Networking on Global Value Chains to Supply Domestic Demand: A Temporal Feedback Loop Analysis Based on OECD's ICIO 2016

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Abstract

The underlying geographical structure of global value chains and the necessary networking among the countries to supply their own domestic demand is the main study object of this paper. The spatial production structure is elucidated the by means of the hierarchical feedback loop methodology. In essence, this methodology offers a detailed view of economic interactions, first by identifying the paths of influence across regions, and then by proposing a hierarchical extraction method to identify the paths in terms of their economic importance. This application takes into account value-added flows involved in the supply chains, rather than interregional gross trade. The paper first presents a background perspective on how the fragmentation of production processes has led to the reorganization of economic activities around the globe and within countries. Then, the hierarchical feedback loop methodology is applied using the new OECD's ICIO 2016 database which takes into consideration 64 world regions (63 countries and the rest of the world) and 34 sectors, allowing in this way a macro level analysis, at the global level, of the spatial structure of the flows linking major economies across trade blocks. Therefore, the results allow a better understanding of how the production fragmentation takes place in the world so the countries can supply the needs of their domestic demand.

Keywords: Fragmentation; Feedback Loop Analysis; Global Value Chains; Trade in Value Added; Inter Country Input-Output Tables.

[1] The contents of this publication express the views of the authors and does not necessarily represent the views of OECD or of its member countries.

1. Introduction

Over the last few decades, the fragmentation of production processes has redefined comparative advantages at global level, inducing great changes in the spatial location and organization of economic activity. At the same time, the reorganization of value chains generated a complex system of interdependent flows, linking regions all over the world. As the process of fragmentation continues, inter-regional dependency will assume even greater importance in explaining the growth and path of development of economies (HEWINGS; OOSTERHAVEN, 2015). Therefore, there is increasing relevance in studying the spatial organization of production systems, a topic that has not received sufficient attention in the literature. Also, considering that the final goal of the countries in their integration on the international trade is to benefit their own economies and to improve the quality of life of their inhabitants, it is important to know how the trade networking among countries takes place for them to better attend their own domestic demand needs.

To study production fragmentation across space, the inter-regional input-output methodology constitutes a natural and important analytical framework. In this paper, our objective is elucidating the geographical structure of global value chains' (GVCs) flows related to the domestic final demand by means of the hierarchical feedback loop analysis. In essence, this methodology offers a detailed view of economic interactions by first identifying the paths of influence across regions and then proposing a hierarchical extraction method to identify the paths in terms of their economic importance flows (POLENSKE; HEWINGS, 2004).

The hierarchical feedback loop methodology has already been applied for analyzing the spatial structure of gross trade flows within Europe (SONIS *et al*, 1993), Asia (SONIS *et al*, 1995), the Midwest region in the USA (SEO *et al*, 2004), and on the production side value added trade flows to the Brazilian case, where it was applied to an enlarged Input-Output system, comprising a Brazilian states Interregional Input-Output table integrated into a World Input-Output table comprising the main countries in the World (IMORI et al, 2016). It has also been employed for identifying the economic interactions among industries within Chicago region (LIU; HEWINGS, 2014). Our paper focuses on supply chain dependencies of the 63 countries present in OECD´s Intercountry Input-Output (ICIO) systems.

The remainder of this paper is organized as follows. In section 2, the hierarchical feedback loop methodology is explored. Section 3 presents the results, and the final comments are presented in section 4.

2. Methodology

In this paper, we focus on the spatial organization of production processes in the line with trade in value added (TiVA) studies, where we are interested in understanding how the networking among the country takes place, so they can attend their own domestic final consumption Several methodologies can be employed for analyzing inter-regional and intersectoral dependencies. In this paper, we address the identification and interpretation of global economic structure by means of the hierarchical feedback loop analysis of value added flows within GVCs. In essence, this approach offers a more detailed view of economic interactions by first identifying the paths of influence across regions and then proposing a hierarchical extraction method to identify the paths in terms of their economic importance flows (POLENSKE; HEWINGS, 2004).

For our empirical analysis, we apply the 2016 release of OECD´s ICIO database, comprising 63 countries and rest of the World regions for the global economy, for the years 1995, 2000, 2005 and 2011.

The OECD´s ICIO database (http://oe.cd/i-o) makes a detailed treatment of basic price, non-resident expenditures, re-exports and international trade of goods and services for each country. As the result, ICIO export figures show a more complete picture than other International MRIO databases.

2.1. Supply chains' value added flows

From the basic Leontief model, the total output of an economy can be expressed as the sum of intermediate consumption and final consumption (MILLER; BLAIR (2009)) as

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \tag{1}$$

$$(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{B} \tag{2}$$

$$\mathbf{x} = \mathbf{B}\mathbf{y} \tag{3}$$

where $\mathbf{x}$ is the $n\times1$ total output vector (n is the number of industries in the system), $\mathbf{A}$ is the $n\times n$ direct input coefficients matrix, $\mathbf{y}$ is the $n\times1$ final demand vector, and $\mathbf{B}$ is the Leontief

inverse matrix. Considering **G** as the $n \times n$ diagonal matrix of value added coefficients, we can describe the value added related input-output model as:

$$\mathbf{w} = \mathbf{Gx} \quad (4)$$

from (3):

$$\mathbf{w} = \mathbf{GBy} \quad (5)$$

where **w** is the $n \times 1$ value added vector.

In our empirical analysis, we applied the ICIO model where the final demand of each country is treated isolated from the others, in this way, and having *r* as the number of countries in the system, one has that the dimensions of the above matrices become: a) **x**, **y**, and **w**, size [(*r.n)* × r]; and b) **A**, **B**, and **G**, size (*r.n)* × *(r.n).*

For the value chain of the final product *t* with completion in the region *j*, we define the foreign value added as all value added outside the region of completion *j*:

$$FVA_t^j = \sum_s \sum_{i \neq j} w_s^{ij} \quad (6)$$

Here, w_s^{ij} is the value added generated directly and indirectly in industry *s* of region *i* for the production of final products consumed in region *j*. There is one column for each GVC, characterized by the region-industry of completion, with cells showing the origin of value added. The sum across all industries participating in a GVC is equal to the value of the country domestic final demand. Since final output values equal global expenditure on the product, the summation of across columns equals world GDP, measured from the expenditure side. A given row represents the value-added from a given region-industry to all GVCs. Thus, the summation across the row, depicted in the final column, equals the value added in an industry. Summed across all industries, this equals world GDP, measured from the production side (TIMMER *et al*, 2015).

2.2. Hierarchical feedback loop analysis

In our empirical application, we apply the hierarchical feedback loop approach developed by Sonis and Hewings (1988, 1990) to facilitate the identification of the spatial structure of the GVCs.[2]

We consider the *(r.n)* × *(r)* matrix **W**, of supply chain's value added flows:

[2] This section draws on Sonis *et al* (1995).

$$\mathbf{W} = \begin{pmatrix} \mathbf{W}_{11} & \mathbf{W}_{12} & \cdots & \mathbf{W}_{1r} \\ \mathbf{W}_{21} & \mathbf{W}_{22} & \cdots & \mathbf{W}_{2r} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{W}_{r.n,1} & \mathbf{W}_{r.n.2} & \cdots & \mathbf{W}_{r.n,r} \end{pmatrix} \tag{7}$$

where each cell

$$\mathbf{W}_{ij} = \left\| w_s^{ij} \right\| \tag{8}$$

represents the value added from sectors in region *i* to the GVCs of region *j*. Define:

$$t_{ij} = \sum_s w_s^{ij} \tag{9}$$

as the sum of flows between all industries within each submatrix $\mathbf{W}_{ij}$. Hence, the $r \times r$ matrix of aggregate flows is defined as:

$$\mathbf{T} = \left\| t_{ij} \right\| \tag{10}$$

The major focus of our empirical application in this paper is the identification of feedback loops that reveal the economic networking of each region. A series of aggregate transactions is specified such that each region is allowed precisely one transaction flow entering it and one flow leaving it. Such a series of transactions is called "feedback loop", since each and every region influences itself at the end of the loop. A feedback loop is complete if it includes all regions. A complete feedback loop is either closed or can be decomposed into a set of closed subloops. If the entering flow and the leaving flow for the same region are identical, the smallest closed subloop possible has been identified, i.e. the influence that a region directly exerts on itself, its domestic self-influence.

Economically, a series of transactions represents a chain of bilateral influences which are based on either backward or forward linkages. Thus, the economic meaning of a feedback loop is indicating how strongly (at each hierarchical level) each region is connected to all other regions included in the loop. By focusing on complete loops, one can evaluate the place and position of each region relative to all others.

For a set of *n* regions, the amount of all complete feedback loops is equal to *n!*. One method for dealing with this large amount of complete feedback loops is the derivation of some hierarchical structure. Essentially, the hierarchical feedback loop approach, proposed by Sonis and Hewings (1988), extracts complete feedback loops that successively account for the largest possible sum of transaction flows in each stage of the selection process. This procedure continues until all transaction flows have been included.

A complete feedback loop is presented by a submatrix $\mathbf{T}_x$ of flows extracted from the matrix $\mathbf{T} = \left\| t_{ij} \right\|$ of aggregate transaction flows. $\mathbf{T}_x$ must include in each row and in each

column precisely one non-zero entry from the matrix **T** and zeros elsewhere. Replacing all the non-zero entries of $\mathbf{T}_x$ by units, a so-called permutation matrix $\mathbf{P}_x$ is obtained, corresponding to a permutation of the sequence of numbers 1, 2, …, r. This permutation (of regions) represents the structure of the flows in the corresponding feedback loop. Hence, the submatrix $\mathbf{T}_x$ is referred to as a quasi-permutation matrix. Moreover, the flow intensity of a complete feedback loop (V_x) is defined as the sum of all transaction flows of $\mathbf{T}_x$.

Within the hierarchical feedback loop approach, the hierarchy of complete feedback loops is defined as the sequence of quasi-permutation submatrices $\mathbf{T}_x$ chosen according to the rank-size of their flow intensities V_x. Thus, on the top of the hierarchy, one finds the complete feedback loop with maximal flow intensity. The procedure is summarized in the following steps:

- **Step 1**: For the matrix $\mathbf{T} = \|t_{ij}\|$ of aggregate transaction flows, find the quasi-permutation submatrix $\mathbf{T}_1$ (and the corresponding permutation matrix $\mathbf{P}_1$) associated with the complete feedback loop with maximal flow intensity (V_1). This loops stands on the top of the hierarchy.
- **Step 2**: Replace in **T** the flows from $\mathbf{T}_1$ by arbitrary large negative numbers. For this new matrix $\mathbf{T}'$ find the quasi-permutation submatrix $\mathbf{T}_2$ (and the corresponding permutation matrix $\mathbf{P}_2$) associated with the complete feedback loop with maximal flow intensity (V_2). Since the flows from the top feedback loop have been replaced by arbitrary large negative numbers in $\mathbf{T}'$, they will not be included in this hierarchically subsequent loop.
- **Step 3** through *r*-1: repeat step 2 for the matrix $\mathbf{T}'$.

After *r*-1 steps, one obtains a sequence of *r* complete feedback loops, ordered according to the decreasing size of their flow intensities.

3. Results

In order to understand the spatial configuration of global production processes to attend the countries domestic final demand, first we look at the individual national level, focusing on where each region sources the goods and services consumed domestically. This works as an indication of each region's dependency on the international supply networks. Next, we take the global perspective and apply the feedback loop methodology table for hierarchically identifying the myriad of economic interaction in the GVCs.

3.1. Supply chain interdependency for domestic demand

One important question to analyze in this study is to know if the trade and networking of the countries occur mainly among me main trading regions or if it is wider spread among the countries in the world. To do so, the 63 countries and the rest of world region are aggregated into 5 trade zones as follow[3]:

1. ***NAFTA*** - North American Free Trade Association: *CAN, MEX, USA*;
2. ***ZSCA*** - South and Central America: *CHL, ARG, BRA, COL, CRI, PER*;
3. ***ZEUR*** – Europe: *AUT, BEL, CZE, DNK, EST, FIN, FRA, DEU, GRC, HUN, ISL, IRL, ITA, LVA, LUX, NLD, NOR, POL, PRT, SVK, SVN, ESP, SWE, CHE, GBR, BGR, CYP, HRV, LTU, MLT, ROU, RUS*;
4. ***ZASI*** - East and South East Asia: *JPN, KOR, BRN, CHN, HKG, IDN, KHM, MYS, PHL, SGP, THA, TWN, VNM*;
5. ***ZOTH*** - Other regions: *AUS, ISR, NZL, TUR, IND, MAR, SAU, TUN, ZAF, ROW*.

Looking at the Foreign Value Added (FVA) content in the domestic final demand, Tables 1 and 2 show at the bottom that the weighted average shares of FVA in the domestic final demand increased from 16.3% in 1995 to 18.0% in 2000, 19.9% in 2005 and 21.3% in 2011, showing an increasing dependence of the countries on imports of goods and services. This increase in the FVA shares is not uniform among the countries, increasing for some and oscillating for others, however, the decrease of shares in some countries, through time is more than compensate from the increase in the other countries shares, as the final results shows. The overall implication of this result is that the countries in the world are more open and integrated in the GVCs.

[3] The list of the regions and countries names is presented in Annex I.

