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FDI in China and global production networks: Assessing the role of and impact on big world players

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Abstract

How can countries successfully engage in global production networks? We provide a Computable General Equilibrium analysis of the impact of FDI on global production networks in Textiles, Chemicals, Electronics and Machinery, dividing the world economy in six regions (China, East Asia, Japan, EU28, the U.S. and the group of Emerging and Developing Economies). Interestingly for the policy maker, although the four sectors have contrasting production technologies, their Chinese exports and imports still follow a similar trend: East Asia and Japan are Chinese main intermediate suppliers while the US, Europe and the Emerging and Developing Economies play more the role of final markets. FDI inflows have benefitted China and we quantify by how much they have raised Chinese wages, GDP, national income and export competitiveness. By contrast, being an intermediate supplier or playing mostly the role of big final market in the network is not enough to succeed in your integration with China. The extent of the (positive or negative) effects is very much related to whether the structure of production (i.e., sectors' weight in GDP) of the different economies is similar to (and therefore more easily crowded out by) Chinese booming sectors.
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1. Introduction

Many governments seek policies to attract Foreign Direct Investment (FDI) and try to take part in global production networks. FDI has played a vital role in moving the center of manufacturing from the North to the South (Chen & De Lombaerde, 2014; Baldwin, 2016). The rise of China as a production center and engine of world growth, as well as, the huge FDI inflows it has received has raised many discussions (Lin, 2016). In this paper we provide quantitative evidence on the main mechanisms by which FDI inflows accruing to China interact with global production networks. We focus on flows going to manufactures, that have for long dominated Chinese FDI inflows and given rise to "Factory Asia" (Baldwin, 2016; Baldwin, 2011). We aim at replying to relevant policy questions such as: Should countries engage in global production networks? Which are the determinants of the failure or success in taking part in those networks? What are the main micro and macroeconomic outcomes of FDI inflows accruing to China? What does, then, the 'Made in China' really mean? What can other regions expect from it?

Most of the analyses on production networks and trade regionalization have been carried out using gravity models, intensity indices or network analysis tools (Iapadre & Tajoli, 2014). By contrast, in this paper we use a computable general equilibrium (CGE) model, which considers the interplay of six regions in which the world economy has been split and has a long tradition as a prominent tool for policy analysis (Dixon & Rimmer, 2016). The six regions are: China, East Asia, Japan, EU28, the U.S. and the group of Emerging and Developing Economies (EMD)[1] . This technique allows us to model the impact of FDI, which has seldom been modelled using CGEs (see Latorre, 2009; Tarr, 2012; Fernández-Pacheco et al., 2018).

By means of our CGE model we can combine the interaction of a wide set of macro and microeconomic variables. In addition, several aspects of FDI and production networks can be studied, such as its differential impact across networks, sectors, countries or regions, depending on technologies of production, export orientation and import reliance, among other factors. Our approach incorporates the real data on total costs and production in the different sectors of the regions we consider, and their multiple foreign trade connections through networks, which underlie their corresponding results at higher levels (such as GDP growth, aggregate foreign trade and welfare). In this sense, we go beyond the approach taken by the few multi-country general equilibrium models which explicitly consider FDI (such as, Arita & Tanaka, 2014; Burstein & Monge-Naranjo, 2009; Costas et al., 2013; McGrattan & Prescott, 2009; Ramondo, 2014; Ramondo & Rodríguez-Clare, 2013) and fail to offer any impact across sectors in the economy. Their analyses have relied in most cases on aggregates of manufacturing sectors, which we disaggregate, while we also cover services sectors and the entire economy.

The model, thus, captures the presence of Asian production networks, together with the main destinations of final and intermediate goods produced by China. Lin and Wang (2018), using the datasets of 'valued-added exports' derived in the global input-output analysis of Johnson and Noguera (2012) and Johnson (2014), obtain that imported intermediates to China keep increasing and that China has become more and more integrated in a global production network. However, in this paper, we go beyond the data describing the presence of networks and try to quantify the consequences of the particular linkages of each region, country and sector with the Chinese economy. This should be of interest for the policy maker.

[1] East Asia is constituted by Republic of Korea, Taipei China, Hong Kong China, and ASEAN countries (Singapore, Cambodia, Indonesia, Republic Lao, Malaysia, Philippines, Thailand and Vietnam). The emerging and developing (EMD) region is mainly composed by developing countries classified in the latter group by the IMF (2016).

