</th>
<th>Rest of World (RoW)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry</strong></td>
<td>Intermediate use of domestic output</td>
<td>Intermediate use of domestic output</td>
<td>Intermediate use of domestic output</td>
<td>Final use of domestic output</td>
<td>Final use of domestic output</td>
<td>Final use of domestic output</td>
</tr>
<tr>
<td><strong>Intermediate use of exports from B</strong></td>
<td>Intermediate use by B of exports from A</td>
<td>Intermediate use by RoW of exports from B</td>
<td>Final use by A of exports from B</td>
<td>Final use by RoW of exports from B</td>
<td>Final use by RoW of exports from B</td>
<td>Final use by exports from B</td>
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<tr>
<td><strong>Intermediate use of exports from RoW</strong></td>
<td>Intermediate use by B of exports from RoW</td>
<td>Intermediate use of domestic output</td>
<td>Final use by A of exports from RoW</td>
<td>Final use by RoW of exports from RoW</td>
<td>Final use of domestic output</td>
<td>Output in RoW</td>
</tr>
</tbody>
</table>

**Value added**
- Output in A
- Output in B
- Output in RoW

**Total**
- Output in A
- Output in B
- Output in RoW
Methodology: The input-output framework

- $S$ sectors, $N$ countries.
- Each country-sector produces a single differentiated good: $SN$ products.
- Production ($x$) is either used to satisfy final demand ($y$) or used as an intermediate input ($z$) in production (at home or abroad).
- Market clearing condition:

$$x_i(s) = \sum_j y_{ij}(s) + \sum_j \sum_t z_{ij}(s, t)$$  \hspace{1cm} (1)

- We define the technical coefficients matrix $A$ as a $SN \times SN$ matrix with elements $a_{ij}(s, t) = z_{ij}(s, t)/x_j(t)$.
- We write condition (1) as $x = Ax + y$. Using this expression:

**Fundamental condition**

$$x = (I - A)^{-1}y$$  \hspace{1cm} (2)
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**Fundamental condition**

\[ x = (I - A)^{-1}y \]
Methodology. The input-output framework

- The expression (2) in matrix notation:

\[
\begin{bmatrix}
X_1 \\
X_2 \\
\vdots \\
X_N
\end{bmatrix} = 
\begin{bmatrix}
I - A_{11} & -A_{12} & \cdots & -A_{1N} \\
-A_{21} & I - A_{22} & \cdots & -A_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
-A_{N1} & -A_{12} & \cdots & I - A_{NN}
\end{bmatrix}^{-1} 
\begin{bmatrix}
\sum_i^N Y_{1j} \\
\sum_i^N Y_{2j} \\
\vdots \\
\sum_i^N Y_{Nj}
\end{bmatrix}
\]

\[
= 
\begin{bmatrix}
B_{11} & B_{12} & \cdots & B_{1N} \\
B_{21} & B_{22} & \cdots & B_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
B_{N1} & B_{N2} & \cdots & B_{NN}
\end{bmatrix}^{-1} 
\begin{bmatrix}
Y_1 \\
Y_2 \\
\vdots \\
Y_N
\end{bmatrix}
\]
Methodology. The input-output framework

Multi-regional input-output model

\[
\begin{bmatrix}
X_{11} & X_{12} & \cdots & X_{1N} \\
X_{21} & X_{22} & \cdots & X_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
X_{N1} & X_{N2} & \cdots & X_{NN}
\end{bmatrix}
= 
\begin{bmatrix}
B_{11} & B_{12} & \cdots & B_{1N} \\
B_{21} & B_{22} & \cdots & B_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
B_{N1} & B_{N2} & \cdots & B_{NN}
\end{bmatrix}
\times 
\begin{bmatrix}
Y_{11} & Y_{12} & \cdots & Y_{1N} \\
Y_{21} & Y_{22} & \cdots & Y_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
Y_{N1} & Y_{N2} & \cdots & Y_{NN}
\end{bmatrix}
\]

- With \( N \) countries and \( S \) sectors, \( B \) is a \( SNxSN \) matrix; \( X \) and \( Y \) are \( SNxN \) matrices.

- \( B \) is the total requirement matrix (amount of gross output in producing country \( i \) needed to satisfy final demand in destination country \( j \)).

- \( X \) is the gross output decomposition matrix that gives gross output produced in \( i \) and absorbed in \( j \).

