Fiscal Shocks and International Production Networks: An Empirical Investigation

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Abstract

Recently, a large literature has been developed from the production network models, to be applied in a diversity of fields as financial contagion, trade co-movements or the aggregation of micro shocks. Thus, one theoretical implication introduced by Acemoglu et al. (2015), argue that demand-side shocks (i.e. government spending) spread through the production networks following upstream propagation with greater intensity downstream. This paper empirically evaluates the international transmission of government purchase shocks through a production network. Using industry-level data about international input-output linkages, I extend the empirical approach in Acemoglu et al. (2015) to examine employment responses to government purchases. I find that fiscal shocks have a significant and positive impact on the employment, through the international production network.

Keywords: network; upstream; input-output; global; fiscal spillovers

1 Introduction

Since the recent financial crisis the interest on fiscal policy has increased. Indeed, the effects of fiscal shocks across borders of very connected countries, as the Eurozone, have been the main topic of growing literature (e.g., Hebous and Zimmerman (2012) and (2013), Auerbach and Gorodnichenko(2016), Bicu and Lieb (2015)). While the majority of papers based their analysis in the classical real business cycle and neo keynesian approaches, no author use the production network approach as a mechanism to accounting fiscal spillovers[1]. In the present paper I want to collaborate with the literature on inter- national fiscal spillovers, estimating the effect of the fiscal shock on the employment from the production network approach.

One of the advantages of these promising network-based approaches is their ease in proposing empirically, in contrast the approaches RBC or NK require an adequate identification of the structural fiscal shock, which often remain highly debatable (Perotti (2007)).

The increase in the international trade has been created strong linkages between sectors in different countries. These global value chains constitute a relevant entity where the transmission of shocks is studied (Bicu and Lieb (2016)). For instance, in 2011, the basic metal and fabricated metal industries underpinned the bulk of Chinese demand for Australian intermediate exports. So, fiscal shocks in one country could affect not only this particular sector, but also, sectors in the global manufacturing network. Furthermore, fluctuations in foreign orders can quickly lead to changes in domestic production.

Production network model is a relevant framework to understand the transmission across sectors-countries. Acemoglu et al. (2015), shows that inside the US economy, different kind of shocks had significant indirect effects. Also, the propagation follows an upstream spread for demand-side shocks and downstream propagation for supply-side shocks.

[1] Devereux, Gente and Yu, have a contemporary work in progress titled "Production Networks and International Fiscal Spillovers"

The rest of the work is divided into 6 sections. The second section develops the theory of the input link model, here I will present the baseline model developed by Acemoglu et al. (2015) and then the extension to a multinational scheme following Johnson (2014) and Duval et al. (2016). In section 3, I describe the data and show some precisions with respect to the periods analyzed. Section 4 refers to the econometric model and estimation methods, presented here the base model and the different specifications that include the model that distinguishes between the national and foreign component of the network effects, also briefly describes the clustering methodology . While in section 5 I will show the results. Finally, section 6 includes the conclusions.

2 Theory

This section presents the inter-country production network model and their network-based propagation channels. In particular, I proceed from the static version of Johnson (2014), then derive different propagation functions for each type of shock (demand side and supply side), following the methodology developed by Acemoglu et al. (2015). In order to keep intuition simple, I first show the derivation of the propagation channels in a three-sector model and then extend this implication to a multi-sector, multi-country model.

2.1 Simple input-linkages model and propagation channels

I consider the model developed by Acemoglu et al. (2015) from the seminal work of Long and Plosser (1983). In the model, we have a competitive economy that include n sectors all them with a Cobb-Douglas[2] production function:

$$q_i = e^{z_i} l_i^{\theta_i} \prod_{j=1}^{n} x_{ji}^{\omega_{ji}} \tag{1}$$

Where x_{ji} is the product of sector j used as input by sector i, l_i is labor, and z_i is a specific-sector productivity shock. Also, the model assumes constant returns to scale in each sector:

$$\theta_i + \sum_{j=1}^{n} \omega_{ji} = 1$$

[2]Although the results are easy to extract assuming Cobb-Douglas technologies and preference, recent works show that qualitative implications is maintained using non-Cobb-Douglas functions (see Acemoglu, Ozdaglar and Thabaz-Salehi (2015))

The preference function of the households is given by:

$$u(c_i, l) = \gamma(l) \prod_{i=1}^{n} c_i^{\beta_i}, \tag{2}$$

Where c_i is the final consumption of good produced by sector i, β_i designates the weight of good i in the preferences, and $\gamma(l)$ is a decreasing function that captures the disutility of labor supply.

For its part, the clearing condition of output establishes that production in each sector is used as input in other sectors, or consumed as final good by households or the government.

$$q_i = c_i + \sum_{j=1}^{n} x_{ij} + G_i, \tag{3}$$

Where G_i denotes government purchases of good i.

To finance its purchases, the government impose a lump-sum tax, T. This implies $T = \sum_{i=1}^{n} p_i G_i$, where p_i is the price of good i. If the household incomes come only of labor (wl), the household budget constraint is given by:

$$\sum_{i=1}^{n} p_i c_i = wl - T. \tag{4}$$

Then the competitive solution is solve in the usual fashion. Now I will use the main results of downstream and upstream propagation[3] and a three-sector economy to clarify the dynamics below this theoretical implication.

A Three-Sector Example

Consider an economy with three sectors as depicted in figure 1 in appendix C. In this economy, sector 1 is the exclusive costumer of sector 2, sector 2 is the exclusive costumer of sector 3, and sector 3 is the exclusive costumer of sector 1. The network generated by these relationships is just illustrative and not remove any generality to the results.

[3]The complete mathematical derivation established by Acemoglu et al. (2015) is available in the Appendix A.

Following the results of Acemoglu et al. (2015), the supply-side shocks, like productivity shocks, impact on the output's price while remain unchanged the labor supply due the decreasing in household consumption for this sector's good. This combined effect, encourage that its costumer industry use this input less intensively and thus reduce its own production.

Thus, in the actual framework, the sectoral production functions are therefore given as:

$$q_1 = e^{z_1} l_1^{\theta_1} x_{21}^{\omega_{21}}, \quad q_2 = e^{z_2} l_2^{\theta_2} x_{32}^{\omega_{32}}, and \quad q_3 = e^{z_3} l_3^{\theta_3} x_{13}^{\omega_{13}},$$

Then assuming constant returns to scale and some algebraic manipulations[4] the sector 1's output changes against the productivity shock is:

$$d \ \ln q_1 = \frac{d\, z_1 + \omega_{21} d\, z_2 + \omega_{32}\omega_{21} d\, z_3}{1 - \ \omega_{32}\omega_{21}\omega_{13}}$$

It can be seen that the sectoral output is affected by the productivity shocks of all the sectors by exclusively through a downstream propagation. For instance, z_2 impacts to sector 1 through the linkage seller-costumer, in other words, down the production chain. Furthermore, the sector 3's productivity shock impacts to sector 1 indirectly through the term $\omega_{32}\,\omega_{21}$ this implies that in a first time the shocks in sector 3 affects to its costumer (sector 2), and in turn, sector 2 impacts to its costumer, sector 1.

By its part, consider government spending shocks in nominal terms, $d\,\tilde{G}_i$, in absence of productivity shocks ($d\, z_1 = d\, z_2 = d\, z_3 = 0$) and with $\beta_1 = \beta_2 = \beta_3 = \frac{1}{3}$. After solve the simplified model its possible derive[5] the impact in sector 1's output as:

$$d\,\tilde{q}_1 = \frac{1}{1 - \omega_{21}\omega_{13}\omega_{32}} \begin{Bmatrix} d\tilde{G}_1 + \omega_{13}\omega_{32} d\tilde{G}_2 + \omega_{13} d\tilde{G}_3 \\ -\dfrac{(1 + \omega_{13} + \omega_{13}\omega_{32})}{3(1+\lambda)} \left[d\tilde{G}_1 + d\tilde{G}_2 + d\tilde{G}_3\right] \end{Bmatrix}$$

Again, the previous equation shows that output is affected by the shocks of the rest of sectors. However, now the impact is directed from costumer to seller. For instance, sector 2's government shock affect sector 1 through their influence in its sole costumer industry, the sector 3.