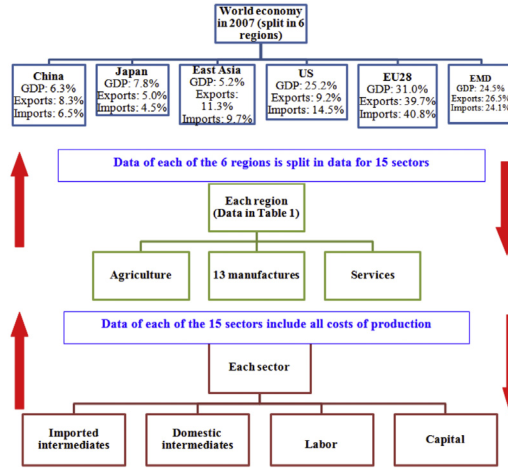

Fig. 1. Multilevel data in the model (2007).
Source: Authors' calculation based on Narayanan, Aguiar & McDougall (2012).
Note: see Table 1.

The rest of the paper is organized as follows. Section 2 describes the role of the different regions as production centers, intermediate suppliers and final markets. Section 3 presents the model and simulations. The results are analyzed in section 4, while section 5 concludes.

2. Data

Our model relies on the real data for the world economy provided by the GTAP8 database (Narayanan et al., 2012), which we split in six regions and fifteen sectors. Fig. 1 reflects the different levels of data. It incorporates the weight of the six regions in the world economy (China, Japan, East Asia, U.S., EU28 and the group of Emerging and Developing Economies, EMD). These regions, in turn, have 15 sectors (13 manufactures, agriculture and services), for which there is a complete set of real values about their total costs (bottom level of Fig. 1). We can see that these costs include capital and labor remunerations, as well as domestic and imported intermediates (all of them with their corresponding taxes). Labor costs have been rising in the last years in China. But multinationals want to lower *total* costs, which is what we include in our analysis. On the other hand, data on imported intermediates is of upmost importance for the study of global production networks. The more foreign investors source internationally, the lower the opportunities for local firms to become engaged in global production networks.

Fig. 1 gives an outline (GDP, exports and imports) of regions' shares in the world.[2] In 2007, Europe is the largest economy (31% of world GDP), ranking first also in world trade (about 40%). The U.S. and EMD come next in their GDP shares (both around 25%) but they are very different

[2] The information refers to the year 2007, i.e., before the financial crisis of 2008. The absolute values of GDP (which are not reproduced in Fig. 1) and their shares in the world resemble well the ones from the World Bank "World Development Indicators" in current dollars of 2007, which is the source used by GTAP for macroeconomic variables (Hussein & Aguiar, 2012). For trade data issues like re-exports are dealt carefully by the GTAP team, which uses United Nations COMTRADE data (Gehlhar et al., 2010). In addition, the Input-Output structure of our model and dataset reproduces the one available in GTAP9, as documented in Yu and Chen (2016).