- \( Y \) is the final demand matrix that gives the goods produced in \( i \) that are consumed in \( j \).
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**Methodology. Estimating value-added trade**

### Value-added production matrix $\hat{V}_{BY}$

$$
\begin{bmatrix}
\hat{V}_1 & 0 & \cdots & 0 \\
0 & \hat{V}_2 & \cdots & 0 \\
\vdots & \vdots & \ddots & \vdots \\
0 & 0 & \cdots & \hat{V}_N \\
\end{bmatrix}
\begin{bmatrix}
X_{11} & X_{12} & \cdots & X_{1N} \\
X_{21} & X_{22} & \cdots & X_{2N} \\
\vdots & \vdots & \ddots & \vdots \\
X_{N1} & X_{N2} & \cdots & X_{NN} \\
\end{bmatrix}
= \\
\begin{bmatrix}
\hat{V}_1 \sum_{j}^{N} B_{1j} Y_{j1} & \hat{V}_1 \sum_{j}^{N} B_{1j} Y_{j2} & \cdots & \hat{V}_1 \sum_{j}^{N} B_{1j} Y_{jN} \\
\hat{V}_2 \sum_{j}^{N} B_{2j} Y_{j1} & \hat{V}_2 \sum_{j}^{N} B_{2j} Y_{j2} & \cdots & \hat{V}_2 \sum_{j}^{N} B_{2j} Y_{jN} \\
\vdots & \vdots & \ddots & \vdots \\
\hat{V}_N \sum_{j}^{N} B_{Nj} Y_{j1} & \hat{V}_N \sum_{j}^{N} B_{Nj} Y_{j2} & \cdots & \hat{V}_N \sum_{j}^{N} B_{Nj} Y_{jN} \\
\end{bmatrix}
$$

(4)

- **Elements in the diagonal** $\rightarrow$ value added absorbed at home.

- **Elements off the diagonal** $\rightarrow$ value added absorbed abroad., i.e., value-added exports.
Methodology. Estimating value-added trade

**Value-added production matrix $\hat{V}BY$**

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Methodology. Concepts

- Following Johnson & Noguera (2012a):

**Value added exports (VA Exports)**

\[
\text{VAExports}_i = \sum_{j \neq i}^N VX_{ij} = V_i \sum_{j \neq i}^N \sum_{n=1}^N B_{in} Y_{nj}
\]

\[
= V_i \sum_{j \neq i}^N B_{ii} Y_{ij} + V_i \sum_{j \neq i}^N B_{ij} Y_{jj} + V_i \sum_{j \neq i}^N \sum_{t \neq i,j}^N B_{ij} Y_{jt}
\]

1. VA embodied in exports of final goods.
2. VA embodied in exports of intermediate goods.
3. *Indirect* VA exports.
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Methodology. Concepts
Integration in GVC: measures of vertical specialization.

- **VS**: import content of exports (= foreign content)

Backward participation

\[
VS = \sum_{i \neq j} V_j B_j E_{i*} = \sum_{t \neq i} \sum_{j \neq i} V_t B_{ti} Y_{ij} + \sum_{t \neq i} \sum_{j \neq i} V_t B_{ti} A_{ij} (I - A_{jj})^{-1} Y_{jj} + \\
+ \sum_{j \neq i} V_t B_{ti} (I - A_{jj})^{-1} E_{j*}
\]

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2. Foreign VA embodied in exports of intermediate goods.
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Integration in GVC: measures of vertical specialization.

- **VS**: import content of exports (= foreign content)

**Backward participation**

\[
VS = \sum_{i \neq j} N \sum_{t \neq i, j \neq i} V_j B_{ji} E_{i*} = \sum_{t \neq i, j \neq i} N \sum_{t \neq i} V_t B_{ti} Y_{ij} + \sum_{t \neq i, j \neq i} N \sum_{t \neq i} V_t B_{ti} A_{ij} (I - A_{jj})^{-1} Y_{jj} + \\
+ \sum_{j \neq i} N \sum_{j \neq i} V_t B_{ti} (I - A_{jj})^{-1} E_{j*}
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Methodology. Concepts

Integration in GVC: measures of vertical specialization.

- **VS1**: Exports of intermediate goods that are used as inputs by other countries to produce their exports (i.e., domestic value added in partners’ exports).