Looking at the regions considered here, one can observe that the NAFTA region is the main source of FVA for Canada and Mexico, while for the USA, Europe and Asia are the most important regions as sources of FVA. For South and Central America, overall the integration among the countries in this region is small when compared to the importance of the FVA from the other regions. On the other end, Europe and Asia show to be the regions where the countries are more integrated in terms of production, meaning that the FVA from the countries inside these regions represent the main shares of the source of their FVA. For the other countries in the world it is clear the importance of Europe as the main source of FVA.

Overall, decomposing the World FVA shares sourced from the regions considered here, one can see the overall decrease, from 1995 to 2011, in the shares of NAFTA (18.3% to 15.0%) and Europe (46.4% to 37.9%), at the same time that there is an increase in the shares of Central and South America (2.4% to 3.7%), Asia (21.9% to 24.5%), and Rest of the World (11.0% to 18.9%). Showing in this way a decrease in the concentration of the international trade, as it becomes more “equalitarian” and spread among the world countries, which is a point we are going to explore more below.

Table 1
Foreign Value Added Shares in Domestic Final Demand, by Country of Completion, 1995 and 2000 (%)

Region	Country	1995						2000					
		NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL	NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL
NAFTA	CAN	14.6	0.3	4.4	4.4	1.2	24.8	16.5	0.4	5.0	4.0	2.1	28.1
	MEX	11.4	0.3	2.8	2.3	0.7	17.5	13.1	0.4	2.9	2.4	1.3	20.2
	USA	2.0	0.3	3.1	3.8	1.3	10.5	2.5	0.4	3.5	3.9	2.0	12.3
ZSCA	ARG	2.8	1.4	3.3	1.5	1.0	10.1	3.2	1.7	3.1	1.5	1.9	11.4
	BRA	2.7	0.9	3.0	1.3	1.3	9.2	3.4	1.2	3.5	1.6	2.1	11.8
	CHL	7.0	2.9	6.3	4.0	2.5	22.7	5.9	5.0	4.3	2.7	5.3	23.3
	COL	5.9	1.0	4.3	2.2	2.8	16.2	5.5	0.9	3.3	1.9	4.0	15.6
	CRI	14.8	1.9	6.4	4.0	6.0	33.0	17.6	1.5	6.3	4.3	7.2	37.0
	PER	5.1	2.8	4.3	3.1	1.9	17.1	5.2	2.4	3.9	3.2	2.2	16.9
ZEUR	AUT	1.6	0.1	24.0	1.7	1.6	29.1	2.3	0.3	23.4	2.0	5.0	33.0
	BEL	2.8	0.3	24.0	2.2	1.9	31.3	4.1	0.5	23.8	2.0	3.9	34.2
	BGR	1.9	1.6	25.8	1.9	4.3	35.6	2.6	1.3	26.9	2.1	7.3	40.3
	HRV	1.6	0.3	25.4	1.3	2.2	30.8	2.5	0.3	24.8	1.9	3.5	33.0
	CYP	5.8	0.4	25.0	5.3	3.8	40.2	6.0	0.4	24.2	5.1	7.2	42.9
	CZE	2.2	0.3	26.0	2.4	6.3	37.2	4.0	0.3	29.1	2.1	5.0	40.4
	DNK	2.0	0.3	18.8	2.5	1.5	25.2	2.9	0.4	19.1	2.7	2.5	27.5
	EST	2.8	0.3	39.2	2.5	2.2	46.9	3.5	0.4	23.9	4.3	15.2	47.3
	FIN	2.6	0.2	17.0	2.8	0.9	23.4	3.1	0.3	17.5	2.6	2.1	25.6
	FRA	2.0	0.3	12.1	1.7	1.6	17.7	2.8	0.3	13.1	2.2	2.7	21.2
	DEU	1.9	0.3	12.3	2.3	1.8	18.5	3.1	0.3	14.3	3.0	3.0	23.7
	GRC	1.7	0.3	17.2	2.0	1.8	23.0	3.7	0.3	16.1	3.3	6.8	30.3
	HUN	3.6	0.4	26.8	2.6	1.9	35.3	4.0	0.4	30.8	3.7	4.0	42.9
	ISL	4.5	0.2	21.6	2.8	1.6	30.7	6.4	0.2	23.3	3.2	2.9	35.9
	IRL	9.6	0.3	23.9	4.3	2.0	40.1	12.6	0.5	24.3	4.0	3.3	44.7
	ITA	1.9	0.4	13.1	1.6	2.2	19.2	2.4	0.5	13.2	2.0	3.9	22.0
	LVA	1.8	0.2	24.7	1.1	2.7	30.6	2.8	0.2	25.6	1.2	4.3	34.1
	LTU	1.7	0.2	25.1	0.8	3.4	31.2	2.1	0.3	22.3	2.3	3.6	30.7
	LUX	3.5	0.2	42.0	1.4	1.8	49.0	7.2	0.8	43.8	3.5	3.4	58.6
	MLT	4.4	0.5	37.6	5.1	4.3	51.9	5.3	0.4	33.3	4.7	5.8	49.5
	NLD	3.5	0.5	19.6	2.6	2.2	28.4	4.2	0.5	17.3	2.9	3.6	28.6
	NOR	2.9	0.2	20.5	3.0	1.3	27.9	3.8	0.3	18.4	3.6	2.2	28.2
	POL	1.2	0.2	14.4	1.2	1.7	18.7	2.1	0.3	19.1	2.2	3.0	26.6
	PRT	1.8	0.5	20.1	1.8	2.6	26.8	2.2	0.6	19.9	1.9	5.7	30.4
	ROU	1.4	0.3	17.2	1.4	3.3	23.6	1.7	0.4	17.8	1.6	4.4	25.8
	RUS	2.5	0.9	13.1	3.1	5.2	24.8	2.7	0.4	9.5	2.1	8.6	23.3
	SVK	2.5	0.3	29.0	2.1	2.1	35.9	2.7	0.2	34.4	2.7	3.1	43.2
	SVN	1.9	0.4	31.2	2.0	2.1	37.5	2.3	0.4	31.3	2.4	3.6	40.0
	ESP	1.9	0.4	13.1	1.7	2.0	19.2	2.8	0.6	16.1	2.5	3.7	25.8
	SWE	2.7	0.2	19.8	2.1	1.1	25.9	4.0	0.2	20.8	2.4	1.9	29.3
	CHE	2.3	0.2	20.4	2.2	1.4	26.5	3.8	0.4	23.0	2.8	2.5	32.4
	GBR	3.7	0.3	13.6	3.1	2.2	22.9	4.8	0.3	12.3	3.3	2.5	23.3

Continue ...

Table 1 (Continued)
Foreign Value Added Shares in Domestic Final Demand, by Country of Completion, 1995 and 2000 (%)

Region	Country	1995						2000					
		NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL	NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL
ZASI	BRN	6.2	0.3	12.7	24.0	3.6	46.8	7.3	0.8	11.2	17.0	3.9	40.2
	KHM	3.2	0.2	6.8	22.5	2.3	35.0	4.3	0.3	6.0	23.8	5.3	39.6
	CHN	1.7	0.2	2.6	5.2	1.1	10.9	1.9	0.2	2.6	5.5	2.1	12.3
	HKG	4.7	0.2	6.1	18.8	3.0	32.8	4.2	0.1	3.9	13.7	2.3	24.2
	TWN	6.5	0.5	6.3	14.5	3.3	31.2	7.2	0.3	5.3	15.6	4.5	32.9
	IDN	3.0	0.5	5.4	9.5	3.3	21.7	4.0	0.4	4.3	10.5	6.1	25.4
	JPN	2.1	0.2	1.6	2.0	1.3	7.1	2.4	0.1	1.7	2.5	1.8	8.5
	KOR	5.8	0.4	4.8	9.1	3.7	23.8	6.0	0.4	4.3	9.9	5.9	26.5
	MYS	6.9	0.8	11.7	23.9	5.2	48.4	8.4	0.7	9.0	23.9	7.0	49.0
	PHL	5.7	0.4	5.4	13.8	3.1	28.4	5.5	0.3	4.3	12.0	5.3	27.3
	SGP	10.2	0.5	10.4	23.8	6.2	51.2	14.0	0.5	10.6	22.0	6.9	54.1
	THA	4.2	0.5	8.3	17.4	4.1	34.5	4.6	0.6	6.0	15.4	7.0	33.6
	VNM	2.3	0.3	6.9	20.2	4.0	33.8	3.7	0.4	7.8	22.6	7.5	42.0
ZOTH	AUS	4.2	0.2	5.6	6.4	1.8	18.2	4.8	0.2	5.0	6.8	3.2	20.1
	IND	1.6	0.2	3.6	2.4	3.6	11.3	1.6	0.2	2.8	2.0	5.5	12.1
	ISR	6.3	0.2	15.2	3.8	3.7	29.2	6.4	0.3	11.5	3.4	9.3	31.0
	MAR	3.4	1.0	14.2	2.9	4.0	25.6	3.7	0.9	13.9	3.2	5.1	26.8
	NZL	4.3	0.3	6.4	6.2	7.2	24.3	4.1	0.4	4.4	4.8	12.8	26.4
	SAU	6.5	0.7	11.4	5.8	4.2	28.5	6.2	0.6	9.3	5.8	6.1	28.0
	ZAF	2.8	0.4	10.4	4.2	2.7	20.5	4.1	0.4	9.5	3.5	4.5	22.1
	TUN	2.6	0.4	26.2	1.9	4.1	35.3	2.8	0.5	23.0	2.3	6.2	34.9
	TUR	2.0	0.2	9.8	1.9	2.7	16.6	2.3	0.2	11.0	2.2	4.4	20.1
	ROW	6.4	1.7	13.9	5.8	2.3	30.1	6.4	1.4	14.3	6.6	3.0	31.7
TOTAL		3.0	0.4	7.6	3.6	1.8	16.3	3.7	0.4	7.2	3.9	2.7	18.0

Source: Research data based on OECD´s ICIO.

Table 2
Foreign Value Added Shares in Domestic Final Demand, by Country of Completion, 2005 and 2011 (%)

Region	Country	2005						2011					
		NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL	NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL
NAFTA	CAN	13.4	0.5	5.3	4.0	2.2	25.4	11.4	0.7	4.7	4.5	2.8	24.1
	MEX	10.1	0.9	3.4	3.4	1.6	19.4	10.8	0.8	3.5	4.2	2.0	21.2
	USA	2.7	0.5	4.0	3.9	2.4	13.5	2.6	0.6	4.0	4.4	2.7	14.4
ZSCA	ARG	3.8	4.2	4.8	2.5	3.0	18.2	3.4	4.5	3.9	3.3	3.3	18.3
	BRA	2.6	1.0	3.6	2.1	2.5	11.8	3.0	1.0	3.5	2.9	2.6	13.1
	CHL	5.5	5.3	6.8	4.6	4.7	26.9	6.7	4.6	6.2	6.7	4.4	28.8
	COL	5.5	1.4	3.2	2.4	4.3	16.9	6.2	2.1	3.7	3.9	2.9	18.8
	CRI	14.6	3.7	7.1	5.4	10.9	41.7	13.8	2.6	5.0	5.3	6.6	33.2
	PER	4.6	3.2	4.0	3.5	3.0	18.2	5.5	3.3	4.5	6.0	3.8	23.1
ZEUR	AUT	1.7	0.2	23.7	2.1	3.2	30.8	1.6	0.4	23.4	2.5	4.2	32.1
	BEL	3.1	0.4	23.0	2.4	2.8	31.6	3.3	0.6	22.7	2.5	3.8	32.8
	BGR	2.0	2.3	27.3	3.1	6.6	41.3	1.4	0.6	31.5	2.5	6.1	42.1
	HRV	1.7	0.5	26.1	2.5	3.5	34.4	1.5	0.6	19.8	2.7	5.0	29.6
	CYP	2.9	1.6	26.8	3.0	5.9	40.1	2.5	0.5	25.9	2.8	6.7	38.3
	CZE	1.9	0.3	28.4	3.6	3.1	37.4	2.0	0.5	27.4	5.0	3.9	38.9
	DNK	2.9	0.4	19.7	2.5	2.6	28.0	2.4	0.5	18.3	2.8	2.8	26.8
	EST	2.1	0.4	36.0	4.3	3.4	46.2	2.0	0.4	31.2	4.6	3.7	41.9
	FIN	2.2	0.4	19.4	2.8	2.2	27.0	2.2	0.4	20.9	2.8	3.2	29.4
	FRA	2.1	0.3	13.5	2.4	2.7	21.0	2.3	0.4	13.6	3.0	3.6	22.9
	DEU	2.6	0.4	15.2	3.0	2.9	24.0	2.7	0.6	15.8	3.6	3.7	26.5
	GRC	2.2	0.3	16.6	2.7	4.4	26.2	2.0	0.4	15.0	2.5	5.7	25.5
	HUN	2.5	0.2	30.6	3.3	2.7	39.4	2.6	0.3	32.0	3.3	3.1	41.2
	ISL	5.2	0.2	24.6	3.7	2.6	36.3	6.8	1.7	22.4	3.3	3.6	37.7
	IRL	11.0	0.4	23.8	3.3	2.6	41.1	12.6	0.6	27.4	3.2	3.8	47.6
	ITA	1.7	0.4	13.5	2.0	3.7	21.4	1.8	0.6	13.8	2.8	4.7	23.7
	LVA	1.6	0.2	32.9	1.7	3.2	39.6	1.5	0.3	31.4	2.5	3.4	39.0
	LTU	1.5	0.2	23.3	2.2	3.2	30.4	1.3	0.4	28.7	2.2	3.6	36.1
	LUX	3.8	0.7	46.7	3.7	3.1	57.9	5.5	0.5	42.4	5.5	5.6	59.6
	MLT	2.7	0.6	33.3	3.0	6.2	45.8	2.6	0.4	29.9	2.5	5.3	40.7
	NLD	3.1	0.5	15.8	2.1	2.4	23.9	3.4	0.8	16.1	2.7	3.0	26.0
	NOR	2.8	0.3	18.3	2.6	2.0	26.0	2.7	0.5	15.9	3.8	2.6	25.4
	POL	1.6	0.4	20.4	2.7	2.7	27.8	1.7	0.5	21.6	4.4	3.4	31.6
	PRT	1.4	0.8	19.4	1.4	5.2	28.2	1.5	1.2	19.9	1.8	4.8	29.1
	ROU	1.5	0.4	20.7	2.0	4.2	28.8	1.6	0.5	20.7	2.2	4.7	29.7
	RUS	1.7	0.8	11.0	3.7	5.6	22.8	1.8	0.6	10.3	5.4	4.5	22.5
	SVK	1.8	0.3	31.9	4.0	6.6	44.6	1.4	0.4	27.8	4.6	7.5	41.6
	SVN	1.8	0.8	28.8	2.7	6.5	40.6	2.3	0.8	26.7	3.5	6.3	39.6
	ESP	2.1	0.6	15.6	2.7	3.9	24.8	2.3	1.0	13.8	3.0	4.5	24.6
	SWE	3.0	0.3	21.0	2.3	1.9	28.5	2.9	0.4	20.5	3.0	2.4	29.3
	CHE	3.1	0.3	22.2	2.3	2.8	30.8	3.2	0.5	22.3	3.3	3.3	32.6
	GBR	3.6	0.3	13.0	2.9	3.0	22.8	3.8	0.5	13.8	3.9	3.8	25.7

Continue ...