[4]For a detail of mathematical derivation review the Appendix B.
[5]For a detail of mathematical derivation review the Appendix B.

Another important feature described is the resource constraint effect that express that government expenditures reduces the labor income (because is totally financed by taxes on households) and this reduces the final consumption.

2.2 Multi-sector, multi-country model with input linkages.

Following Johnson (2014), I assume that the production functions and final goods aggregators are Cobb-Douglas. Furthermore, each country and sector is endowed with fixed amount of the composite factor, $\bar{V}_i(s)$. In the static version the composite final good (F_i) is equal to consumption (C_i) because there is no investment (I_i).

$$U_i = log\left(\prod_s \prod_j F_{j,i}(s)^{\omega^f_{ji}(s)}\right) \tag{5}$$

$$Q_i(s) = Z_i(s)\bar{V}_i(s)^{\theta_i(s)}\left(\prod_r \prod_j X_{ji}(r \to s)^{\omega^x_{ji}(r\to s)}\right)^{1-\theta_i} \tag{6}$$

Where $\omega^f_{ji}(s)$ and $\omega^x_{ji}(r \to s)$ are the share of goods from sector j in preference and technologies for country i, and $Z_i(s)$ is a sector-specific productivity. Further, the gross output is given by:

$$Q_i(s) = \sum_j F_{ij}(s) + \sum_j \sum_r X_{ij}(s \to r) + G_i(s) \tag{7}$$

Following Acemoglu et al. (2015), it is possible solve the quantities produced as a function of two types of shocks. A profit maximization shows the relationship with productivity shocks ($Z_i(s)$) while through a cost-minimization could be derived the relationship with government shocks.

Downstream propagation:

$$\boldsymbol{Q} = \Omega^t \boldsymbol{Q} + \boldsymbol{Z}$$

$$\boldsymbol{Q} = (\boldsymbol{I} - \Omega^t)^{-\mathbf{1}}\boldsymbol{Z} \tag{8}$$

Where the Ω is a matrix with $\omega^x_{ji}(r \to s) = \frac{x_{r\to s}}{q_s}$ as elements. The Leontief inverse

$(\boldsymbol{I} - \Omega^t)^{-1}$ provides a set of weights that indicates how production responds to productivity shocks.

The weights can be interpreted as the cost share in supplier intermediate industries across countries and sectors. Upstream propagation:

$$\boldsymbol{Q} = \widehat{\Omega}^t \boldsymbol{Q} + \boldsymbol{\Lambda G}$$

$$\boldsymbol{Q} = \left(I - \widehat{\Omega}^t\right)^{-1} \boldsymbol{\Lambda G} \tag{9}$$

Where the $\widehat{\Omega}$ is a matrix with $\widehat{\omega}_{ji}^{x}(r \rightarrow s) = \frac{x_{s\rightarrow r}}{q_s}$ as elements. The Leontief inverse $\left(I - \widehat{\Omega}^t\right)^{-1}$ provides a set of weights that indicates how production responds to demand shocks, particularly government spending. The weights can be interpreted as the sale share in other intermediates sectors across countries and sectors.

3 Data

I use the Inter-Country Input-Output database (ICIO) by OECD. This table contains harmonized intermediate sales between 33 sectors and 65 countries. Due many reasons I use only 20 sectors and 59 countries. Then, I build two clusters: EU cluster and Pacific cluster; each one with 22 countries and that include years from 1995 to 2011.

I only consider the sectoral employment as a 'dependent variable'. I use Trade in Employment database from OECD, because contains sectoral employment measures in thousands.

I just consider one demand shock, the government expenditures changes. I follow Acemoglu et al. (2015) methodology to calculate the shock. I used the annual changes in the aggregate government expenditure by country, this measure includes consumption and investment indistinctly[6].

4 Econometric Model

The empirical approach employed in this paper follows the main results expressed in equations (8) and (9). Additionally, I include a lag of dependent variable to avoid endogeneity problems. Respect the estimation strategy, I regress a panel regression model with sector-fixed effects, and time effects. Also are included posterior estimations with country-fixed effects.

[6] The data is extracted from the Public Finances in Modern History Database of International Monetary Fund.

$$\Delta\ \ln q_i^t(s) = \varphi \Delta \ln q_i^{t-1}(s) + \beta^{own} Shock_i^{t-1}(s) + \beta^{up} Upstream_i^{t-1}(s) + \beta^{do} Downstream_i^{t-1}(s) + \epsilon_i^t(s)$$

Where i is the country, t the year and s the sector. Furthermore, q is the employment in each sector. By its part, $Shock_i^{t-1}(s)$ is the direct shock on the sector, while $Upstream_i^{t-1}(s)$ and $Downstream_i^{t-1}(s)$ capture the indirect shocks spread through the upstream and downstream propagation.

4.1 Propagation variables

I measure downstream and upstream propagation according to Acemoglu et al. (2015). Thus, the indirect effects are calculated as the weighted averages of the shocks over related sectors.

$$Downstream_i^t(s) = \sum_{\forall j} \sum_{\forall r} \left(li.purchase_{j \to i}^t(r \to s) - \mathbf{1}_{i=j}(s=r) \right) \cdot Shock_j^t(r)$$

$$Upstream_i^t(s) = \sum_{\forall j} \sum_{\forall r} \left(li.produce_{i \to j}^t(s \to r) - \mathbf{1}_{i=j}(s=r) \right) \cdot Shock_j^t(r)$$

Where $\mathbf{1}_{i=j}(s=r)$ is equal to 1 when the linkage sector is the own sector.

Leontief inverse is builds from two different approach of sectoral linkages. The purchase share matrix focus on the costumer perspective while the produce share matrix describe the supplier perspective.

$$purchase.share_i^t(s) = \ln\left(\frac{Sales_{j \to i}^t(r \to s)}{Sales_i^t(s)}\right)$$

$$produce.share_i^t(s) = \ln\left(\frac{Sales_{i \to j}^t(s \to r)}{Sales_i^t(s)}\right)$$

For both the Leontief inverse matrix is calculated:

$$li.purchase = (\boldsymbol{I} - purchase.share_i^t(s))^{-1}$$

$$li.produce = (\boldsymbol{I} - produce.share_i^t(s))^{-1}$$

The downstream propagation is built since the purchase share matrix, in other words the focal sector is measure just in its costumer facet, and thus calculate the network shocks in terms of the relative importance of each sector in its own total purchases. Similarly, respect of the upstream propagation the focal sector is understood uniquely as a supplier. In this way, here the calculation of network shocks used the relative importance of each sector in the total sales of the focal sector.

4.2 Government spending shocks

My analysis focus on the government shocks. To calculate this demand shocks first I defined the share of sales for each industry to all countries' government.

$$GovSales\%_i^t(s) = \frac{Sales_i^t(s \rightarrow Gov)}{Sales_i^t(s)}$$

This ratio is combined with the log change in the government expenditure.

$$Shock_i^t(s) = GovSales\%_i^t(s) \cdot \Delta \ln GovExpenditure_i^{t-1}$$

To avoid endogeneity problems, the share in the government purchases is hold fixed at a year base 1995. Thus, the explanatory variable is based on the aggregate changes in the government expenditure that, in general, is driven by political decisions, ideology, budget conditions or exceptional issues like disasters or wars. The government change is lagged one year to reflect the fact that increase purchases have an extended or retarded effect.