### Forward participation

\[
VS1 = V_i \sum_{i \neq j}^{N} B_{ji} E_{i}^* = V_i \sum_{j \neq i}^{N} \sum_{t \neq i,j}^{N} B_{ij} Y_{jt} + V_i \sum_{j \neq i}^{N} \sum_{t \neq i,j}^{N} B_{ij} A_{jt} X_t + V_i \sum_{j \neq i}^{N} \sum_{t \neq i,j}^{N} B_{ij} Y_{ji} + V_i \sum_{j \neq i}^{N} B_{ij} A_{ji} X_i
\]

1. *Indirect* VA exports.
2. Exports of intermediate inputs that will be used abroad to produce exports of intermediate goods.
3. and (4): Domestic VA that returns via final (3) or intermediate (4) imports.
Methodology. Concepts

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\[
\text{Forward participation}
\]

\[
\text{VS1} = V_i \sum_{i \neq j}^N B_{ji} E_{i*} = V_i \sum_{j \neq i}^N \sum_{t \neq i, j} B_{ij} Y_{jt} + V_i \sum_{j \neq i}^N \sum_{t \neq i, j} B_{ij} A_{jt} X_t + \\
V_i \sum_{j \neq i}^N \sum_{t \neq i, j} B_{ij} Y_{ji} + V_i \sum_{j \neq i}^N B_{ij} A_{ji} X_i
\]

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(3) and (4): Domestic VA that returns via final (3) or intermediate (4) imports.
Methodology

Descomposition of gross exports (KWW, 2014)

\[ uE_i = \begin{cases} 
V_i \sum_{j \neq i}^{N} B_{ii} Y_{ij} + V_i \sum_{j \neq i}^{N} B_{ij} Y_{jj} + V_i \sum_{j \neq i}^{N} \sum_{t \neq i,j}^{N} B_{ij} Y_{jt} \\
+ V_i \sum_{j \neq i}^{N} B_{ij} Y_{ji} + V_i \sum_{j \neq i}^{N} B_{ij} A_{ji} (I - A_{ii})^{-1} Y_{ii} + V_i \sum_{j \neq i}^{N} B_{ij} A_{jt} (I - A_{ii})^{-1} E_i \\
+ \sum_{t \neq i}^{N} \sum_{j \neq i}^{N} V_{t} B_{ti} Y_{ij} + \sum_{t \neq i}^{N} \sum_{j \neq i}^{N} V_{t} B_{ti} A_{ij} (I - A_{jj})^{-1} Y_{jj} + \sum_{j \neq i}^{N} V_{t} B_{ti} (I - A_{jj})^{-1} E_j 
\end{cases} \]
Methodology

- Gross exports (E)
  - Value-added exports (VT)
    - (1) DV in direct final goods exports
    - (2) DV in intermediates exports absorbed by direct importers
    - (3) DV in intermediates reexported to third countries IV
    - (4) DV in intermediates that returns via final imports
    - (5) Double counted intermediate exports produced at home
  - Domestic content in intermediate exports that finally returns home (VS1*)
  - Foreign content (VS)
    - (6) FV in final goods exports
    - (7) FV in intermediate goods exports
    - (8) Double counted intermediate exports produced abroad

Domestic content (DC)
### Table: Descomposition of gross exports. Spain, 1995-2011