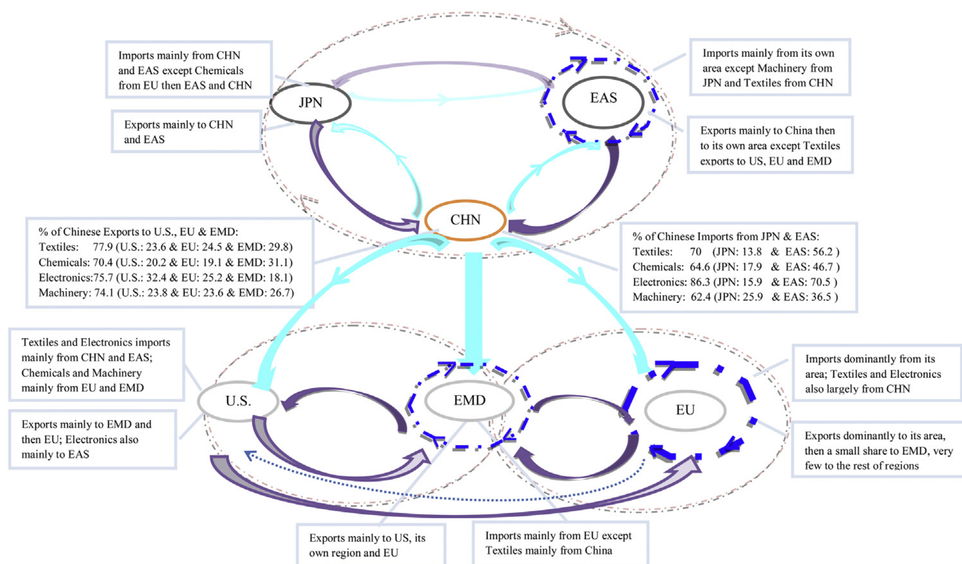

Fig. 2. Main trade relationships in Textiles, Chemicals, Electronics and Machinery among regions.
Source: Authors' caculation based on GTAP 8 Data Base (Narayanan et al., 2012).
Note: see Table 1.

in their trade openness. The US is a quite close economy, so is Japan. China and East Asia, by contrast, are more open since their weight in world trade surpasses their shares of 6.3% and 5.2% in GDP, respectively.

Table 1 offers the definition of the 15 sectors and their relative importance in each region's GDP, exports and imports. The GDP structure reflects the level of development of the different regions. Agriculture and Mining are still important in China and EMD. Services are less important by contrast in these two regions compared with the rest. The four sectors, to which FDI accrues (Textiles, Chemicals, Electronics and Machinery) appear in bold. They account for 19.2% of Chinese GDP. In East Asia, whose GDP structure in manufacturing is very similar to that of China, their weight is 13.3% of GDP. The shares in Japan and Europe are similar and around 10%. The areas in which they are less relevant are the U.S. (7.5%) and EMD (6.4%).

The four sectors receiving FDI inflows are vital for the exports of China (64.5%), East Asia (54.6%) and Japan (53.4%), while they are less important in the rest of regions. There is a strong network between China and East Asia, in which Japan also participates although it is less integrated than the two previous regions. We summarize this in Fig. 2, in which we can see that East Asia provides the vast majority of total Chinese imports ranging from 70.5% in Electronics to 36.5% in Machinery. The next most important single country supplier for China is Japan, which accounts for around 15% of Chinese imports, with the exception of Machinery where it provides 25.9%.Taking into account that 86.3%, 96.9%, 84.5% and 68% of total Chinese imports are of intermediates in Textiles, Chemicals, Electronics and Machinery, respectively, there must be a strong network by which East Asia and, to a lesser extent Japan, provide intermediates to be further processed in China.[3]

[3] The percentage of imports to be used as intermediates is not available in Fig. 2, but their data are derived from the GTAP Database (Narayanan et al., 2012).In Zhou and Latorre (2014a; 2014b) we analyze more deeply the amount of

Table 1
Definition of sectors and their relative importance in each region's GDP, Exports and Imports (2007).