4.3 Clustering sectors

Although the global input-output matrix collected from OECD database include linkages between sectors in 63 countries, that represent around 80 percent of the global trade, could be no a great idea use the total network to evaluate the significance of indirect propagation. How I mentioned before, one of the main assumptions in the model is the tacit implication of a common labor market, which evidently is not true for a worldwide perspective. However, relative strong labor linkages could be assumed for some very close economies (trade, language, culture, geographic distance, etc.), that I called clusters. The idea is simple, there are sectors across countries that have great affinity and consequently more probabilities to impact or be impacted by the members of the cluster. In particular I build the clusters using the relative intermediate sales between sectors. I work with two cluster of 36 countries each one [7], the first group is formed by countries of the Asia-Pacific countries, while the second set include Eurozone countries.

For the clustering, I use the walktrap community finding algorithm [8] implemented in package igraph from R. This approach is based on random walks, and the general idea is that a random walk performance tends to be trapped within same compact community because there are relative few edges that lead outside a given community. I use this algorithm following network literature that reveal the out performance of the walktrap algorithm in comparison with others algorithms [9].

5 Results

The empirical results are consistent with the theoretical proposition that suggest that demand-side shocks are mainly conducted through upstream propagation, especially considering countries from cluster 1. In fact, Tables 3, 4 and 5 show that upstream coefficients are positive and significant for most of periods. On the other hand, downstream coefficients have negative sign and are not significant. The reported increase of employment after a positive fiscal shock is consistent with previous literature results (Burnside, Eichenbaum and Fisher (2004), Pappa (2009) and Ramey (2007)). It is important to note that the own shocks do not have a significant difference to zero in each period taken. This last result suggest that idiosyncratic fiscal shocks affect the employment exclusively by the network propagation (upstream). The absence of statistically relevant direct effects could be related with the fact that the increase of government expenditures is not translated in higher employment levels in all the sectors, at least in the extensive margin. Respect the economic interpretation of the upstream coefficient (the relevant dimension), it is important remark that it is not directly convertible into a quantitative multiplier effect.

[7]See Table 1 with a detailed list.

[8]See Pascal Pons and Matthieu Latapy (2005).

[9]Pons and Latapy (2011) suggest that walktrap algorithm is computed efficiently, while Orman and Labatut (2011) and Yang, Algesheimer and Tessone (2016) shows that this algorithm is robust to increase of the mixing parameter, that determines the heterogeneity of degree distributions, and seize of network.

Nevertheless, it’s possible to attribute some meaning to this coefficient. In particular, its measure the impact (in terms of standard deviations) of the shock to all other -costumer- industries that, weighted by their upstream linkages, on the focal industry.

If you consider the cluster 2 (see tables 8, 9 and 10), the results are not conclusive. Upstream coefficient is just significant by the period 6, while the downstream coefficient is significant by all the sample but weaker than upstream coefficient.

For its part, the one-lag dependent variable results persistent significant and negative. This results are maintained regardless if the specification include fixed effects, time effects or if the proxy of the dependent variable changes, how it’s seen in tables 3 and 4.

When it is distinguished between the origins of the sectors affecting the focal industry, the results suggest a relevant role of the propagation since foreign sectors. In the case of cluster 1, again the upstream coefficients are statistically significant and with positive sign. Likewise, the foreign component of the upstream effect is significant in the majority of periods analyzed, however the coefficient of the domestic component is quantitative higher. This greatest role of domestic component is consistent with Bicu and Lieb (2015) who show that the magnitude of cross-border spillovers never surpasses domestic multipliers.

In relation to the cluster 2, the evidence show again a weak role of the upstream, except for period from 2003 to 2011, for which the domestic component of the upstream propagation is higher than the foreign component.

6 Conclusion

In this paper, I explore the transmission of government expenditure shocks on the employment using an international network production framework. For this purpose, I extended the theoretical proposals of Acemoglu, et al. (2015), that suggest that demand-side shocks spread upstream across a domestic network. By its purpose, I consider clusters of countries with strong linkages and then I assume a scenario with free mobility in labor across countries. Thus, I found evidence that verified the significance of the up- stream propagation of government shocks across an international network. This results are consistent with Acemoglu, et al. (2015).

This study contributes to the literature on the effects of fiscal shocks on a cross-border framework by (1) estimating the network effect (upstream) of fiscal shocks into two international clusters (2) suggesting a new approach to evaluate the international fiscal spillovers (3) estimating the domestic and foreign network effects of fiscal shocks on domestic employment of Asia-Pacific and Eurozone countries, applying a diversity of fixed-effects panel models.

This results encourage the use of production network model to explain the role of idiosyncratic shocks and how the network structure could affect the transmission of shocks, even across countries.

Further research should include the introduction of labor immobility across countries and the differentiation of the origin of debt founding the government expenditure (foreign or domestic). Moreover, additional dependent variables as the exchange rate or the output could offer a wide view of the international network effects. Finally, it could be interesting reveal if the network features have a role in the impact of fiscal spillovers.

Appendices

A Mathematical derivation of channels propagation

Supply-side shock

Now, I show that a profit maximization will conduct to a downstream propagation while a cost minimization will provide an upstream propagation of shocks. In this way, the profit function (Π_i) can be written as:

$$\Pi_i = p_i q_i - l_i \omega - \sum_{j=1}^{n} p_j x_{ji}, \qquad (A1)$$

and the profit maximization implies:

$$\frac{\partial \Pi_i}{\partial l_i} = p_i \frac{\partial q_i}{\partial l_i} - w = 0 \quad \rightarrow \quad \theta_i = \frac{w l_i}{p_i q_i} \qquad (A2)$$

$$\frac{\partial \Pi_i}{\partial x_{ji}} = p_i \frac{\partial q_i}{\partial x_{ji}} - p_j = 0 \quad \rightarrow \quad w_{ji} = \frac{p_j x_{ji}}{p_i q_i} \qquad (A3)$$

In turn, utility maximization problem:

$$\max \quad u(c_i, l) = \gamma(l) \prod_{i=1}^{n} c_i^{\beta_i}$$

$$subject\ to\colon \quad \sum_{i=1}^{n} p_i c_i = wl - T,$$

which implies that final consumption of each good is proportional to its preferences:

$$\frac{p_i c_i}{\beta_i} = \frac{p_j c_j}{\beta_j} \qquad (A4)$$

$$\frac{p_i c_i}{\beta_i} = \kappa \quad \rightarrow \quad p_i c_i = \kappa \beta_i$$

$$\sum_{i=1}^{n} p_i c_i = \kappa \sum_{i=1}^{n} \beta_i$$

$$\sum_{i=1}^{n} p_i c_i = \kappa$$

$$\sum_{i=1}^{n} p_i c_i = \frac{p_i c_i}{\beta_i} \qquad (A5)$$

Lets us set government spending equal to zero. Therefore, the household budget suggest that the final consumption is equal to labor income:

$$\sum_{i=1}^{n} p_i c_i = wl,$$

Using $(A5)$, we have,

$$p_i c_i = \beta_i wl, \qquad \forall i. \tag{A6}$$

Moreover, the first order condition of labor supply is calculated following:

$$\begin{aligned} \frac{\partial u(c_i,l)}{\partial l} &= -\frac{\gamma'(l)\prod_{i=1}^{n} c_i^{\beta_i}}{w} = \lambda \\ \frac{\partial u(c_i,l)}{\partial c_i} &= \frac{\gamma(l)\beta_i \prod_{i=1}^{n} c_i^{\beta_i}}{c_i p_i} = \lambda \end{aligned} \quad \Leftrightarrow \quad \begin{aligned} -\frac{\gamma'(l)}{w} &= \frac{\gamma(l)\beta_i}{c_i p_i} \\ -\frac{\gamma'(l)l}{\gamma(l)} &= 1, \quad (replace\ previous\ result\ A5) \end{aligned}$$

Thereby labor supply is independent of the equilibrium wage because the preference function in (2), produce that income and substitution effects cancel out mutually.