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Gross exports</strong></td>
<td></td>
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</tr>
<tr>
<td>VA exports (1) to (3)</td>
<td>78,71</td>
<td>78,78</td>
<td>77,49</td>
<td>76,66</td>
<td>75,55</td>
<td>73,97</td>
<td>74,56</td>
<td>73,26</td>
<td>72,42</td>
<td>71,78</td>
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<td>69,50</td>
<td>69,49</td>
<td>74,95</td>
<td>71,77</td>
<td>69,41</td>
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</tr>
<tr>
<td>Domestic value added in gross exports (1) to (5)</td>
<td>79,29</td>
<td>79,40</td>
<td>78,13</td>
<td>76,34</td>
<td>72,54</td>
<td>74,18</td>
<td>75,31</td>
<td>75,42</td>
<td>74,17</td>
<td>73,61</td>
<td>72,46</td>
<td>70,06</td>
<td>69,41</td>
<td>71,77</td>
<td>69,41</td>
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<td></td>
</tr>
<tr>
<td>Double counted intermediate exports produced at home (6)</td>
<td>0,15</td>
<td>0,16</td>
<td>0,17</td>
<td>0,20</td>
<td>0,22</td>
<td>0,24</td>
<td>0,26</td>
<td>0,27</td>
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<td>0,27</td>
<td>0,27</td>
<td>0,27</td>
<td>0,27</td>
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<tr>
<td><strong>Domestic content (1) to (6)</strong></td>
<td>79,44</td>
<td>79,55</td>
<td>78,30</td>
<td>77,55</td>
<td>76,54</td>
<td>72,78</td>
<td>74,40</td>
<td>75,53</td>
<td>75,66</td>
<td>74,42</td>
<td>73,61</td>
<td>70,80</td>
<td>70,65</td>
<td>75,96</td>
<td>72,69</td>
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<td>Foreign value added in gross exports (7) to (8)</td>
<td>16,94</td>
<td>16,65</td>
<td>17,58</td>
<td>18,25</td>
<td>18,89</td>
<td>21,53</td>
<td>20,10</td>
<td>19,33</td>
<td>19,02</td>
<td>19,78</td>
<td>20,36</td>
<td>21,87</td>
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<td>22,16</td>
<td>18,91</td>
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<tr>
<td>Double counted intermediate exports produced abroad (9)</td>
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<td>3,79</td>
<td>4,12</td>
<td>4,20</td>
<td>4,57</td>
<td>5,70</td>
<td>5,50</td>
<td>5,14</td>
<td>5,32</td>
<td>5,79</td>
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<td>7,20</td>
<td>7,19</td>
<td>5,13</td>
<td>6,33</td>
<td>7,07</td>
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<tr>
<td><strong>Foreign content (7) to (9)</strong></td>
<td>20,56</td>
<td>20,45</td>
<td>21,70</td>
<td>22,45</td>
<td>23,46</td>
<td>27,22</td>
<td>25,60</td>
<td>24,47</td>
<td>24,34</td>
<td>25,58</td>
<td>26,39</td>
<td>28,63</td>
<td>29,20</td>
<td>29,35</td>
<td>24,04</td>
<td>27,31</td>
<td>29,70</td>
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<td><strong>Vertical specialization</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>VS</td>
<td>20,56</td>
<td>20,45</td>
<td>21,70</td>
<td>22,45</td>
<td>23,46</td>
<td>27,22</td>
<td>25,60</td>
<td>24,47</td>
<td>24,34</td>
<td>25,58</td>
<td>26,39</td>
<td>28,63</td>
<td>29,20</td>
<td>29,35</td>
<td>24,04</td>
<td>27,31</td>
<td>29,70</td>
</tr>
<tr>
<td>VS1</td>
<td>17,4</td>
<td>17,7</td>
<td>18,1</td>
<td>17,9</td>
<td>18,8</td>
<td>19,6</td>
<td>20,6</td>
<td>20,2</td>
<td>21,0</td>
<td>22,1</td>
<td>22,4</td>
<td>22,9</td>
<td>24,47</td>
<td>23,24</td>
<td>21,24</td>
<td>21,53</td>
<td>21,66</td>
</tr>
<tr>
<td>VS1*</td>
<td>0,73</td>
<td>0,78</td>
<td>0,80</td>
<td>0,89</td>
<td>0,98</td>
<td>1,00</td>
<td>1,02</td>
<td>1,00</td>
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<td>1,16</td>
<td>1,19</td>
<td>1,22</td>
<td>1,30</td>
<td>1,16</td>
<td>1,01</td>
<td>0,92</td>
<td>0,90</td>
</tr>
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</table>
VA exports and vertical specialization

- The ratio of value-added to gross exports (VAX ratio) fell by 9 pp. from 1995 to 2011 (79% in 1995; 70% in 2011).
- The foreign content of Spain’s exports rebounded to 29.7% in 2011, up from the 20.5% in 1995 and the 24% in 2009.
  - Decline in 2009 due to the crisis, but the trend has recovered.
- Participation in GVCs: higher backward participation (VS) relative to forward participation (VS1).
- Spain’s value-added content of exports is similar to that of its neighbouring countries.
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Spain’s value-added content of exports is similar to that of its neighbouring countries.
Value-added to exports ratio. International comparison

VAX ratio, 1995 and 2011

[Bar chart showing the value-added to exports ratio for various countries in 1995 and 2011.]
Backward and forward participation (VS and VS1). International comparison

(a) VS

(b) VS1
Heterogeneity between manufacturing and services:

- Manufacturing is more intensive in the use of imported intermediate inputs (backward participation) than services (forward participation).
Analysis by sectors. Manufacturing and services

Share in gross exports and in value added exports

- Higher importance of the service sector in VA terms.
- The share of services in gross exports underestimates its real contribution to the generation of value-added.