Sector/Goods Definition	GDP (%)						Exports (%)						Imports (%)					
	CHN	JPN	EAS	US	EU	EMD	CHN	JPN	EAS	US	EU	EMD	CHN	JPN	EAS	US	EU	EMD
01−14 Agriculture	11.0	1.2	5.5	1.0	1.7	6.6	0.9	0.1	0.8	3.8	1.6	3.8	2.7	2.5	2.0	1.3	2.2	2.6
15−18 Mining	4.0	0.1	3.7	1.2	0.7	11.0	0.5	0.1	3.4	1.1	1.1	32.6	13.9	23.3	12.7	12.6	6.9	7.3
19−26 Food & Beverages	3.2	3.3	3.5	2.2	4.1	4.5	2.0	0.4	3.4	3.1	5.2	4.9	1.8	5.2	3.3	2.9	4.8	4.8
27−29 Textiles	**4.1**	**0.6**	**2.0**	**0.8**	**1.7**	**1.6**	**17.2**	**1.1**	**5.2**	**1.4**	**3.5**	**3.9**	**2.7**	**5.1**	**3.3**	**5.8**	**4.8**	**4.6**
30−31 Woods & Paper	2.1	1.8	1.6	2.4	2.3	1.5	4.2	0.7	2.3	2.7	4.0	2.6	1.9	2.7	1.7	3.6	3.7	3.0
32 Petroleum	0.6	2.6	2.3	0.5	2.1	1.3	1.8	1.5	3.9	4.1	2.2	6.3	2.4	3.8	4.3	3.5	3.0	4.4
33 Chemicals	**5.7**	**2.5**	**4.0**	**2.6**	**3.6**	**2.4**	**7.4**	**12.2**	**10.8**	**13.3**	**15.3**	**6.0**	**12.5**	**7.8**	**10.5**	**8.4**	**13.0**	**10.9**
34−37 Metals	7.4	3.0	3.7	2.2	3.7	3.5	9.8	9.2	6.5	6.1	9.5	10.2	8.4	6.8	10.0	6.7	9.5	9.8
38−39 Motor Vehicles	2.5	2.6	2.8	1.9	2.7	2.0	3.3	24.1	6.1	14.5	13.0	5.9	4.2	4.3	4.5	12.5	11.1	12.4
40 Electronics	**3.0**	**2.8**	**4.6**	**0.6**	**1.0**	**0.8**	**22.5**	**13.5**	**25.3**	**6.8**	**4.5**	**2.3**	**20.2**	**9.0**	**15.4**	**11.0**	**5.7**	**5.4**
41 Machinery	**6.5**	**3.2**	**4.8**	**3.5**	**4.4**	**2.1**	**17.4**	**26.6**	**13.3**	**16.5**	**16.5**	**5.2**	**18.2**	**10.5**	**14.0**	**13.5**	**12.5**	**15.3**
42 Other manufacturing	2.5	0.6	0.6	0.4	1.0	0.8	6.2	1.0	1.2	1.4	1.4	1.3	0.4	1.6	1.2	3.4	1.7	1.5
43−45 Electricity & Gas & Water	3.4	1.9	2.3	2.1	2.3	3.0	0.1	0.0	0.1	0.2	0.6	0.9	0.1	0.1	0.3	0.2	0.7	0.5
46 Construction	6.3	6.4	5.7	6.3	7.1	6.7	0.4	1.3	0.8	0.5	0.7	0.4	0.4	1.3	0.5	0.1	0.6	0.9
47−57 Services	37.9	67.4	52.8	72.5	61.5	52.2	6.2	8.2	16.8	24.5	21.1	13.8	10.3	16.0	16.2	14.3	19.8	16.5
Whole economy	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Authors' calculation based on Narayanan, Aguiar & McDougall (2012).
Note: The definition of sectors follows the ISIC Rev 3 Classification. CHN, JPN, EAS, US, EU and EMD stand for China, Japan, East Asia, United States, Europe and Emerging & Developing Economies, respectively. East Asia is constituted by Republic of Korea, Taipei China, Hong Kong China, and ASEAN countries (Singapore, Cambodia, Indonesia, Republic Lao, Malaysia, Philippine, Thailand and Vietnam). Our emerging and developing (EMD) region is mainly composed by the remaining 110 the countries of the world classified by the IMF in that group. See footnote 1.

Fig. 2 also shows that Chinese geographical export structure contrasts drastically with that of the imports. More than 70% of total Chinese exports go to the U.S., EU and EMD, with EAS being the next important destination (after the U.S., EU and EMD). Imports from EAS are mostly intermediates. This suggests that most of the Chinese final goods go to the U.S., EU and EMD, although there may be also intermediates in those Chinese exports to be further processed in those areas of the world.

Services account for the largest share in exports in the U.S. (Table 1). Exports of Motor vehicles are very important for Japan, while EMD depends heavily on its Mining exports. Textiles exports are very important in China and less important in the rest of regions. The four sectors experiencing FDI increases account for 53.5% of overall Chinese imports and 43.2% in overall East Asian imports, while their weight in imports in the rest of regions is smaller.

Table 2 presents each region's weight in world GDP, exports and imports focusing on the sectors where the FDI shock takes place in China. The brackets of the columns labelled 'World' further offer the importance of the particular sector in total world GDP, exports and imports. By 2007, China has a relatively small weight in total world GDP (6.3%), as shown in Fig. 1. However, Table 2 shows that it still generates important shares of global value added in these four sectors, particularly, in Textiles (16.7%) and Electronics (14.3%). Further, its contribution to world exports in these two latter sectors is of remarkable importance, 30.7% and 22.1%, respectively. China, Japan and East Asia nearly account for half of world exports of Electronics and Textiles. The three regions share a trade pattern by which their role in exports tends to surpass by far their role in imports (i.e., they constitute the 'trade surplus' areas in the world). The contrary applies to the U.S. an EMD, and to a lesser extent to Europe (i.e., the 'trade deficit' areas). Europe is the largest single region in the creation of world value added, exports and imports in the four sectors considered. It stands out, however, in its importance in value added in Chemicals and Machinery and, even more, in exports from these two sectors, in which it exhibits trade surpluses. EMD is relatively important in the production and trade of Textiles but less important in exports from the other three sectors. Note that Textiles, in turn, accounts for a very small share in world GDP (1.5%) and in world exports which, necessary coincide with world imports (both accounting for 4.6% in the total)[4] . Machinery is the most important sector in terms of world trade (13.7%), followed by Chemicals (11.3%) and Electronics (8.4%).