Table 2 (Continued)
Foreign Value Added Shares in Domestic Final Demand, by Country of Completion, 2005 and 2011 (%)

Region	Country	2005						2011					
		NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL	NAFTA	ZSCA	ZEUR	ZASI	ZOTH	TOTAL
ZASI	BRN	7.0	0.4	8.7	17.4	3.9	37.5	9.8	0.5	8.5	21.2	4.7	44.6
	KHM	3.1	0.4	6.8	27.4	5.4	43.1	2.9	0.5	4.6	25.7	5.1	38.8
	CHN	2.1	0.6	3.6	7.2	3.3	16.9	1.8	0.9	3.3	5.4	4.1	15.5
	HKG	3.7	0.3	4.7	12.4	3.5	24.6	4.9	0.5	7.5	20.2	5.5	38.7
	TWN	5.7	0.6	5.7	16.6	6.3	34.8	5.0	1.0	5.6	17.2	8.1	36.9
	IDN	2.8	0.6	4.1	11.1	6.4	25.1	2.0	0.7	3.1	10.5	5.8	22.1
	JPN	2.3	0.2	2.2	3.5	2.9	11.2	2.2	0.5	2.4	4.6	3.8	13.4
	KOR	4.5	0.5	4.7	9.8	6.1	25.6	5.2	1.1	5.7	12.4	8.6	32.9
	MYS	7.0	0.9	10.3	23.2	8.0	49.4	4.9	1.3	7.8	21.8	9.4	45.2
	PHL	4.5	0.5	3.9	12.6	7.1	28.6	3.2	0.6	4.1	12.2	6.8	27.0
	SGP	10.3	1.0	10.7	15.9	10.6	48.5	7.9	1.1	11.6	15.2	11.9	47.6
	THA	3.8	0.8	7.0	17.4	10.4	39.5	3.3	1.2	7.1	18.4	10.8	40.7
	VNM	2.8	0.8	8.4	25.5	9.0	46.6	3.7	1.5	7.4	25.7	10.4	48.7
ZOTH	AUS	3.7	0.3	5.6	7.5	3.1	20.2	3.3	0.4	4.6	7.4	3.5	19.2
	IND	2.0	0.4	4.4	3.9	7.8	18.5	2.9	0.6	5.1	6.2	8.7	23.5
	ISR	6.6	0.8	11.6	4.0	8.4	31.4	5.1	0.4	9.8	4.6	9.4	29.2
	MAR	3.0	1.1	15.5	4.1	6.1	29.8	4.4	1.5	16.3	5.7	8.0	35.9
	NZL	3.6	0.3	6.1	7.2	9.1	26.2	3.4	0.4	6.0	7.5	8.2	25.7
	SAU	4.5	1.0	11.8	6.8	7.4	31.5	4.8	1.4	10.6	9.3	9.0	35.0
	ZAF	3.0	0.7	10.3	5.0	5.3	24.3	2.9	0.7	8.6	5.8	7.4	25.5
	TUN	2.0	0.9	23.1	2.5	6.4	35.0	2.5	1.4	22.4	3.4	8.2	38.0
	TUR	1.8	0.4	11.7	2.9	4.4	21.2	2.5	0.6	12.1	4.8	5.4	25.4
	ROW	5.1	1.6	14.2	6.9	3.6	31.3	4.5	1.7	11.6	7.7	3.8	29.3
TOTAL		3.3	0.6	8.5	4.3	3.2	19.9	3.2	0.8	8.1	5.2	4.0	21.3

Source: Research data based on OECD´s ICIO.

3.2. Feedback Loops

In the previous subsection, we have analyzed, for each region in our model, the reliance on the FVA to attend their domestic consumption. Now, we take the global perspective and identify the paths in global supply chains in terms of the order of their economic importance, by means of the hierarchical feedback loop approach.

For the analysis, all the supply chain's value added flows are aggregated into one industry to reveal the macro-level structure of feedback loops. Table 3 summarizes the hierarchy of complete feedback loops, which are ordered according to the decreasing size of their flow intensities.

As one has 64 economies in the model, the total number of possible feedback loops are 64, being the first one the intraregional flows, while steps 2 to 64 refers to the trade among the economies. From Table 3 it is possible to observe that the shares of the Domestic Value Added (DVA) on the goods and services produced for domestic demand decreased from 83.7% in 1995 to 78.7% in 2011 as a reflex of the increase in the FVA as shown in the previous section and as can be observed in the sum of values from the feedback loops 2 to 64.

As can be seem in Table 3, as one goes down in the hierarchy, the value of the feedback loops decrease as the system maximizes in each step the value of the flows among the 64 economies. Higher shares of the values in the top feedback loops means a concentration of the trade in few interconnections and trade pattern concentrated in few partners; as can be seen in Table 3 the share of the top 12 feedback loops, in the sum of the feedback loops 2 to 64, has a continuous decrease from 61.2% in 1995 to 57.2% in 2011, while the share of the sum of the feedback loops 13 to 24 increased from 38.8% to 42.8%, showing a more fragmented and equalitarian international trade, as it was discussed in the previous section.

To see how the feedback loops have evolved through the years and the steps in a given year, Figure 1 shows: a) the feedback loop 1, which represents the domestic flow and which is the same for all years; b) feedback loop 2 for 1995, 2000, 2005 and 2011; and c) feedback loops 2, 3, 4, 6, 8, 12, 16, 20, 24 and 30 for 2011.

In Figure 1, for each of the feedback loops, with exception of feedback loop1 that represents the domestic part of each individual country, 2 figures are presented: a) the left figure despites the points of interconnections among the countries in an input-output matrix,

points in main block diagonals show that the trade takes place among the countries in the region, while points off the main block diagonals shows the existence of trade among countries in different regions, additionally each color represents the networking of trade among the countries; and b) the figure on the right shows the main networks of countries trade partnership, the thicker the line the greatest the Trade in Value Added (TiVA) among the countries.

From the evolution of feedback loop 2 from 1995 to 2011, overall, one can see that the trade is more concentrated inside the 5 regional blocks used in this paper, with a shorter number of countries in each networking. Going from the feedback loops 2 to 30 for 2011 shows that as one goes down in the feedback loops steps, the trade becomes more global with a larger number of countries in each networking, and a deconcentration of TiVA.

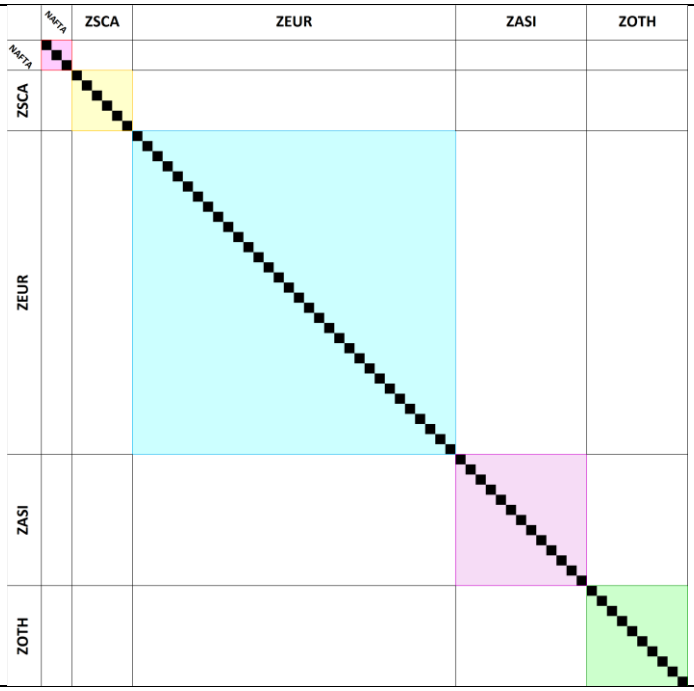
Table 3
World Feedback Loops Value Added – 1995, 2000, 2005 and 2011
Current US$ Million and Shares (%)

World Feedback Loops VA - 1995 to 2011								
Number	US$ Million				Shares			
	1995	2000	2005	2011	1995	2000	2005	2011
1	**23,637,231**	**25,071,894**	**34,528,333**	**52,462,011**	**83.7%**	**82.0%**	**80.1%**	**78.7%**
2 to 64	**4,610,346**	**5,490,258**	**8,552,792**	**14,188,841**	**16.3%**	**18.0%**	**19.9%**	**21.3%**
2	*477,475*	*567,288*	*879,464*	*1,329,002*	*10.4%*	*10.3%*	*10.3%*	*9.4%*
3	*423,304*	*505,561*	*674,492*	*1,106,839*	*9.2%*	*9.2%*	*7.9%*	*7.8%*
4	*328,654*	*421,587*	*639,762*	*985,545*	*7.1%*	*7.7%*	*7.5%*	*6.9%*
5	*283,776*	*370,162*	*548,539*	*817,594*	*6.2%*	*6.7%*	*6.4%*	*5.8%*
6	*246,072*	*300,602*	*482,244*	*751,534*	*5.3%*	*5.5%*	*5.6%*	*5.3%*
7	*221,875*	*258,675*	*398,247*	*635,681*	*4.8%*	*4.7%*	*4.7%*	*4.5%*
8	*198,518*	*239,081*	*370,218*	*586,758*	*4.3%*	*4.4%*	*4.3%*	*4.1%*
9	*184,131*	*212,757*	*324,377*	*521,481*	*4.0%*	*3.9%*	*3.8%*	*3.7%*
10	*163,773*	*188,301*	*290,958*	*493,186*	*3.6%*	*3.4%*	*3.4%*	*3.5%*
11	*152,476*	*170,559*	*259,846*	*458,577*	*3.3%*	*3.1%*	*3.0%*	*3.2%*
12	*141,921*	*158,124*	*236,416*	*429,957*	*3.1%*	*2.9%*	*2.8%*	*3.0%*
13	*114,477*	*130,681*	*220,957*	*410,212*	*2.5%*	*2.4%*	*2.6%*	*2.9%*
14	*106,639*	*122,360*	*204,982*	*358,001*	*2.3%*	*2.2%*	*2.4%*	*2.5%*
15	*99,401*	*113,656*	*188,540*	*329,536*	*2.2%*	*2.1%*	*2.2%*	*2.3%*
16	*91,135*	*105,655*	*172,803*	*313,914*	*2.0%*	*1.9%*	*2.0%*	*2.2%*
17	*83,142*	*97,707*	*163,273*	*299,457*	*1.8%*	*1.8%*	*1.9%*	*2.1%*
18	*76,046*	*90,895*	*155,782*	*272,813*	*1.6%*	*1.7%*	*1.8%*	*1.9%*
19	*71,362*	*87,048*	*140,689*	*261,186*	*1.5%*	*1.6%*	*1.6%*	*1.8%*
20-64	*1,146,168*	*1,349,560*	*2,201,205*	*3,827,568*	*24.9%*	*24.6%*	*25.7%*	*27.0%*
2-12					61.2%	61.8%	59.7%	57.2%
23-64					38.8%	38.2%	40.3%	42.8%
Total	**28,247,576**	**30,562,152**	**43,081,125**	**66,650,852**				

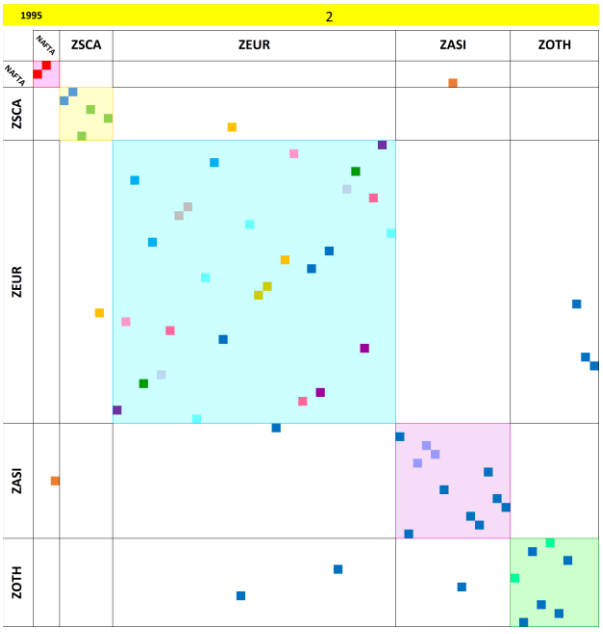
Source: Research data based on OECD´s ICIO.