Now I take logs in the production network function (1) and then totally differentiate.

$$d\ln q_i = dz_i + \theta_i d\ln l_i + \sum_{j=1}^{n} \omega_{ji} d\ln x_{ji} \tag{A7}$$

Then I will proceed to totally differentiate $A2$ and $A3$. I assume that $d\ ln\ w = 0$.

$$d\ln q_i + d\ln p_i = d\ln l_i \tag{A8}$$

and

$$d\ ln\ q_i + \ d\ ln\ p_i = \ d\ ln\ x_{ji} + \ d\ ln\ p_j. \tag{A9}$$

After substituting equations $(A8)$ and $(A9)$ into $(A7)$ I have:

$$d\ln q_i = dz_i + \theta_i(d\ln q_i + d\ln p_i) + \sum_{j=1}^{n} \omega_{ji}\big(d\ln q_i + d\ln p_i - d\ln p_j\big). \tag{A10}$$

Now noted that due labor supply remain unchanged ($d\ ln\ l_i = 0$) the changes in prices spread completely into production $(A8)$ and consumption $(A6)$. So, its possible extract prices from the last equation:

$$d\ln q_i = dz_i + \theta_i(d\ln q_i - d\ln c_i) + \sum_{j=1}^{n} \omega_{ji}\big(d\ln q_i - d\ln c_i + d\ln c_j\big).$$

Recalling the constant returns to scale assumption $\left(\theta_i + \sum_{j=1}^{n} \omega_{ji} = 1\right)$ is easy simplifies to an expression that linked the final consumptions with the supply-side shock:

$$d\ln c_i = dz_i + \sum_{j=1}^{n} \omega_{ji}\, d\ln c_j.$$

Rewritten these terms as a matrix:

$$\begin{aligned} \boldsymbol{d}\ln\boldsymbol{c} &= \boldsymbol{dz} + \boldsymbol{\Omega d}\ln\boldsymbol{c} \\ \boldsymbol{d}\ln\boldsymbol{c} &= (\boldsymbol{I} - \boldsymbol{\Omega})^{-\mathbf{1}}\boldsymbol{dz} \end{aligned} \tag{A11}$$

Next, combining $A3$, $A4$ and 3, I get the follow expression:

$$\frac{q_i}{c_i} = 1 + \sum_{i=1}^{n} \omega_{ji} \frac{\beta_j q_j}{\beta_i c_j},$$

Which implies:

$$\boldsymbol{d}\ ln\ \boldsymbol{q} \ = \ \boldsymbol{d}\ ln\ \boldsymbol{c} \tag{A12}$$

Finally, from $A10$ and $A11$, I obtain:

$$\boldsymbol{d}\ ln\ \boldsymbol{q} \ = \ (\boldsymbol{I} - \boldsymbol{\Omega})^{-\mathbf{1}}\, \boldsymbol{dz} \tag{A13}$$

Demand-side shock

For this part I will assume the absence of productivity shocks. Also, I start considering a cost minimization. Now I define the unit cost function of sector i as:

$$C_i(p_1, p_2, \dots, p_n, w) = B_i w^{\theta_i} \prod_{j=1}^{n} p_j^{\omega_{ji}},$$

where

$$B_i = \left[\frac{1}{\theta_i}\right]^{\theta_i} \prod_{j=1}^{n} \left[\frac{1}{\omega_{ji}}\right]^{\omega_{ji}}$$

Then a zero profit condition implies unit price equals (p_i) unit cost (C_i):

$$\ln p_i = \ln B_i + \theta_i \ln w + \sum_{j=1}^{n} \omega_{ji} \ln p_j \qquad \forall i \in 1, \dots, n. \qquad (A14)$$

Taking wage as numeraire, I have $\theta_i \ln w = 0$, so the new expression shows that for a given set of productivity shocks the equilibrium prices are determined regardless the government purchases. In other words, demand-side shocks have not impact on prices because they are completely determined by supply-side shocks.

Furthermore, from $(A6)$ consumption remains unchanged because price was not impacted. Additionally, from the clearing condition (3) noted that the supply as input to the rest of sectors remain constant regardless of the change in G_i. However, due the prices are fixed I can obtain from $(A2)$ and $(A3)$:

$$d \ln q_i = d \ln x_{ji} \quad and \quad d \ln q_i = d \ln l_i$$

These expressions means that changes in production levels in one sector affect its demand for inputs from the rest of sectors while the labor supply changes impact in the output sector, respectively.

Meanwhile, under the presence of government purchases the first order condition of labor supply is defined as:

$$\frac{wl}{wl - T} = -\frac{l\gamma'(l)}{\gamma(l)} \qquad (A15)$$

Where $T = \sum_{i=1}^{n} p_i G_i$.

Assuming that $\gamma(l) = (1 - l)^{\lambda}$, and recalling that wage is taken as numeraire, its obtain:

$$l = \frac{1 + \lambda \sum_{i=1}^{n} p_i G_i}{1 + \lambda} \qquad (A16)$$

Now rearranging equation $A6$ I can replace the last expression in order to show that the government expenditure affects the final consumption.

$$p_i c_i = \beta_i [lw - T]$$

$$= \frac{\beta_i}{1 + \lambda} \left[1 - \sum_{j=1}^{n} p_j G_j\right]$$

Applying total differentiation

$$d(p_i c_i) = -\frac{\beta_i}{1+\lambda}\sum_{j=1}^{n} d\left(p_j G_j\right). \qquad (A17)$$

The last derivations imply that, even with fixed prices, labor supply will change because of changes in consumption (resulting from government purchases). Now, considering that resource constraint (3) implies:

$$dq_i = dc_i + \sum_{j=1}^{n} dx_{ij} + dG_i$$

Combining the (A16), (A17) with (A2) and (A3).

$$\frac{d(p_i q_i)}{p_i q_i} = \sum_{j=1}^{n} \omega_{ij} \frac{d(p_j q_j)}{p_i q_i} + \frac{dG_i}{q_i} - \frac{\beta_i}{(1+\lambda)} \sum_{j=1}^{n} \frac{(dp_j G_j)}{p_i q_i}$$

$$= \sum_{j=1}^{n} \widehat{\omega}_{ij} \frac{d(p_j q_j)}{p_j q_j} + \frac{d\tilde{G}_i}{p_i q_i} - \frac{\beta_i}{(1+\lambda)} \sum_{j=1}^{n} \frac{\left(d\tilde{G}_j\right)}{p_i q_i},$$

Where $\tilde{G}_j = p_j G_j$ and $\frac{d(p_i q_i)}{p_i q_i} = d \ln q_i$, because prices are constant. It's not irrelevant to note the difference between $\omega_{ij} = \frac{p_i x_{ij}}{p_i q_i}$ and $\widehat{\omega}_{ij} = \frac{p_i x_{ij}}{p_i q_i}$. The first term, indicates the relative cost of an input purchase, while the second implies the share of a determined intermediate output in the total input sells. In other words, ω_{ij} capture the relative importance of shocks on costumers into the sellers performance (seller perspective). Similarly, $\widehat{\omega}_{ij}$ capture the relative importance of certain costumer into seller sales (seller perspective). Writing the matrix notation of the previous equation.

$$\mathbf{d\ln q} = \widehat{\mathbf{\Omega}}^{\mathbf{t}}\mathbf{d\ln q} + \mathbf{\Lambda d\overline{G}}$$

$$= (\boldsymbol{I} - \widehat{\mathbf{\Omega}}^{\boldsymbol{t}})^{-\mathbf{1}} + \mathbf{\Lambda d\overline{G}}$$

$$= \widehat{\boldsymbol{H}}^{\boldsymbol{t}}\mathbf{\Lambda d\overline{G}} \qquad (A19)$$

B Three-sector economy example

In this simplify economy each sector sells their output as an intermediate product to an unique sector while purchases as input the product of another different sector. Thus, sector 1 buys to sector 2 and sells to sector 3; for its part, sector 2 buys to sector 3 and sells to sector 1, and finally, sector 3 buys to sector 1 and sells to sector 2. These commercial relationships are drawn in figure C1 from Appendix C.