![Bar chart showing the comparison between manufacturing and services in gross exports and value added exports for the years 1995 and 2011. The chart indicates that services have a higher share in value added exports compared to manufacturing.]
Analysis by sectors. Manufacturing and services

VAX ratio (ratio of value added to gross exports)
Analysis by sectors. Manufacturing industries

VAX ratio (ratio of value added to gross exports)
### Sectors. Global value chain income.

Increase in sector interdependencies.

<table>
<thead>
<tr>
<th>Sector of origin</th>
<th>Other manufac. industries (2)</th>
<th>Services (3)</th>
<th>Other sectors (4)</th>
<th>Domestic VA (1) to (4)</th>
<th>Foreign VA</th>
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<tbody>
<tr>
<td>Agri-food sector</td>
<td>54.7</td>
<td>5.5</td>
<td>24.2</td>
<td>2.7</td>
<td>87.0</td>
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<tr>
<td>Manufacturing, nec; recycling</td>
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<td>16.5</td>
<td>26.3</td>
<td>4.0</td>
<td>81.7</td>
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<tr>
<td>Traditional manufac. Sector</td>
<td>44.1</td>
<td>5.0</td>
<td>26.1</td>
<td>5.8</td>
<td>81.1</td>
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<td>21.6</td>
<td>3.0</td>
<td>80.5</td>
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<tr>
<td>Basic Metals and Fabricated Metal</td>
<td>46.6</td>
<td>6.5</td>
<td>21.7</td>
<td>5.0</td>
<td>79.8</td>
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<td>Chemicals</td>
<td>40.8</td>
<td>7.6</td>
<td>26.1</td>
<td>4.7</td>
<td>79.2</td>
</tr>
<tr>
<td>Electrical and Optical Equipment</td>
<td>39.6</td>
<td>10.5</td>
<td>23.2</td>
<td>3.1</td>
<td>76.4</td>
</tr>
<tr>
<td>Transport Equipment</td>
<td>32.1</td>
<td>13.6</td>
<td>20.5</td>
<td>3.1</td>
<td>69.2</td>
</tr>
<tr>
<td>Total Manufacturing</td>
<td>43.2</td>
<td>-</td>
<td>24.9</td>
<td>9.9</td>
<td>78.0</td>
</tr>
</tbody>
</table>

(a) 1995

<table>
<thead>
<tr>
<th>Sector of origin</th>
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</tr>
<tr>
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<td>32.0</td>
<td>14.3</td>
<td>25.5</td>
<td>3.5</td>
<td>75.3</td>
</tr>
<tr>
<td>Machinery, Nec</td>
<td>38.6</td>
<td>11.0</td>
<td>21.6</td>
<td>3.1</td>
<td>74.4</td>
</tr>
<tr>
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<td>35.7</td>
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<td>25.8</td>
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<tr>
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<td>30.5</td>
<td>9.3</td>
<td>22.5</td>
<td>3.1</td>
<td>65.3</td>
</tr>
<tr>
<td>Transport Equipment</td>
<td>25.2</td>
<td>8.7</td>
<td>24.0</td>
<td>2.9</td>
<td>60.7</td>
</tr>
<tr>
<td>Total Manufacturing</td>
<td>35.9</td>
<td>-</td>
<td>25.3</td>
<td>7.2</td>
<td>68.5</td>
</tr>
</tbody>
</table>

(b) 2011
Sectors. Services content in manufacturing

Services content in manufacturing industries’ production. Domestic and foreign.
Summary and conclusions

1. Spain’s participation in GVC:
   - Higher *backward participation*.
   - The value-added to exports ratio (VAX ratio) fell 9 pp. from 1995 to 2011 → The foreign content of Spanish exports rebounded.

2. Manufacturing and services:
   - Manufacturing is more intensive in the use of imported intermediate inputs (higher VS) than services, which show a higher forward participation (VS1).
   - The share of manufacturing (services) in total exports is lower (higher) when flows are analyzed in value-added terms:
     - Services play an essential role in GVCs (inputs in the production and exports of manufacturing products): a well-functioning of this sector is essential.
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  - It may limit the role of the external sector as an engine of growth: not all export growth translates into growth of domestic value added.
  - But importing intermediates can also be positive: more efficient inputs and involvement in GVCs can foster external competitiveness.
  - Further research: what’s the impact of participation in GVC on domestic VA and economic performance?
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