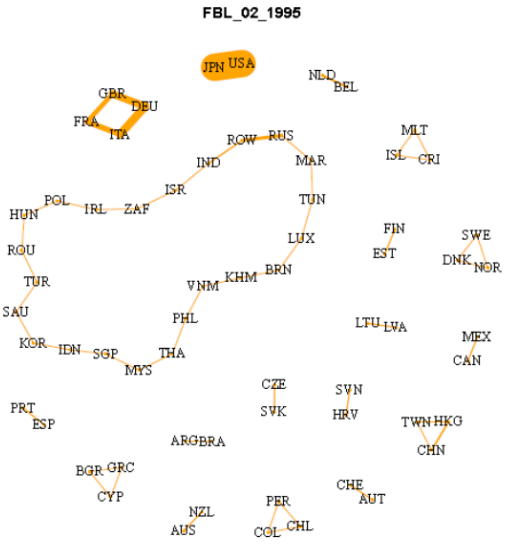
Figure 1
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

Feedback Loop 1



Feedback Loop 2, 1995

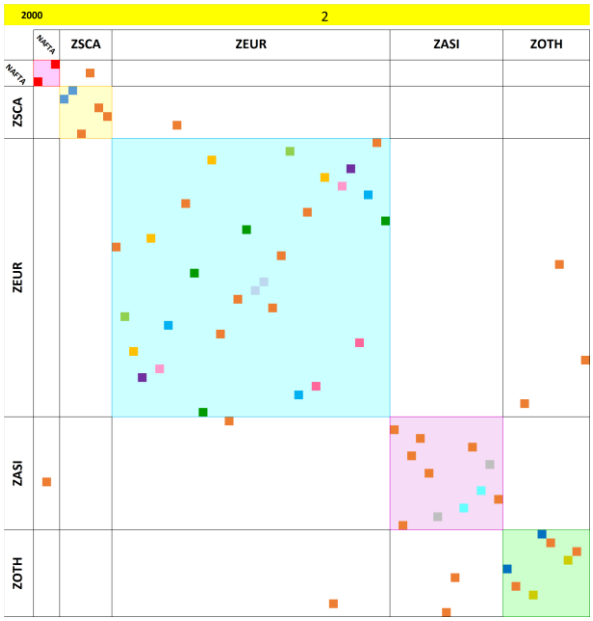


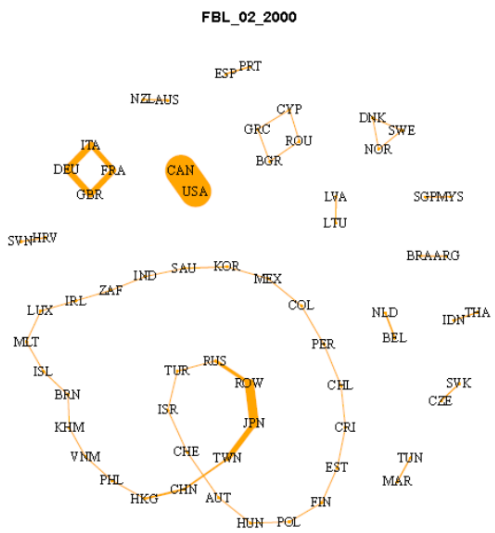


Continue …

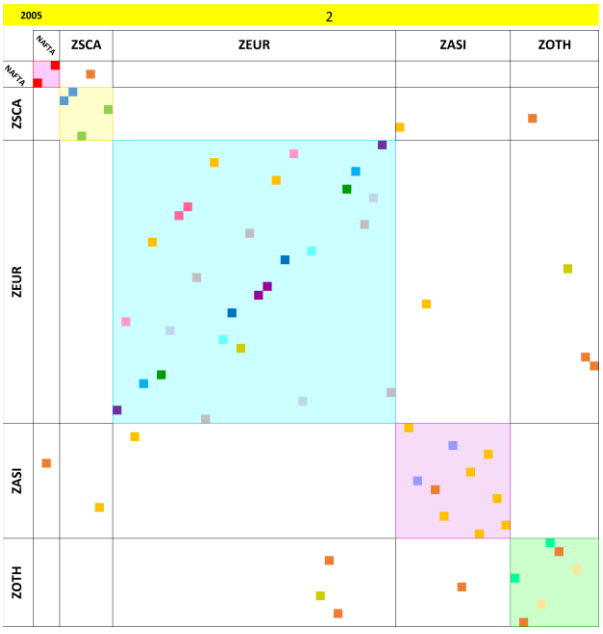
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

Feedback Loop 2, 2000





Feedback Loop 2, 2005



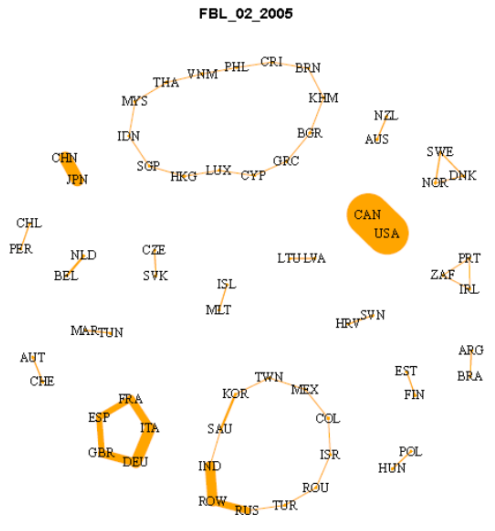


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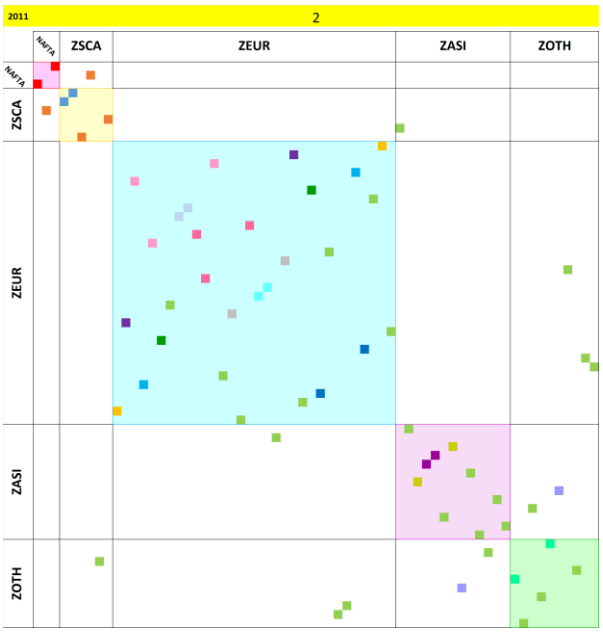
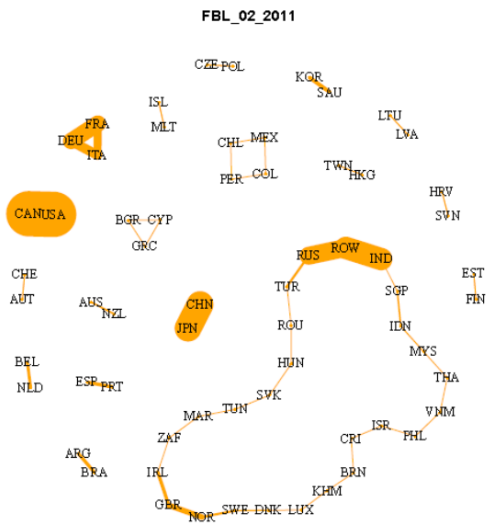
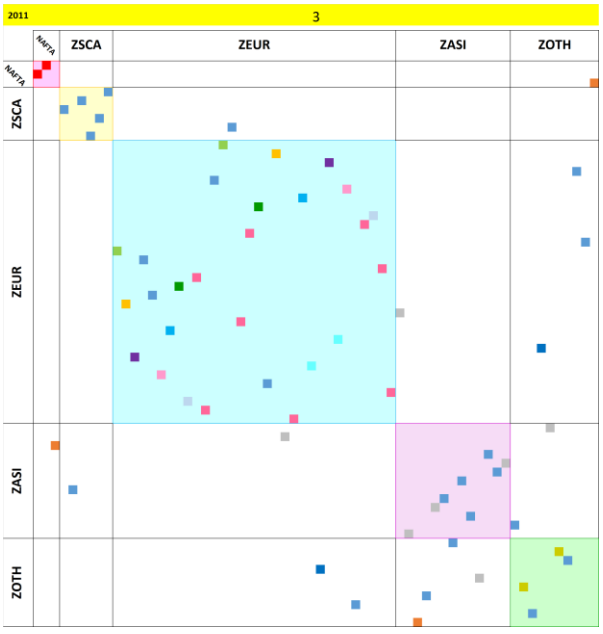
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

Feedback Loop 2, 2011





Feedback Loop 3, 2011



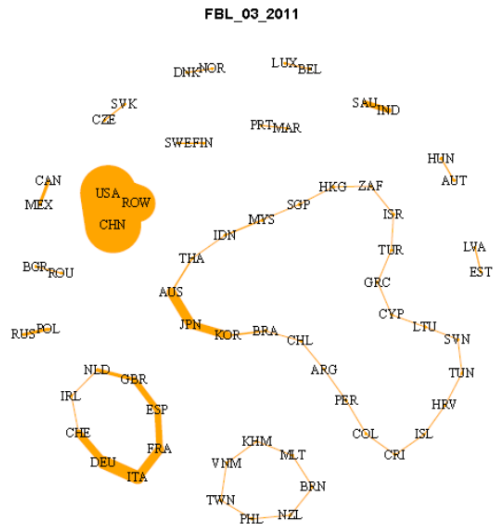


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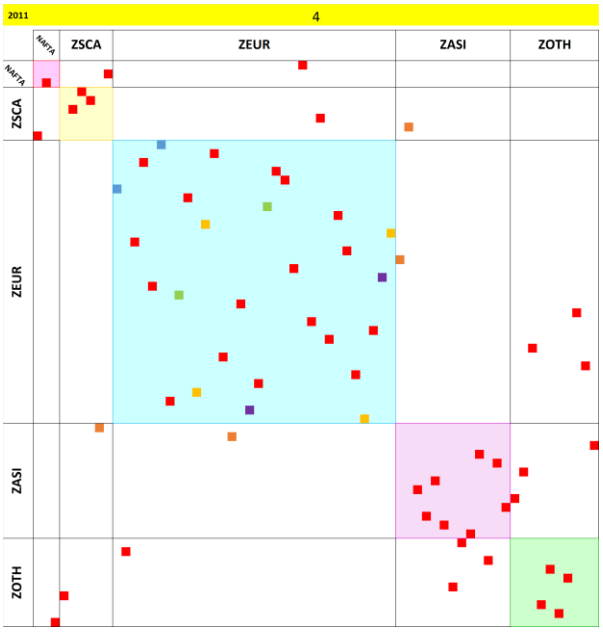
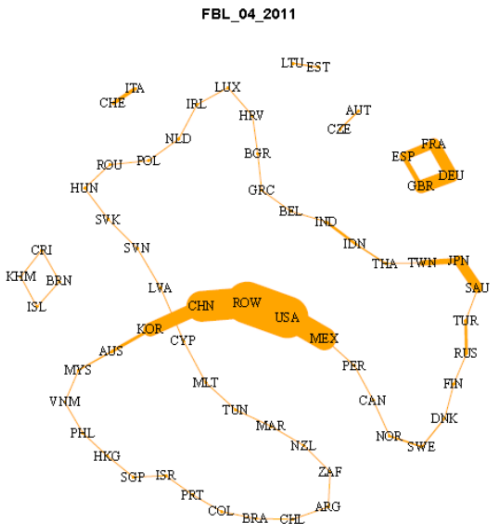
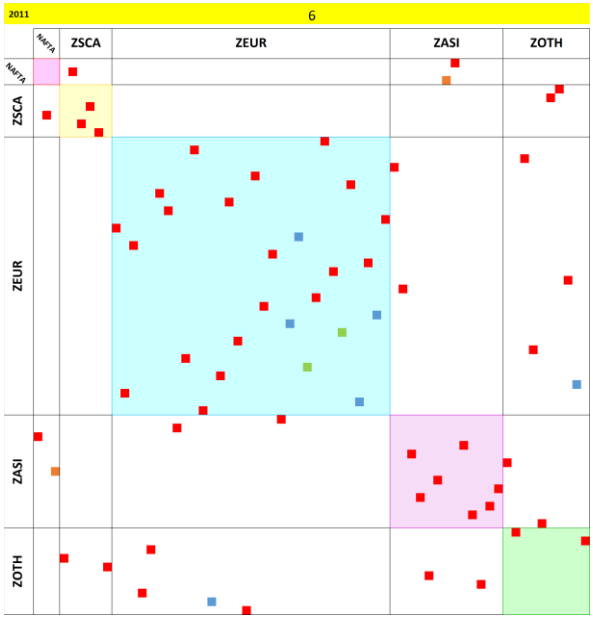
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