Supply-side shock

Suppose, that $u(c_1, c_2, c_3, l) = \lambda(l) \prod_{i=1}^{3} c_i^{1/3}$. Also, recall the general production function to then specify each sector's production function.

$$q_i = e^{z_i} l_i^{\theta_i} x_{ji}^{\omega_{ji}}, \quad \forall i \in 1, 2, 3. \qquad \begin{cases} q_1 = e^{z_1} l_1^{\theta_1} x_{21}^{\omega_{21}} \\ q_2 = e^{z_2} l_2^{\theta_2} x_{32}^{\omega_{32}} \\ q_3 = e^{z_3} l_3^{\theta_3} x_{13}^{\omega_{13}} \end{cases}$$

Now we start from equation $A10$ that is built from combining of the total differentiation of production function $(A7)$ and first order condition of households $(A8)$ and firms $(A9)$. For instance, the equation to sector 1 is given by:

$$d \ \ln q_1 = dz_1 + \theta_1(d \ln q_1 + d \ln p_1) + \omega_{21}(d \ln q_1 + d \ln p_1 - d \ln p_2). \qquad (B1)$$

Recall the constant return to scale $\theta_i + \omega_{ji} = 1$, I can simplify $B1$.

$$-d \ ln \ p_1 \ = \ d \ z_1 \ - \ \omega_{21} \ d \ ln \ p_2.$$

Then I will use A8 in order to eliminate the prices in the previous equation.

$$dlnq_1 \ - \ dlnl_1 = dz_1 \ + \ \omega_{21}(d \ lnq_2 - \ dlnl_2)$$

$$dlnq_1 = dz_1 + \omega_{21} d \ lnq_2 - \omega_{21} dlnl_2 + d \ln l_1 \qquad (B2)$$

Analogously, I have similar results to sector 2 and sector 3 that setting a system of three equations. After some algebraic manipulations and regarding $dlnl_i$, I have:

$$d \ln q_1 = \frac{dz_1 + \omega_{21} dz_2 + \omega_{32}\omega_{21} dz_3}{1 - \omega_{21}\omega_{32}\omega_{13}} \qquad (B3)$$

$$d \ln q_2 = \frac{dz_2 + \omega_{32} dz_3 + \omega_{13}\omega_{32} dz_1}{1 - \omega_{21}\omega_{32}\omega_{13}} \qquad (B4)$$

$$d \ln q_3 = \frac{dz_3 + \omega_{13} dz_1 + \omega_{21}\omega_{13} dz_2}{1 - \omega_{21}\omega_{32}\omega_{13}} \qquad (B5)$$

Demand-side shock

Again I consider the economy described in appendix C. I start since the resource constraint depicted in equation A18, and since the general result that demand shocks not impact on prices. Henceforth, I will refer all variables in nominal values, which will be scripted by a tilde.

$$d\tilde{q}_i = d\tilde{c}_i + d\tilde{x}_{ij} + d\tilde{G}_i \qquad (B6)$$

The previous equation shows that government spending affects production directly through the term $d\ G_i$. However, there are other effects originated in the market labor $(A17)$, that implies consumption affectations.

$$d\tilde{c}_i = -\frac{\beta_i}{1+\lambda}\sum_{i=1}^{3} d\tilde{G}_i$$

Recall $_1 = \beta_2 = \beta = \frac{1}{3}$,

$$d\tilde{c}_i = -\frac{1}{3(1+\lambda)}\sum_{i=1}^{3} d\tilde{G}_i \qquad (B7)$$

Also, are present indirect effects from the first order condition of firms (A3) that implies an impact since the demand for inputs.

$$\omega_{ij} = \frac{\tilde{x}_{ij}}{\tilde{q}_j}$$

$$d\tilde{x}_{ij} = \omega_{ij} d\tilde{q}_j \qquad (B8)$$

Thus, combining $B7$ and $B8$ in $B6$ I obtain.

$$d\tilde{q}_i = -\frac{1}{3(1+\lambda)}\sum_{i=1}^{3} d\tilde{G}_i + \omega_{ij} d\tilde{q}_j + d\tilde{G}_i$$

Finally, after solve the system of equations I have:

$$d\tilde{q}_1 = \frac{1}{1-\omega_{21}\omega_{13}\omega_{32}}\left\{\begin{matrix} d\tilde{G}_1 + \omega_{13}\omega_{32} d\tilde{G}_2 + \omega_{13} d\tilde{G}_3 \\ -\frac{(1+\omega_{13}+\omega_{13}\omega_{32})}{3(1+\lambda)}\left[d\tilde{G}_1 + d\tilde{G}_2 + d\tilde{G}_3\right] \end{matrix}\right\} \qquad (B9)$$

$$d\tilde{q}_2 = \frac{1}{1-\omega_{21}\omega_{13}\omega_{32}}\left\{\begin{matrix} d\tilde{G}_2 + \omega_{21}\omega_{13} d\tilde{G}_3 + \omega_{21} d\tilde{G}_1 \\ -\frac{(1+\omega_{21}+\omega_{21}\omega_{13})}{3(1+\lambda)}\left[d\tilde{G}_1 + d\tilde{G}_2 + d\tilde{G}_3\right] \end{matrix}\right\} \qquad (B10)$$

$$d\tilde{q}_3 = \frac{1}{1-\omega_{21}\omega_{13}\omega_{32}}\left\{\begin{matrix} d\tilde{G}_3 + \omega_{32}\omega_{21} d\tilde{G}_1 + \omega_{32} d\tilde{G}_2 \\ -\frac{(1+\omega_{32}+\omega_{32}\omega_{21})}{3(1+\lambda)}\left[d\tilde{G}_1 + d\tilde{G}_2 + d\tilde{G}_3\right] \end{matrix}\right\} \qquad (B11)$$