Feedback Loop 4, 2011





Feedback Loop 6, 2011



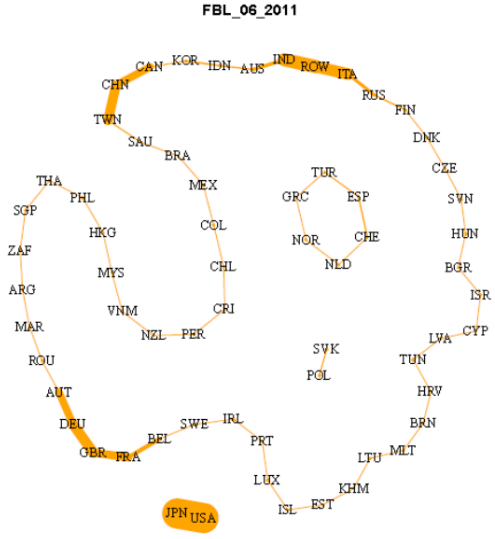


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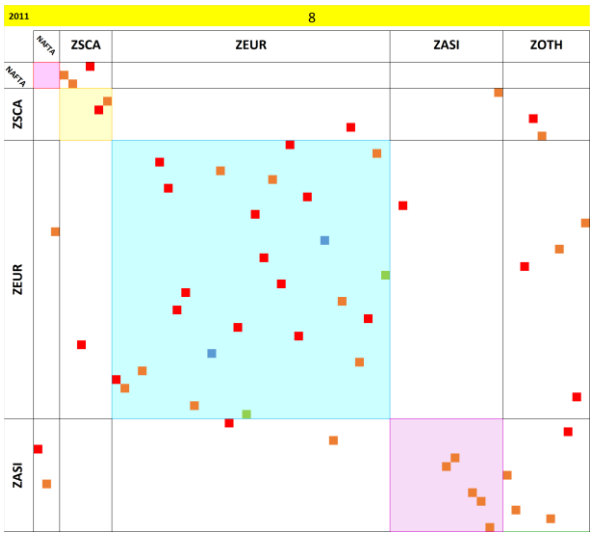
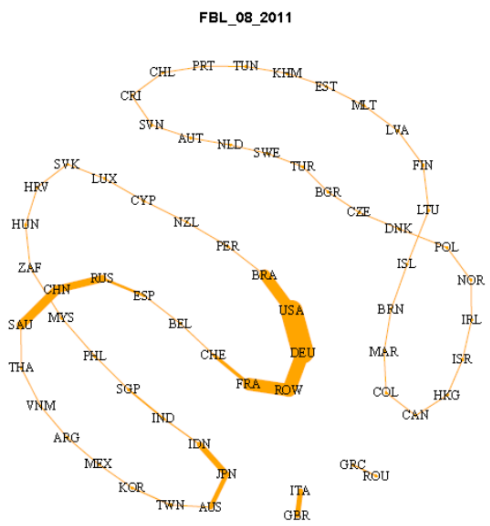
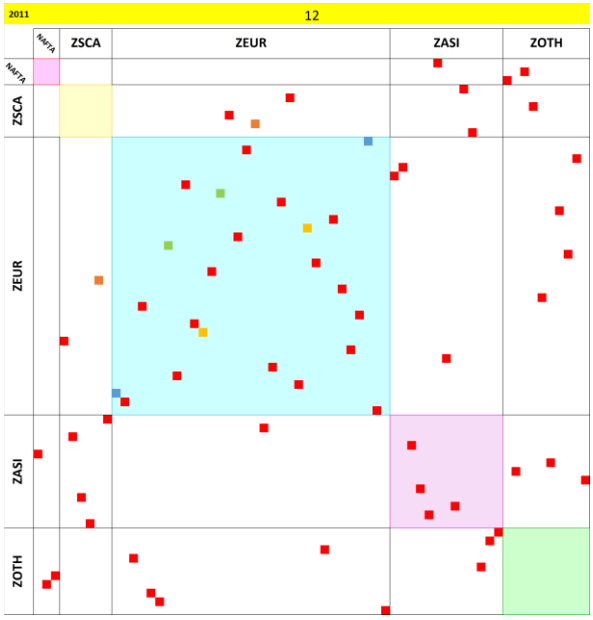
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

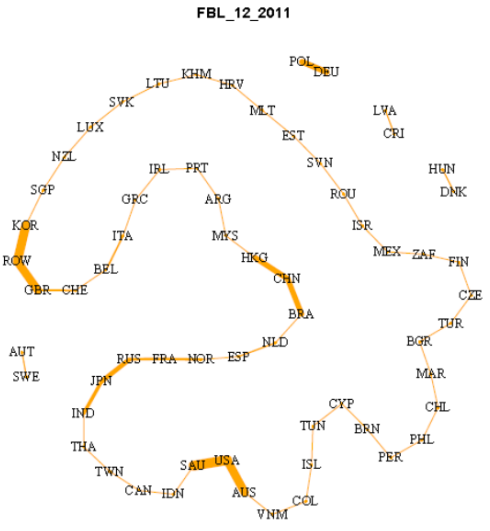
Feedback Loop 8, 2011





Feedback Loop 12, 2011

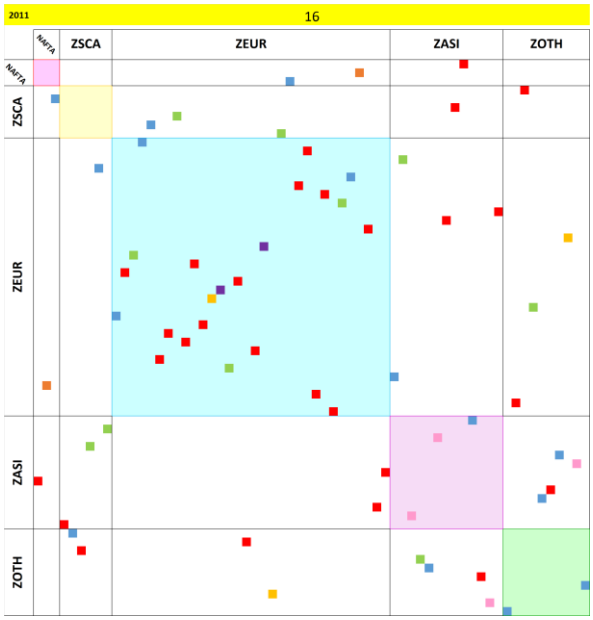


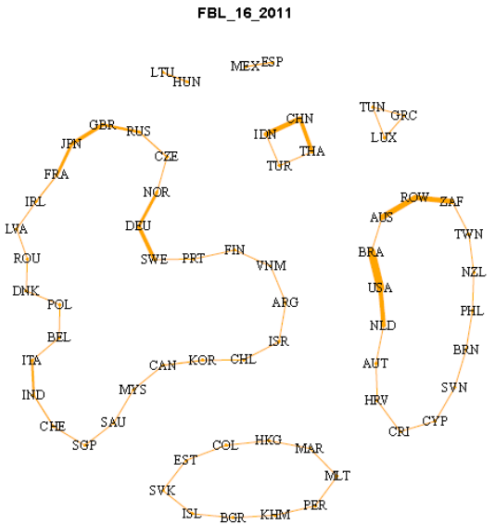


Continue …

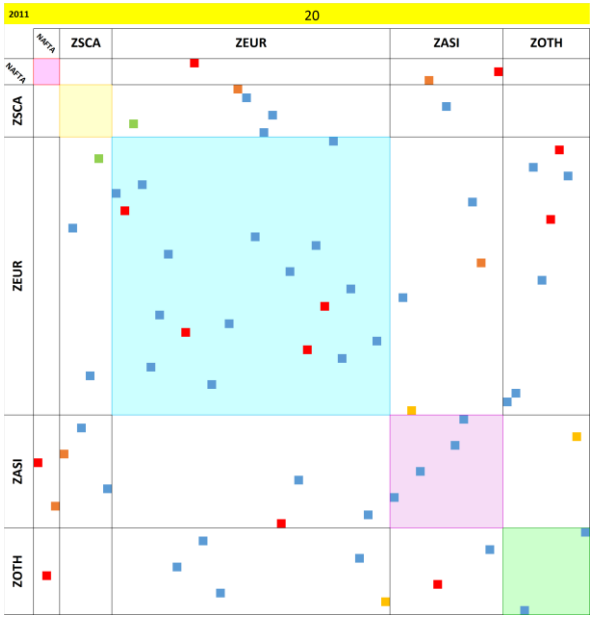
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

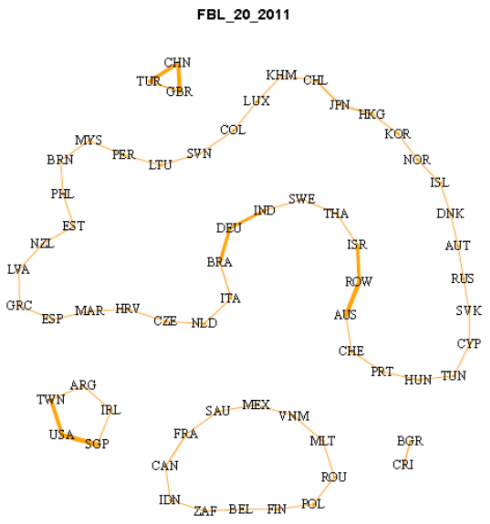
Feedback Loop 16, 2011





Feedback Loop 20, 2011

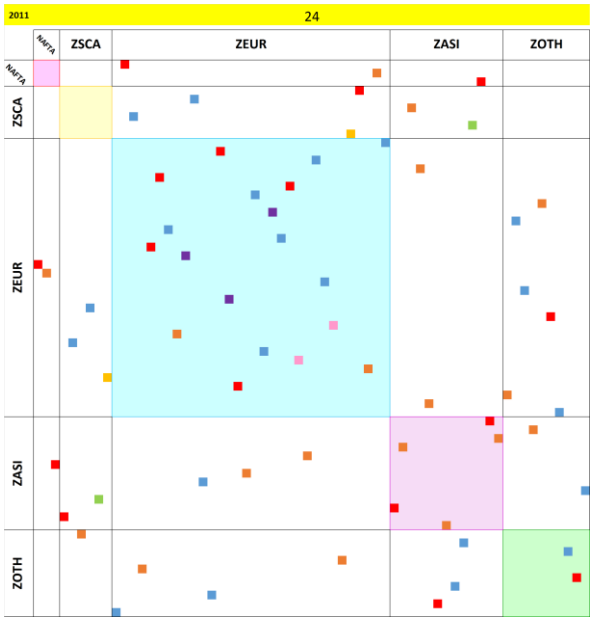


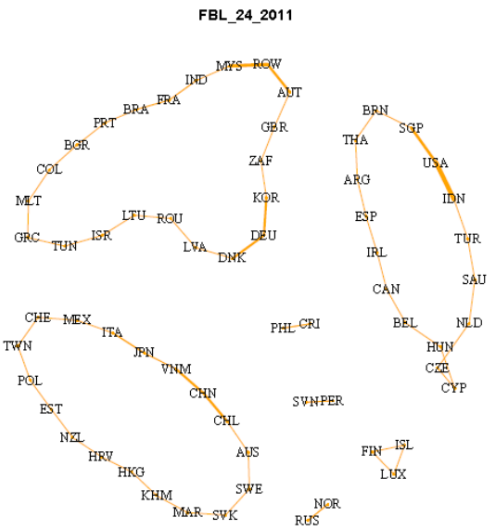


Continue …

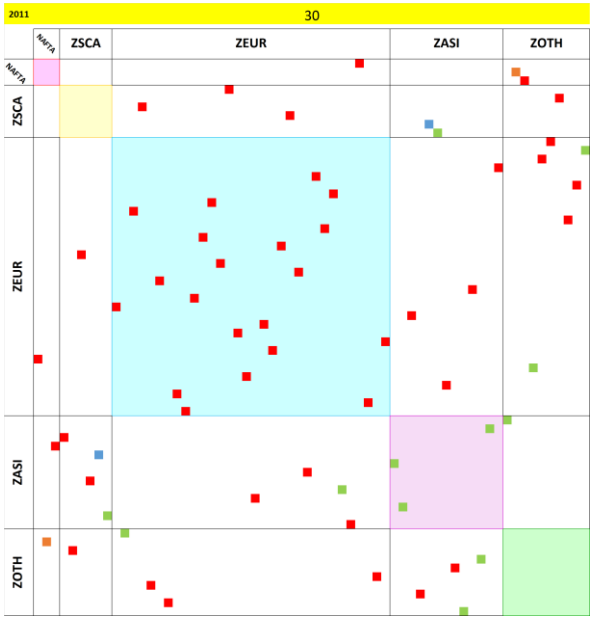
Figure 1 (Continued)
Decomposition of Supply Chain's Value Added Flows into Feedback Loops: Networking of Main Trading Partners, Selected Feedback Loops and Years

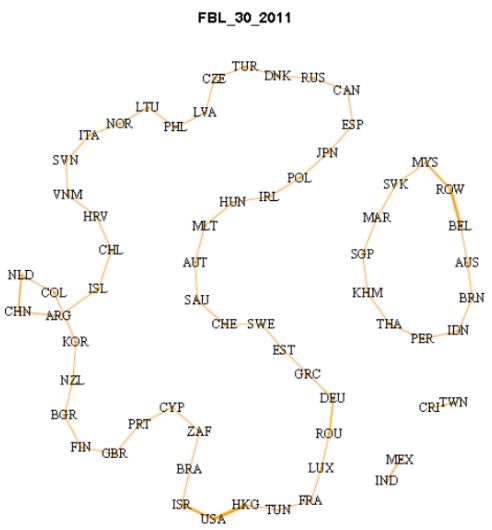
Feedback Loop 24, 2011





Feedback Loop 30, 2011





Source: Research data based on OECD´s ICIO.

The focus of our analysis is now directed to the feedback loops 2 to 6 and their evolution from 1995 to 2001 as presented in Tables 4 to 8 and Figures 2 to 6. In Tables 4 to 8 the main subloops are presented with the main economies highlighted in red and the arrows indicating how they changed the main trade partners throughout the years. The complete set of countries networking for each feedback loop and year considered here is presented in Figures 2 to 6, with the thicker lines representing the greatest TiVA among the countries.

In all of the feedback loops 2 to 6 it is possible to observe that the countries usually change their main patterns through time, indicating a dynamic in the international where the countries would change they network of main partners as a way to obtain the most of benefits and gains that they can get from the international trade. In such a way, in the feedback loop 2 the main partner of Japan in 1995 is the USA and in 2005 and 2011 is China, while in 2000 Japan is part with a large network of countries; for the USA, in 2000, 2005 and 2010 the main partner is this feedback loop is Canada; in Europe, the main trade partners in 1995 and 2000 are France, United Kingdom, Germany and Italy, in 2005 Spain is added to this group and in 2011 this group comprises only Germany, France and Italy with the United Kingdom joining a large network of countries, and Spain making a pairwise with Portugal as it did in 1995 and 2005. A close look at Figure 2 can revealed the main network of countries and usually inside their on region, as defined in this paper.

As one goes down in the feedback loops 3 to 6 it is possible to observe the countries being more integrated in the world trade, with less pairwise subloops.

In summary, the top feedback loops reveal a spatial structure for the global supply chains networks where the flows linking major economies across trade blocks are becoming dominant. Together with the results for supply chain interdependency for individual countries, obtained in subsection 3.1, we observe that production fragmentation has truly become global, and not merely circumscribed to trade blocks.

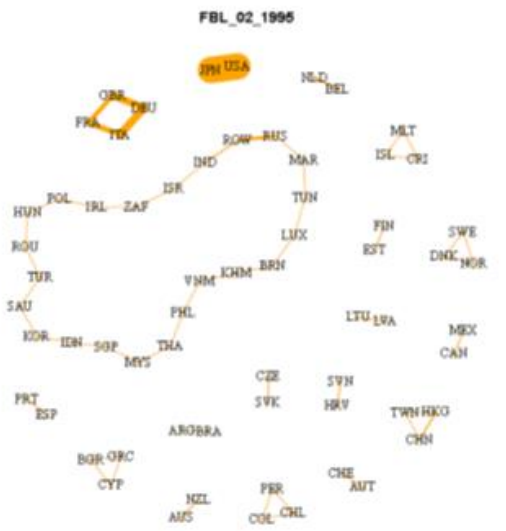
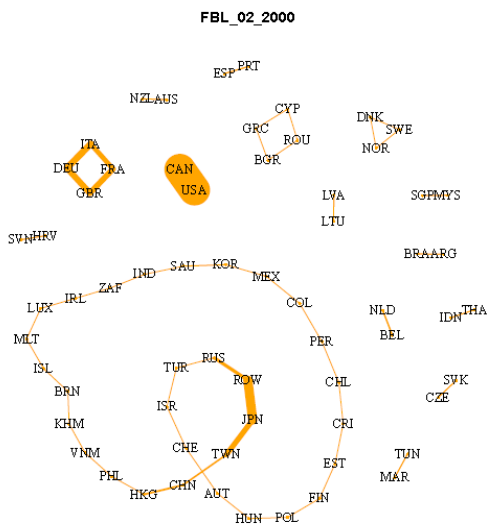
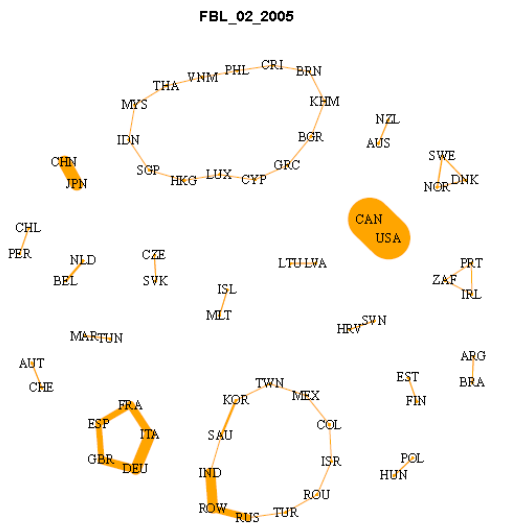
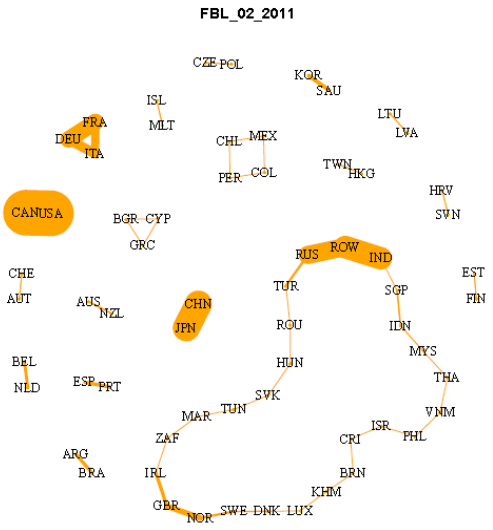
Table 4
2nd Feedback Loop in Value Added for 1995, 2000, 2005 and 2011
Main Countries and Networking of Trading Partners – US$ Million (Current Values)

Feedback Loops 2 1995		Feedback Loops 2 2000		Feedback Loops 2 2005	
(USA,JPN)	227,763	(CAN,USA)	258,652	(CAN,USA)	349,671
(CAN,MEX)	4,356	(MEX,CHL,COL,CRI,PER,AUT,EST,FIN,HUN,ISL, IRL,LUX,MLT,POL,RUS,CHE,BRN,KHM,CHN, HKG,TWN,JPN,KOR,PHL,VNM,IND,ISR,SAU, ZAF,TUR,ROW)	130,975	(MEX,COL,ROU,RUS,TWN,KOR,IND,ISR,SAU, TUR,ROW)	117,103
(CHN,HKG,TWN)	16,972			(CHN,JPN)	122,995
(HUN,IRL,LUX,POL,ROU,RUS,BRN,KHM,IDN, KOR,MYS,PHL,SGP,THA,VNM,IND,ISR,MAR, SAU,ZAF, TUN,TUR,ROW)	42,802				
(FRA,DEU,ITA,GBR)	123,678	(FRA,DEU,ITA,GBR)	116,795	(FRA,DEU,ITA,ESP,GBR)	196,875
(ARG,BRA)	7,491	(ARG,BRA)	9,227	(ARG,BRA)	4,165
Total	**423,064**	**Total**	**515,649**	**Total**	**790,808**
Share	**89%**	**Share**	**91%**	**Share**	**90%**

Feedback Loops 2 2005		Feedback Loops 2 2011	
(CAN,USA)	349,671	(CAN,USA)	411,494
(MEX,COL,ROU,RUS,TWN,KOR,IND,ISR,SAU, TUR,ROW)	117,103	(MEX,CHL,COL,PER)	8,155
(CHN,JPN)	122,995	(CHN,JPN)	264,777
		(CRI,DNK,HUN,IRL,LUX,NOR,ROU,RUS,SVK, SWE,GBR,BRN,KHM,IDN,MYS,PHL,SGP,THA, VNM,IND,ISR,MAR,ZAF,TUN,TUR,ROW)	316,769
(FRA,DEU,ITA,ESP,GBR)	196,875	(FRA,DEU,ITA)	170,875
(ARG,BRA)	4,165	(ARG,BRA)	29,036
		(KOR,SAU)	27,611
Total	**790,808**	**Total**	**1,228,717**
Share	**90%**	**Share**	**92%**

Source: Research data based on OECD´s ICIO.

Figure 2
2nd Feedback Loop in Value Added, Networking of Main Trading Partners: 1995, 2000, 2005 and 2011

Feedback loop 2, 1995	Feedback loop 2, 2000
	
Feedback loop 2, 2005	**Feedback loop 2, 2011**
	

Source: Research data based on OECD´s ICIO.

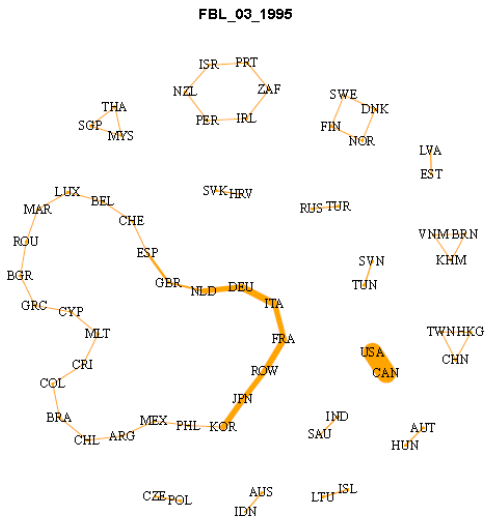
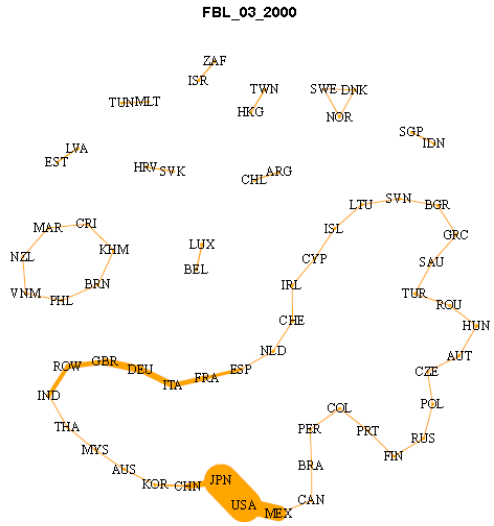
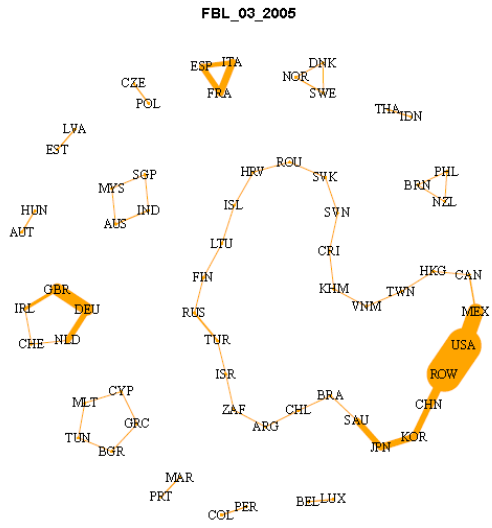
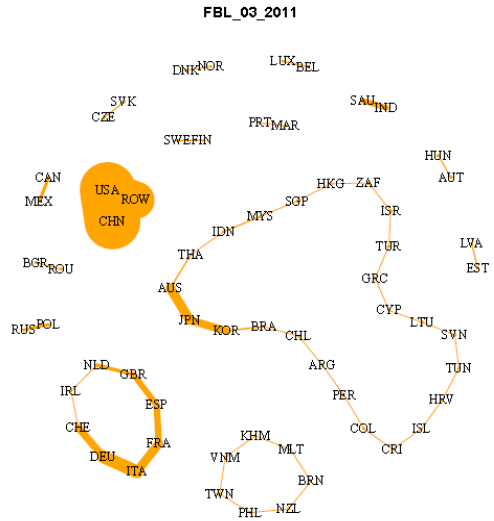
Table 5
3rd Feedback Loop in Value Added for 1995, 2000, 2005 and 2011
Main Countries and Networking of Trading Partners – US$ Million (Current Values)

Feedback Loops 3 1995		Feedback Loops 3 2000		Feedback Loops 3 2005	
(CAN,USA)	172,459				
(MEX,ARG,BRA,CHL,COL,CRI,BEL,BGR,CYP, FRA,DEU,GRC,ITA,LUX,MLT,NLD,ROU,ESP, CHE,GBR, JPN,KOR,PHL,MAR,ROW)	207,461	(CAN,MEX,USA,BRA,COL,PER,AUT,BGR,CYP, CZE,FIN,FRA,DEU,GRC,HUN,ISL,IRL,ITA,LTU, NLD,POL,PRT,ROU,RUS,SVN,ESP,CHE,GBR, CHN,JPN,KOR,MYS,THA,AUS,IND,SAU, TUR,ROW)	480,453	(CAN,MEX,USA,ARG,BRA,CHL,CRI,HRV,FIN, ISL,LTU,ROU,RUS,SVK,SVN,KHM,CHN,HKG, TWN,JPN, KOR,VNM,ISR,SAU,ZAF,TUR,ROW)	425,801
(CHN,HKG,TWN)	11,313			(FRA,ITA,ESP)	87,638
(IND,SAU)	2,151			(DEU,IRL,NLD,CHE,GBR)	109,734
(RUS,TUR)	5,033			(MYS,SGP,AUS,IND)	14,605
Total	**398,417**	**Total**	**480,453**	**Total**	**637,778**
Share	**94%**	**Share**	**95%**	**Share**	**95%**