C Figures

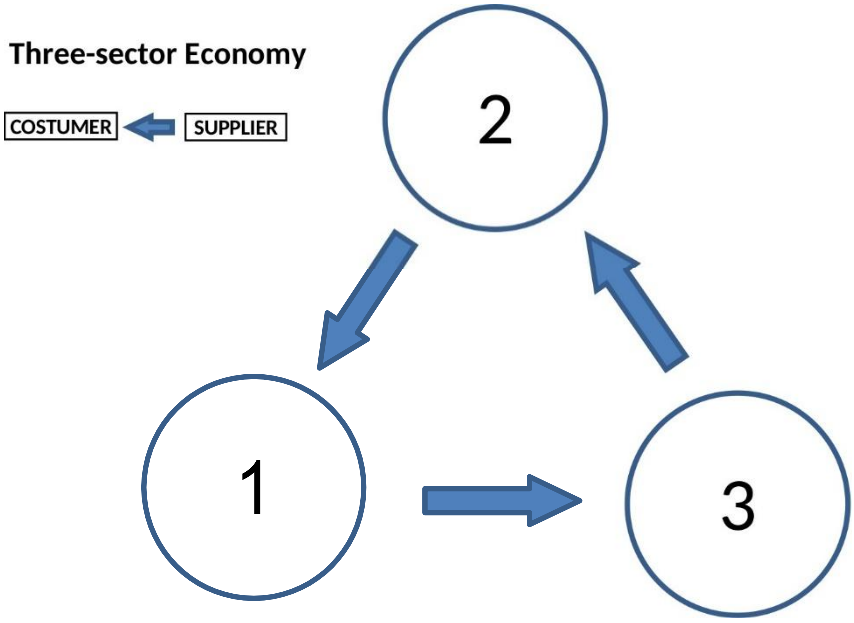

Figure 1: There-sector economy with close linkages between sectors

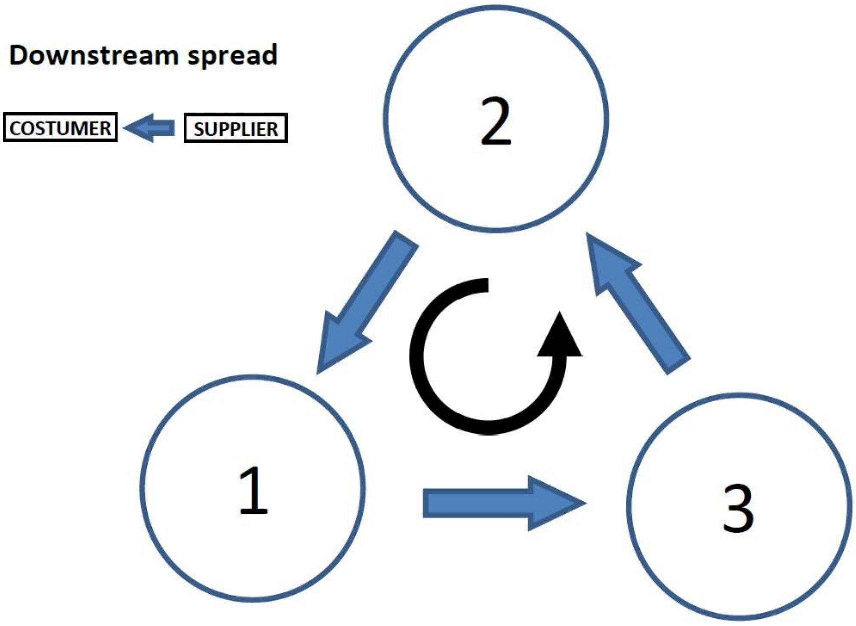

Figure 2: There-sector economy with close linkages between sectors

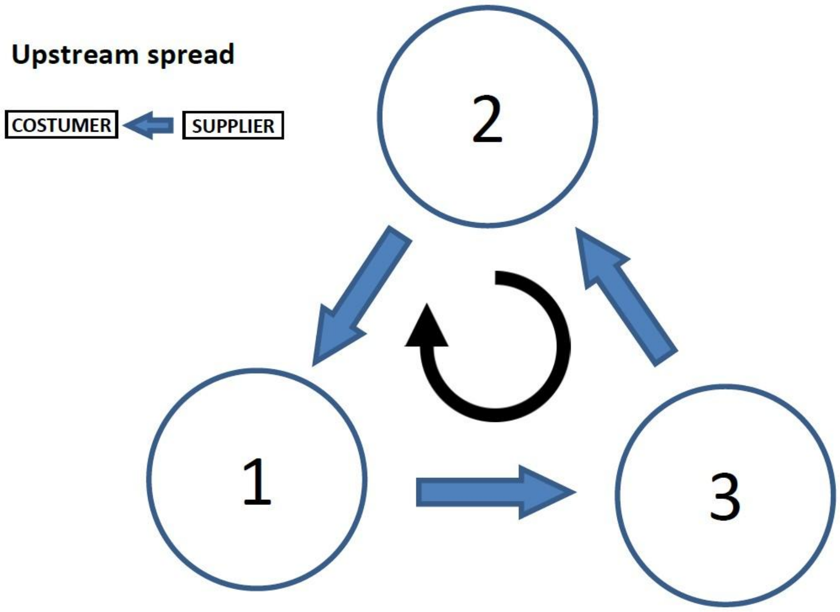

Figure 3: There-sector economy with close linkages between sectors

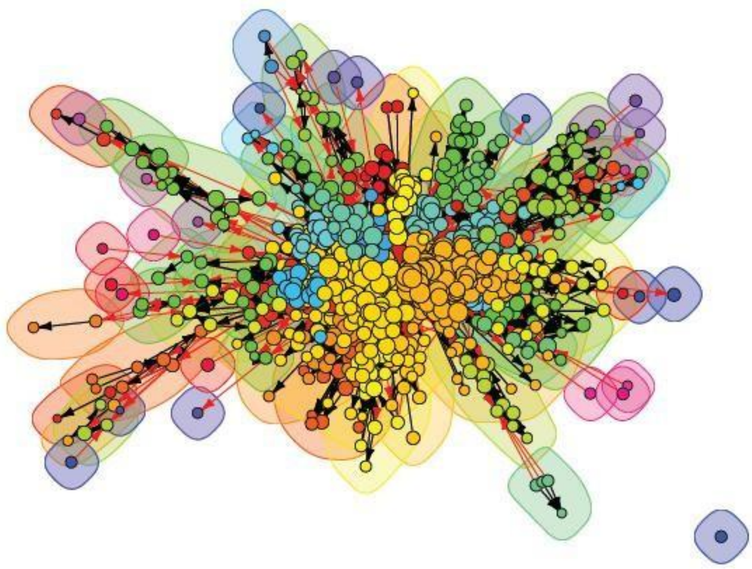

Figure 4: World production network. (Source: Prepared by the author based on ICIO database - OECD). Each sphere represent a pair sector-country.

D Tables

CLUSTER 1			
Australia	HongKongSAR	Mexico	Thailand
Canada	Indonesia	Malaysia	United States
Chile	Ireland	Philippines	Viet Nam
China	Israel	Romania	South Africa
Colombia	Japan	Saudi Arabia	
Greece	Korea	Singapore	

CLUSTER 2			
Austria	France	Morocco	Slovak Republic
Belgium	United Kingdom	Netherlands	Slovenia
Switzerland	Hungary	Norway	Sweden
Czech Republic	Ireland	Poland	South Africa
Germany	Italy	Portugal	
Spain	Luxembourg	Russian Federation	

Table 1: Cluster of countries using short random walk communities algorithm.

Periods Included

year	per1	per2	per3	per4	per5	per6
1995						
1996						
1997						
1998						
1999						
2000						
2001						
2002						
2003						
2004						
2005						
2006						
2007						
2008						
2009						
2010						
2011						

Table 2: In the regressions I used many samples to check robustness. The periods are arbitrary chosen.

	1997:2011	1997:2000	2000:2007	2007:2011	1997:2003	2003:2011
	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.
L.dlempn	-0.031*	-0.328***	-0.051**	-0.278***	-0.150***	-0.087***
	(0.016)	(0.037)	(0.026)	(0.027)	(0.026)	(0.022)
shock_g_	-0.022	-0.041	-0.045	0.026	-0.011	-0.010
	(0.021)	(0.028)	(0.046)	(0.030)	(0.028)	(0.032)
UP	0.002*	0.006***	0.016*	0.001	0.002	0.001
	(0.001)	(0.002)	(0.009)	(0.001)	(0.002)	(0.004)
DO	-0.004	-0.005	-0.000	0.000	-0.006	0.002
	(0.003)	(0.004)	(0.000)	(0.000)	(0.004)	(0.007)
constant	0.026	-0.038	0.139***	-0.120***	-0.036	0.069***
	(0.018)	(0.024)	(0.029)	(0.031)	(0.023)	(0.026)
Adj. R^2	-0.075	-0.310	-0.163	-0.198	-0.173	-0.136
DF_R	3896.000	596.000	1796.000	896.000	1496.000	2096.000
BIC	12380.480	1586.489	6513.492	3074.634	4522.067	7367.989

* p<0.10,
** p<0.05,
*** p<0.01

Table 3: Cluster 1 with baseline specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the baseline model and consider fixed effects and one-lag dependent variable. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries. The first column include all the sample, while since the second until the last columns used sub-periods defined in Table 1.