Feedback Loops 3 2005		Feedback Loops 3 2011	
		(CAN,MEX)	26,250
(CAN,MEX,USA,ARG,BRA,CHL,CRI,HRV,FIN, ISL,LTU,ROU,RUS,SVK,SVN,KHM,CHN,HKG, TWN,JPN, KOR,VNM,ISR,SAU,ZAF,TUR,ROW)	425,801	(ARG,BRA,CHL,COL,CRI,PER,HRV,CYP,GRC,ISL, LTU,SVN,HKG,IDN,JPN,KOR,MYS,SGP,THA, AUS, ISR,ZAF,TUN,TUR)	137,137
(FRA,ITA,ESP)	87,638	(USA,CHN,ROW)	604,664
(DEU,IRL,NLD,CHE,GBR)	109,734	(FRA,DEU,IRL,ITA,NLD,ESP,CHE,GBR)	233,969
(MYS,SGP,AUS,IND)	14,605	(POL,RUS)	22,148
		(IND,SAU)	34,758
Total	**637,778**	**Total**	**1,058,925**
Share	**95%**	**Share**	**96%**

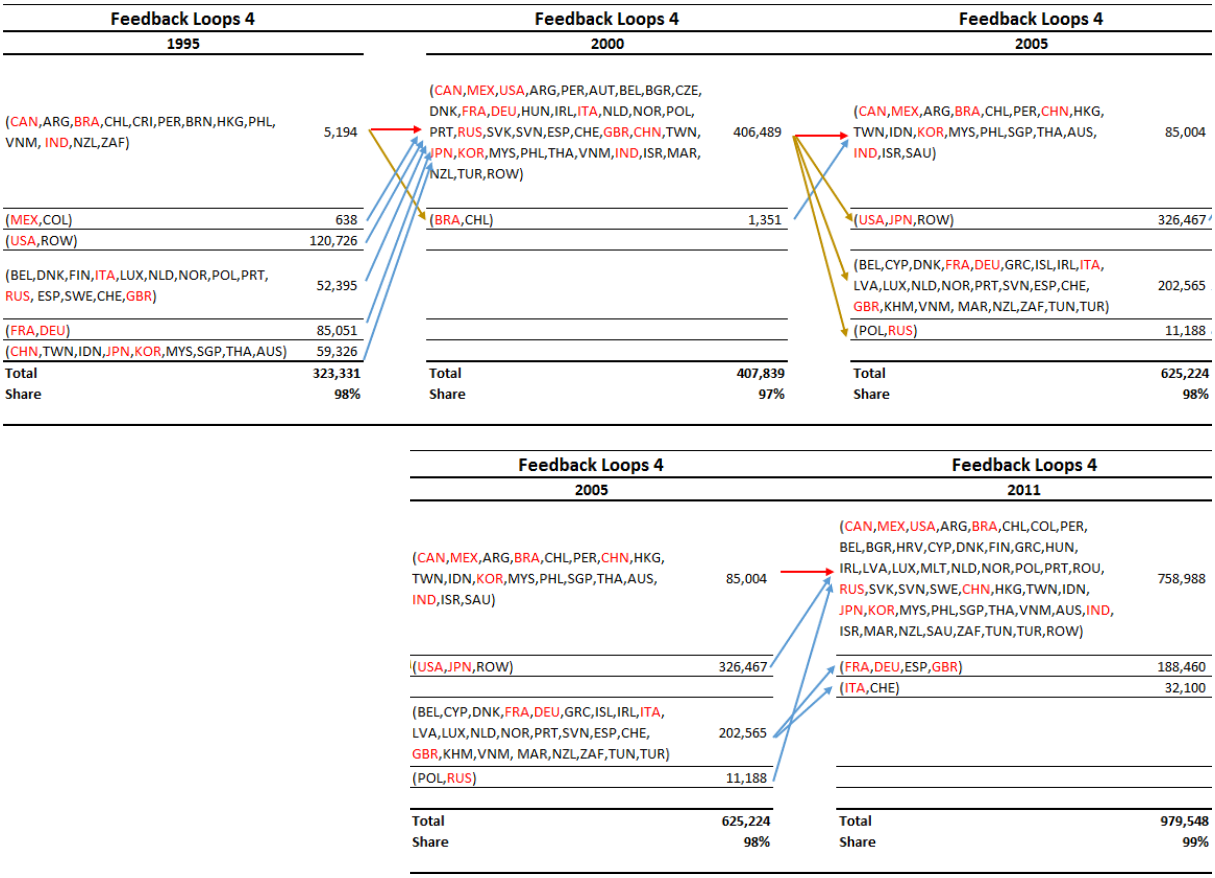
Source: Research data based on OECD´s ICIO.

Figure 3
3rd Feedback Loop in Value Added, Networking of Main Trading Partners: 1995, 2000, 2005 and 2011

Feedback loop 3, 1995	Feedback loop 3, 2000
	
Feedback loop 3, 2005	**Feedback loop 3, 2011**
	

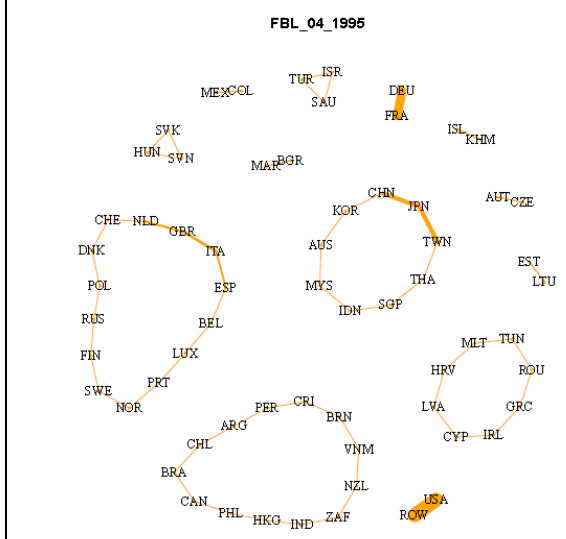
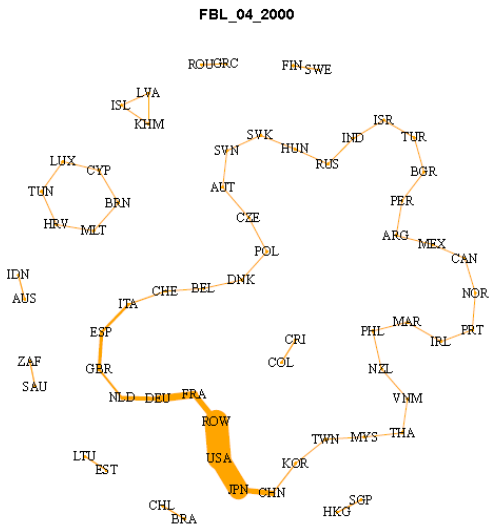
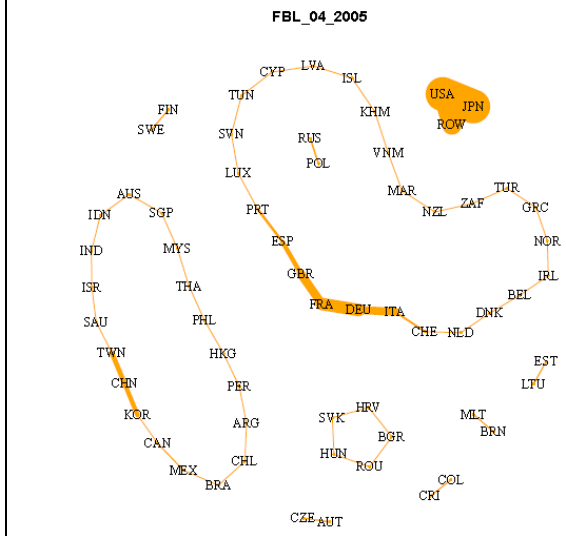
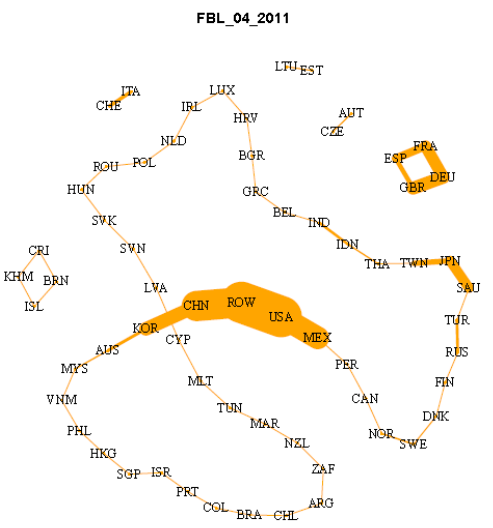
Source: Research data based on OECD´s ICIO.

Table 6
4th Feedback Loop in Value Added for 1995, 2000, 2005 and 2011
Main Countries and Networking of Trading Partners – US$ Million (Current Values)



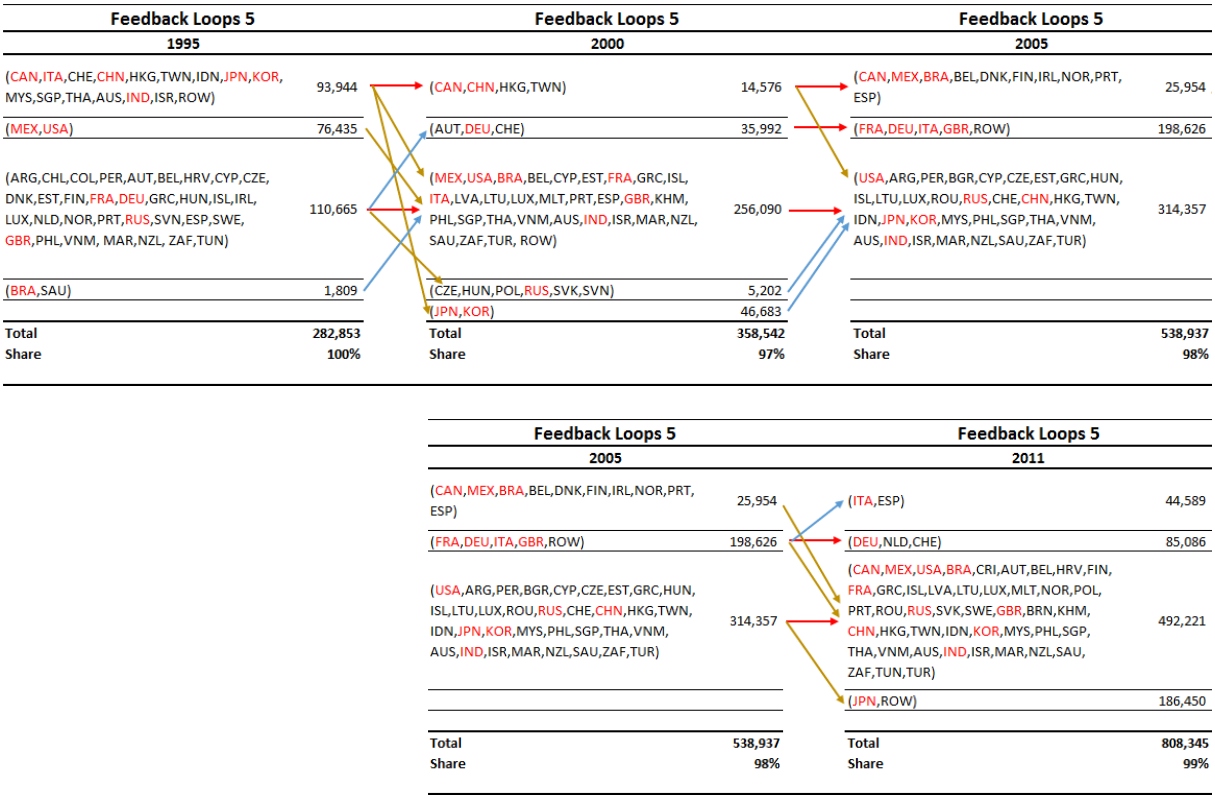
Source: Research data based on OECD´s ICIO.

Figure 4
4th Feedback Loop in Value Added, Networking of Main Trading Partners: 1995, 2000, 2005 and 2011

Feedback loop 4, 1995	Feedback loop 4, 2000
	
Feedback loop 4, 2005	**Feedback loop 4, 2011**
	

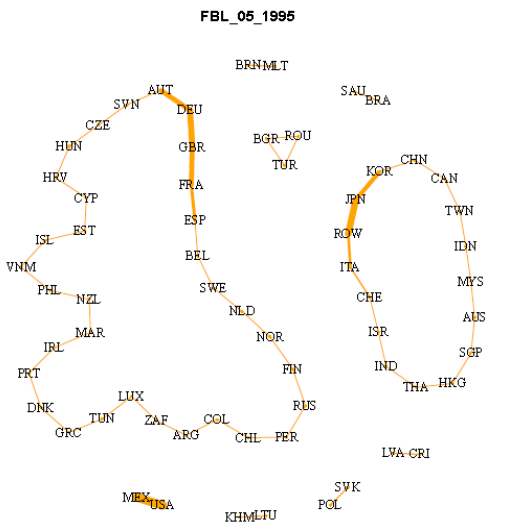
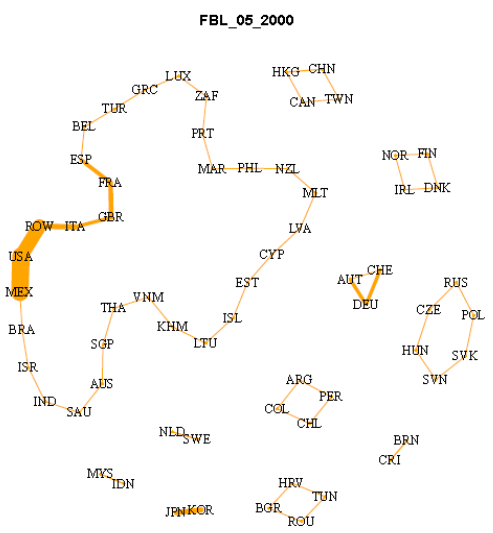
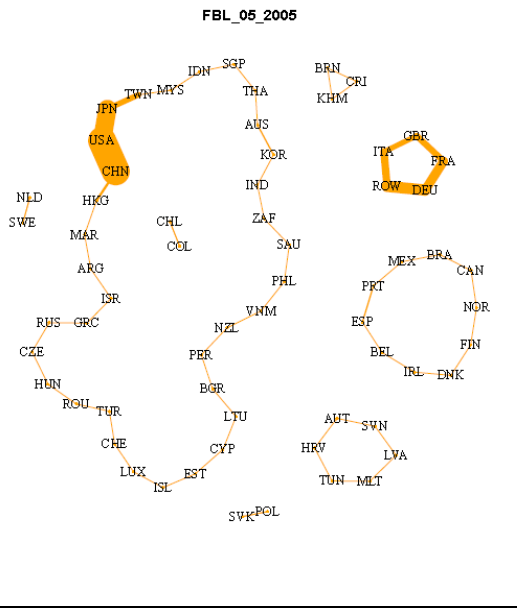
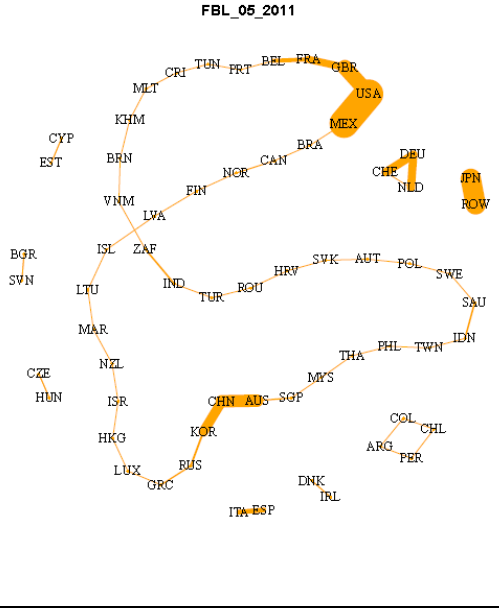
Source: Research data based on OECD´s ICIO.

Table 7
5th Feedback Loop in Value Added for 1995, 2000, 2005 and 2011
Main Countries and Networking of Trading Partners – US$ Million (Current Values)



Source: Research data based on OECD´s ICIO.

Figure 5
5th Feedback Loop in Value Added, Networking of Main Trading Partners: 1995, 2000, 2005 and 2011

Feedback loop 5, 1995	Feedback loop 5, 2000
	
Feedback loop 5, 2005	**Feedback loop 5, 2011**
	

Source: Research data based on OECD´s ICIO.

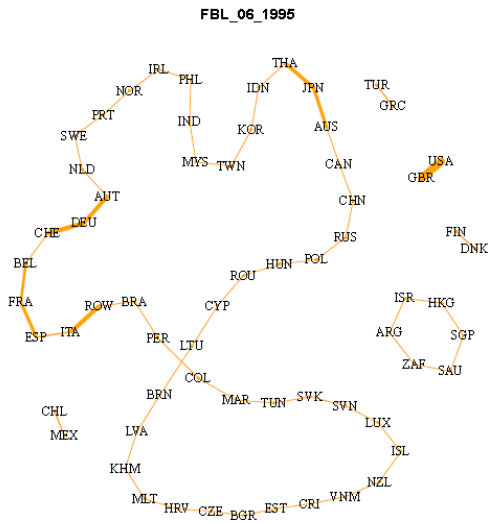
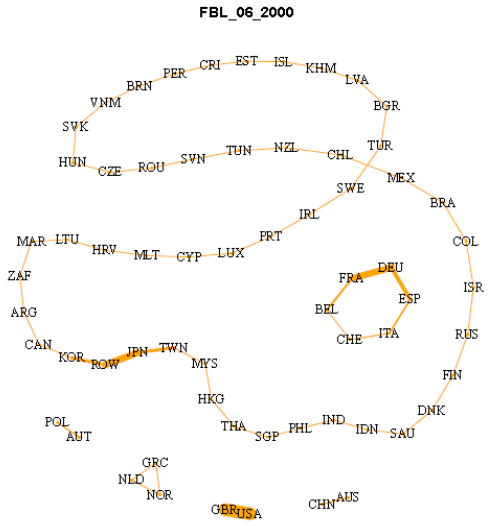
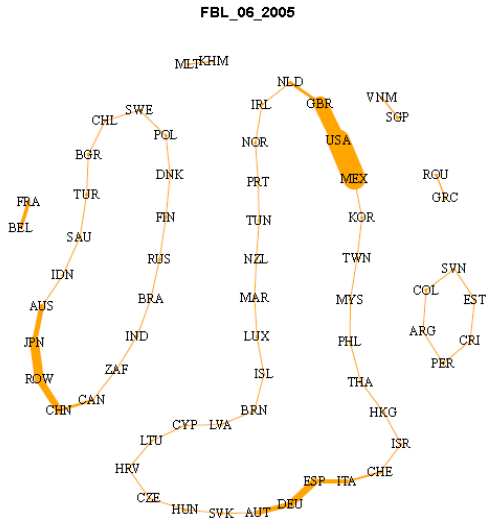
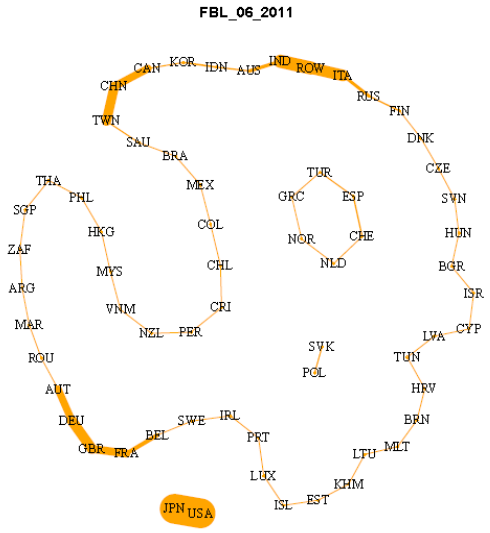
Table 8
6th Feedback Loop in Value Added for 1995, 2000, 2005 and 2011
Main Countries and Networking of Trading Partners – US$ Million (Current Values)

Feedback Loops 6		Feedback Loops 6		Feedback Loops 6	
1995		2000		2005	
(CAN,BRA,COL,CRI,PER,AUT,BEL,BGR,HRV, CYP,CZE,EST,FRA,DEU,HUN,ISL,IRL,ITA,LVA, LTU,LUX,MLT,NLD,NOR,POL,PRT,ROU,RUS, SVK,SVN,ESP,SWE,CHE,BRN,KHM,CHN, TWN,IDN,JPN,KOR,MYS,PHL,THA,VNM,AUS, IND,MAR,NZL,TUN, ROW)	164,934	(CAN,MEX,ARG,BRA,CHL,COL,CRI,PER,BGR, HRV,CYP,CZE,DNK,EST,FIN,HUN,ISL,IRL,LVA, LTU,LUX,MLT,PRT,ROU,RUS,SVK,SVN,SWE, BRN,KHM,HKG,TWN,IDN,JPN,KOR,MYS,PHL, SGP,THA,VNM,IND,ISR,MAR,NZL,SAU,ZAF, TUN,TUR,ROW)	84,900	(MEX,USA,AUT,HRV,CYP,CZE,DEU,HUN,ISL, IRL,ITA,LVA,LTU,LUX,NLD,NOR,PRT,SVK,ESP, CHE,GBR,BRN,HKG,TWN,KOR,MYS,PHL,THA, ISR,MAR,NZL,TUN)	303,071
(MEX,CHL)	597	(BEL,FRA,DEU,ITA,ESP,CHE)	79,360	(CAN,BRA,CHL,BGR,DNK,FIN,POL,RUS,SWE, CHN,IDN,JPN,AUS,IND,SAU,ZAF,TUR,ROW)	145,112
(USA,GBR)	74,957	(USA,GBR)	124,153	(BEL,FRA)	31,179
		(CHN,AUS)	6,916		
Total	**240,489**	**Total**	**295,329**	**Total**	**479,363**
Share	**98%**	**Share**	**98%**	**Share**	**99%**

Feedback Loops 6		Feedback Loops 6	
2005		2011	
(MEX,USA,AUT,HRV,CYP,CZE,DEU,HUN,ISL, IRL,ITA,LVA,LTU,LUX,NLD,NOR,PRT,SVK,ESP, CHE,GBR,BRN,HKG,TWN,KOR,MYS,PHL,THA, ISR,MAR,NZL,TUN)	303,071	(CAN,MEX,ARG,BRA,CHL,COL,CRI,PER,AUT, BEL,BGR,HRV,CYP,CZE,DNK,EST,FIN,FRA,DEU, HUN,ISL,IRL,ITA,LVA,LTU,LUX,MLT,PRT,ROU, RUS,SVN,SWE,GBR,BRN,KHM,CHN,HKG,TWN, IDN,KOR,MYS,PHL,SGP,THA,VNM,AUS,IND, ISR,MAR, NZL,SAU,ZAF,TUN,ROW)	460,704
(CAN,BRA,CHL,BGR,DNK,FIN,POL,RUS,SWE, CHN,IDN,JPN,AUS,IND,SAU,ZAF,TUR,ROW)	145,112	(USA,JPN)	261,511
(BEL,FRA)	31,179		
Total	**479,363**	**Total**	**722,214**
Share	**99%**	**Share**	**96%**

Source: Research data based on OECD´s ICIO.

Figure 6
6th Feedback Loop in Value Added, Networking of Main Trading Partners: 1995, 2000, 2005 and 2011

Feedback loop 6, 1995	Feedback loop 6, 2000
	
Feedback loop 6, 2005	**Feedback loop 6, 2011**
	

Source: Research data based on OECD´s ICIO.

4. Concluding remarks

In this paper, to study the geographical structure of TiVA, in the GVC, necessary to supply the domestic final demand of the countries, from 1995 to 2011, we applied the hierarchical feedback loop methodology. In contrast to other studies that employed this methodology previously, we considered the regional interdependencies as depicted in OECD´s ICIO tables, taking into account value-added flows, rather than inter-regional gross trade.

The results overall show the increase importance of the FVA to attend the domestic demand needs of the countries, which is accompanied by a fragmentation of the production processes and the supply chains networks linking major economies across trade blocks becoming dominant.

It was also possible to trace the networking of trade among the countries with the identification of the main trade partners and how this partnership changed through time.

Despite the light that this study throws on the structure of the international trade, it raises other important questions not considered here and where the feedback loops methodology can be applied, like: a) what is the networking structure of the international trade from the production side; b) is the interconnection among the countries when producing goods and services to the domestic market the same as when producing to the international market; c) what is the role of commodities, industrial goods and services in the international trade, does the overall conclusion of this paper applies to these different markets?

5. References

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Annex I
Regions and Countries in the ICIO Model

Region	Country Abrev.	Country Name
NAFTA	CAN	Canada
	MEX	Mexico
	USA	United States
ZSCA	ARG	Argentina
	BRA	Brazil
	CHL	Chile
	COL	Colombia
	CRI	Costa Rica
	PER	Peru
ZEUR	AUT	Austria
	BEL	Belgium
	BGR	Bulgaria
	HRV	Croatia
	CYP	Cyprus
	CZE	Czech Republic
	DNK	Denmark
	EST	Estonia
	FIN	Finland
	FRA	France
	DEU	Germany
	GRC	Greece
	HUN	Hungary
	ISL	Iceland
	IRL	Ireland
	ITA	Italy
	LVA	Latvia
	LTU	Lithuania
	LUX	Luxembourg
	MLT	Malta
	NLD	Netherlands
	NOR	Norway
	POL	Poland
	PRT	Portugal
	ROU	Romania
	RUS	Russia
	SVK	Slovak Republic
	SVN	Slovenia
	ESP	Spain
	SWE	Sweden
	CHE	Switzerland
	GBR	United Kingdom

Region	Country Abrev.	Country Name
ZASI	BRN	Brunei Darussalam
	KHM	Cambodia
	CHN	China (People's Republic of)
	HKG	Hong Kong (China)
	TWN	Chinese Taipei
	IDN	Indonesia
	JPN	Japan
	KOR	Korea
	MYS	Malaysia
	PHL	Philippines
	SGP	Singapore
	THA	Thailand
	VNM	Viet Nam
ZOTH	AUS	Australia
	IND	India
	ISR	Israel
	MAR	Morocco
	NZL	New Zealand
	SAU	Saudi Arabia
	ZAF	South Africa
	TUN	Tunisia
	TUR	Turkey
	ROW	Rest of the World

Note:

NAFTA: North American Free Trade Association

ZSCA: South and Central America

ZEUR: Europe

ZASI: East and South East Asia

ZOTH: Other regions