	1997:2011	1997:2000	2000:2007	2007:2011	1997:2003	2003:2011
	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.
L.dlempn	-0.041**	-0.327***	-0.061**	-0.302***	-0.148***	-0.104***
	(0.016)	(0.038)	(0.026)	(0.027)	(0.026)	(0.022)
shock_g_	-0.009	-0.040	-0.046	0.055*	-0.009	0.021
	(0.021)	(0.028)	(0.046)	(0.030)	(0.028)	(0.032)
UP	0.002*	0.006***	0.016*	0.001	0.002	0.001
	(0.001)	(0.002)	(0.009)	(0.001)	(0.002)	(0.004)
DO	-0.004	-0.005	-0.000	0.000	-0.006	0.003
	(0.003)	(0.004)	(0.000)	(0.000)	(0.004)	(0.007)
Adj. R^2	-0.046	-0.310	-0.145	-0.129	-0.175	-0.089
DF_R	3883.000	594.000	1790.000	893.000	1491.000	2089.000
BIC	12361.741	1596.855	6519.421	3019.818	4556.321	7313.413

* p<0.10,
** p<0.05,
*** p<0.01

Table 4: Cluster 1 with first alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the first alternative specification and not only consider fixed effects but also time effects. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L2.lempn	-0.963***	0.710*	-2.710***	-1.848***	-1.592***	-1.909***
	(0.080)	(0.389)	(0.201)	(0.419)	(0.273)	(0.136)
shock g	0.008	0.008	-0.026	0.010	0.014	0.010
	(0.021)	(0.040)	(0.052)	(0.033)	(0.031)	(0.031)
UP	0.002	0.011*	0.025**	-0.000	0.001	0.003
	(0.002)	(0.006)	(0.011)	(0.001)	(0.002)	(0.005)
DO	-0.004	-0.005	0.000	0.000	-0.006	-0.002
	(0.003)	(0.009)	(0.000)	(0.000)	(0.004)	(0.007)
Adj. R^2	-0.012	-0.971	-0.052	-0.377	-0.218	-0.006
DF_R	3584.000	295.000	1491.000	594.000	1192.000	1790.000
BIC	11320.097	658.242	5489.645	2264.648	3646.105	6050.365

* p<0.10, ** p<0.05, *** p<0.01

Table 5: Cluster 1 with second alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the second alternative specification and consider fixed effects, time effects. Furthermore, a second-lag of the dependent variable is considered as explanatory variable. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L.dlempn	-0.031*	-0.326***	-0.051**	-0.279***	-0.149***	-0.087***
	(0.016)	(0.037)	(0.026)	(0.027)	(0.026)	(0.022)
shock g	-0.030	-0.019	-0.031	0.031	-0.008	-0.020
	(0.023)	(0.032)	(0.054)	(0.031)	(0.031)	(0.042)
D UP	0.002	0.013**	0.030	0.005	-0.001	0.012
	(0.005)	(0.006)	(0.031)	(0.005)	(0.006)	(0.018)
F UP	0.002*	0.005**	0.016*	0.001	0.002	0.000
	(0.001)	(0.002)	(0.009)	(0.001)	(0.002)	(0.004)
D DO	-0.013	0.011	-0.004***	0.001	-0.001	-0.020
	(0.010)	(0.013)	(0.001)	(0.001)	(0.013)	(0.023)
F_DO	-0.003	-0.006	0.000	0.000	-0.007*	0.003
	(0.003)	(0.004)	(0.000)	(0.000)	(0.004)	(0.007)
constant	0.026	-0.038	0.141***	-0.121***	-0.036	0.069***
	(0.018)	(0.024)	(0.030)	(0.031)	(0.023)	(0.026)
Adj. R^2	-0.075	-0.308	-0.159	-0.198	-0.174	-0.136
DF_R	3894.000	594.000	1794.000	894.000	1494.000	2094.000
BIC	12396.136	1595.467	6519.845	3085.781	4536.446	7382.050

* p<0.10, ** p<0.05, *** p<0.01

Table 6: Cluster 1 with third alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L.dlempn	-0.041**	-0.324***	-0.061**	-0.303***	-0.147***	-0.103***
	(0.016)	(0.038)	(0.026)	(0.027)	(0.026)	(0.022)
shock g	-0.016	-0.017	-0.030	0.062**	-0.006	0.010
	(0.023)	(0.032)	(0.054)	(0.031)	(0.031)	(0.042)
D UP	0.003	0.013**	0.031	0.006	-0.000	0.011
	(0.005)	(0.006)	(0.031)	(0.005)	(0.006)	(0.017)
F UP	0.002	0.005**	0.016*	0.001	0.002	0.001
	(0.001)	(0.002)	(0.009)	(0.001)	(0.002)	(0.004)
D_DO_	-0.013	0.011	-0.004***	0.001	-0.001	-0.019
	(0.010)	(0.013)	(0.001)	(0.001)	(0.013)	(0.023)
F_DO_	-0.003	-0.007	0.000	0.000	-0.007*	0.004
	(0.003)	(0.004)	(0.000)	(0.000)	(0.004)	(0.007)
Adj. R^2	-0.047	-0.308	-0.141	-0.128	-0.176	-0.089
DF_R	3881.000	592.000	1788.000	891.000	1489.000	2087.000
BIC	12377.377	1605.653	6524.776	3030.150	4570.716	7327.527

* p<0.10, ** p<0.05, *** p<0.01

Table 7: Cluster 1 with fourth alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects and time effects. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L2.lempn	-0.966***	0.627	-2.693***	-1.855***	-1.569***	-1.912***
	(0.080)	(0.393)	(0.201)	(0.420)	(0.273)	(0.137)
shock g	-0.010	0.030	-0.001	0.012	0.004	-0.014
	(0.023)	(0.044)	(0.059)	(0.034)	(0.033)	(0.042)
D UP	-0.003	0.027**	0.052*	-0.000	-0.009	0.010
	(0.005)	(0.012)	(0.031)	(0.005)	(0.007)	(0.018)
F UP	0.002	0.009	0.024**	-0.000	0.001	0.003
	(0.002)	(0.006)	(0.011)	(0.001)	(0.002)	(0.005)
D_DO_	-0.019**	-0.000	-0.003**	0.001	-0.006	-0.034
	(0.010)	(0.017)	(0.001)	(0.001)	(0.013)	(0.023)
F_DO_	-0.003	-0.004	0.000	0.000	-0.006	0.000
	(0.003)	(0.009)	(0.000)	(0.000)	(0.004)	(0.007)
Adj. $\bar{R}^2$	-0.012	-0.969	-0.049	-0.379	-0.218	-0.006
DF_R_	3582.000	293.000	1489.000	592.000	1190.000	1788.000
BIC	11333.114	666.376	5496.661	2276.866	3657.464	6063.158

* p<0.10, ** p<0.05, *** p<0.01

Table 8: Cluster 1 with fifth alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects, time effects and the second-lag of dependent variable as an explanatory variable. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011	1997:2000	2000:2007	2007:2011	1997:2003	2003:2011
	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.
L.dlempn	0.076***	-0.170***	0.004	-0.242***	-0.006	0.009
	(0.014)	(0.033)	(0.020)	(0.028)	(0.024)	(0.018)
shock_g_	-0.066**	-0.136	-0.033	-0.171**	0.009	-0.086**
	(0.028)	(0.102)	(0.032)	(0.083)	(0.041)	(0.042)
UP	0.002	-0.001	-0.000	-0.000	0.001	0.009***
	(0.001)	(0.006)	(0.002)	(0.001)	(0.002)	(0.003)
DO	0.004**	-0.014	-0.000**	-0.000	0.003	0.003
	(0.002)	(0.013)	(0.000)	(0.001)	(0.002)	(0.003)
Constant	-0.125***	-0.069***	-0.078***	-0.357***	-0.123***	-0.143***
	(0.014)	(0.024)	(0.019)	(0.031)	(0.019)	(0.020)
Adj. R^2	-0.069	-0.454	-0.165	-0.259	-0.200	-0.138
DF_R	5432.000	832.000	2504.000	1252.000	2086.000	2924.000
BIC	16447.822	2537.833	7845.253	4540.604	6385.043	9506.611

* p<0.10,
** p<0.05,
*** p<0.01

Table 9: Cluster 2 with baseline specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the baseline model and consider fixed effects and one-lag dependent variable. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries. The first column include all the sample, while since the second until the last columns used sub-periods defined in Table 1.

	1997:2011	1997:2000	2000:2007	2007:2011	1997:2003	2003:2011
	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.	Coef./S.E.
L.dlempn	0.066***	-0.169***	-0.007	-0.292***	-0.012	-0.011
	(0.014)	(0.033)	(0.020)	(0.029)	(0.024)	(0.018)
shock_g_	-0.029	-0.134	-0.021	-0.002	0.038	-0.034
	(0.027)	(0.102)	(0.031)	(0.078)	(0.042)	(0.040)
UP	0.002	-0.001	-0.000	-0.000	0.001	0.008**
	(0.001)	(0.006)	(0.002)	(0.001)	(0.002)	(0.003)
DO	0.003**	-0.013	-0.000**	-0.000	0.003	0.003
	(0.002)	(0.013)	(0.000)	(0.001)	(0.002)	(0.003)
Adj. R^2	-0.009	-0.455	-0.145	-0.052	-0.190	-0.032
DF_R	5419.000	830.000	2498.000	1249.000	2081.000	2917.000
BIC	16208.628	2550.373	7835.501	4258.187	6397.834	9228.005

* p<0.10,
** p<0.05,
*** p<0.01

Table 10: Cluster 2 with first alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the first alter- native specification and not only consider fixed effects but also time effects. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L2.lempn	-2.158***	1.106	-3.853***	-3.590***	-3.979***	-3.035***
	(0.095)	(0.777)	(0.197)	(0.572)	(0.293)	(0.200)
shock g	-0.010	0.085	-0.028	-0.065	0.071*	-0.019
	(0.027)	(0.124)	(0.032)	(0.090)	(0.040)	(0.038)
UP	0.002	-0.003	0.001	0.001	0.001	0.007**
	(0.001)	(0.005)	(0.002)	(0.001)	(0.002)	(0.003)
DO	0.003**	-0.024	-0.000*	-0.000	0.003*	0.000
	(0.002)	(0.017)	(0.000)	(0.001)	(0.002)	(0.003)
Adj. R^2	0.079	-0.989	0.008	-0.222	-0.114	0.062
DF_R	5002.000	413.000	2081.000	831.000	1664.000	2500.000
BIC	14572.380	1294.666	6322.834	3154.936	5054.481	7453.676

* p<0.10, ** p<0.05, *** p<0.01

Table 11: Cluster 2 with second alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This is the second alternative specification and consider fixed effects, time effects. Furthermore, a second-lag of the dependent variable is considered as explanatory variable. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L.dlempn	0.076***	-0.170***	0.004	-0.244***	-0.007	0.009
	(0.014)	(0.033)	(0.020)	(0.028)	(0.024)	(0.018)
shock g	-0.064**	-0.143	-0.036	-0.165**	-0.000	-0.069
	(0.028)	(0.105)	(0.032)	(0.084)	(0.041)	(0.054)
D UP	0.033	0.144*	-0.020	0.011	-0.008	0.032*
	(0.024)	(0.076)	(0.014)	(0.010)	(0.036)	(0.017)
F UP	0.001	0.001	0.000	-0.000	0.001	0.008**
	(0.001)	(0.006)	(0.002)	(0.001)	(0.002)	(0.003)
D DO	-0.008	-0.129***	-0.001***	-0.000	-0.028*	-0.012
	(0.012)	(0.046)	(0.000)	(0.002)	(0.016)	(0.022)
F DO	0.004**	-0.011	-0.000	-0.000	0.004*	0.003
	(0.002)	(0.013)	(0.000)	(0.001)	(0.002)	(0.003)
Constant	-0.123***	-0.069***	-0.078***	-0.353***	-0.126***	-0.143***
	(0.014)	(0.024)	(0.019)	(0.031)	(0.020)	(0.020)
Adj. R^2	-0.069	-0.440	-0.160	-0.259	-0.199	-0.138
DF R	5430.000	830.000	2502.000	1250.000	2084.000	2922.000
BIC	16462.338	2537.189	7845.496	4553.390	6396.011	9520.056

* p<0.10, ** p<0.05, *** p<0.01

Table 12: Cluster 2 with third alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L.dlempn	0.065***	-0.169***	-0.007	-0.293***	-0.013	-0.010
	(0.014)	(0.033)	(0.020)	(0.029)	(0.024)	(0.018)
shock g	-0.030	-0.141	-0.025	0.000	0.028	-0.015
	(0.028)	(0.105)	(0.032)	(0.078)	(0.042)	(0.051)
D UP	0.017	0.146*	-0.022	0.006	-0.023	0.031*
	(0.023)	(0.076)	(0.014)	(0.009)	(0.036)	(0.016)
F UP	0.002	0.001	-0.000	-0.000	0.001	0.007**
	(0.001)	(0.006)	(0.002)	(0.001)	(0.002)	(0.003)
D_DO_	-0.010	-0.129***	-0.001***	0.000	-0.031*	-0.011
	(0.011)	(0.046)	(0.000)	(0.002)	(0.016)	(0.021)
F_DO_	0.004**	-0.010	-0.000	-0.000	0.004*	0.003
	(0.002)	(0.013)	(0.000)	(0.001)	(0.002)	(0.003)
Adj. R^2	0.066	0.047	0.027	0.215	0.014	0.101
DF_R_	5417.000	828.000	2496.000	1247.000	2079.000	2915.000
BIC	16223.951	2549.642	7837.275	4272.419	6407.517	9241.248

* p<0.10, ** p<0.05, *** p<0.01

Table 13: Cluster 2 with fourth alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects and time effects. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

	1997:2011 Coef./S.E.	1997:2000 Coef./S.E.	2000:2007 Coef./S.E.	2007:2011 Coef./S.E.	1997:2003 Coef./S.E.	2003:2011 Coef./S.E.
L2.lempn	-2.162***	1.279	-3.864***	-3.589***	-3.967***	-3.034***
	(0.095)	(0.777)	(0.196)	(0.572)	(0.293)	(0.200)
shock g	-0.015	0.037	-0.028	-0.063	0.062	0.007
	(0.027)	(0.130)	(0.033)	(0.090)	(0.040)	(0.049)
D UP	-0.011	0.028	-0.017	0.001	-0.048	0.033**
	(0.023)	(0.107)	(0.014)	(0.010)	(0.037)	(0.015)
F UP	0.002	-0.002	0.001	0.001	0.001	0.006**
	(0.001)	(0.005)	(0.002)	(0.001)	(0.002)	(0.003)
D DO	-0.008	-0.157***	-0.001***	-0.001	-0.021	-0.011
	(0.011)	(0.058)	(0.000)	(0.003)	(0.016)	(0.020)
F DO	0.004**	-0.024	-0.000	-0.000	0.004*	0.000
	(0.002)	(0.017)	(0.000)	(0.001)	(0.002)	(0.003)
Adj. R^2	0.153	0.030	0.182	0.191	0.115	0.200
DF R	5000.000	411.000	2079.000	829.000	1662.000	2498.000
BIC	14587.985	1296.670	6320.345	3169.098	5064.226	7465.619

* $p<0.10$,
** $p<0.05$,
*** $p\leq0.01$

Table 14: Cluster 2 with fifth alternative specification. Estimations consider network sale relationships between sectors and the propagation of government expenditure shocks. This third alternative specification consider fixed effects, time effects and the second-lag of dependent variable as an explanatory variable. Furthermore, the upstream and downstream effects are aggregates according the origin (domestic or foreign) of the sectors that affecting the focal sector. The values of shocks and dependent variables are standardized in terms of standard-deviations units. Downstream and upstream flows use the Leontief inverse to provide the full chain of interconnections across cluster of countries.

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