To sum up, in 2007 China accounts for rather reduced shares in world GDP, exports and imports. In the sectors receiving the FDI shock, however, China is considerably more important than on average in the world. The construction of "Factory Asia" had already begun. The data we have analyzed point to the existence of a strong integration of China with East Asia and to a less intense one of China with Japan. Both regions supply most of the intermediates that are further processed in China. The U.S., EU and EMD are not important suppliers of intermediates but play more the role of markets for China. The EU is by far the region with highest weights in GDP, exports and imports before the financial crisis.

imports and their use (i.e., whether they are for private or public consumption, investment or intermediates), for less sectors (only Textiles, Electronics and Machinery) and regions (China, East Asia, U.S. and ROW). Unfortunately, GTAP does not offer simultaneous information of imports by use *and* source (i.e., we do not know simultaneously whether Chinese imports from East Asia are of intermediates). However, the isolated data reveal several outstanding trends that we have tried to summarize here.

[4] Both the exports and the imports are calculated at FOB value. We have also compared the exports and imports at CIF value with the ones at FOB value. The differences are very small and do not affect our results.

Table 2
Each region's weight in world GDP, exports and imports of Textiles, Chemicals, Electronics and Machinery (2007).

Sector	Regional % in world sectoral GDP						World	Regional % in world sectoral exports						World	Regional % in world sectoral imports						World
	CHN	JPN	EAS	US	EU	EMD		CHN	JPN	EAS	US	EU	EMD		CHN	JPN	EAS	US	EU	EMD	
Textiles	16.7	3.2	7.0	13.6	34.4	25.1	100 (1.5)	30.7	1.2	12.7	2.7	30.3	22.4	100 (4.6)	3.7	5.0	7.0	18.3	41.6	24.4	100 (4.6)
Chemicals	11.3	6.4	6.6	20.7	35.9	19.0	100 (3.1)	5.4	5.4	10.7	10.8	53.6	14.0	100 (11.3)	7.3	3.1	9.2	10.8	46.0	23.6	100 (11.3)
Electronics	14.3	16.9	18.6	10.8	24.3	15.2	100 (1.3)	22.1	8.1	34.0	7.5	21.1	7.2	100 (8.4)	15.3	4.9	17.8	19.0	27.7	15.4	100 (8.4)
Machinery	11.0	6.9	6.8	24.0	37.4	14.0	100 (3.7)	10.5	9.7	11.0	11.1	47.6	10.1	100 (13.7)	8.5	3.5	9.9	14.4	36.8	27.0	100 (13.7)

Source: Authors' calculation based on Narayanan, Aguiar & McDougall (2012).
Note: see Table 1.

3. The model and simulation

Our CGE model includes the real data described in the previous section in a robust theoretical framework, namely, the Arrow-Debreu general equilibrium model (e.g., Arrow & Hahn, 1971) using a duality approach (Dixit & Norman, 1980). As mentioned in the introduction, in so doing it covers a wide representation of different sectors in the economy which is lacking in other multi-country general equilibrium models. An advantage of the stylized models is that several of them include a more advanced microeconomic performance, such as heterogenous firms (e.g., Arita & Tanaka, 2014; Costas et al., 2013). However, these latter models are also simplified along other dimensions like not considering trade (Arita & Tanaka, 2014; Ramondo, 2014) or omitting the fixed costs of production of Multinationals (Costas et al., 2013). A few of them have also modelled Multinationals in a perfect competition framework (Ramondo, 2014; Ramondo & Rodríguez-Clare, 2013; Burstein & Monge-Naranjo, 2009; McGrattan & Prescott, 2009), as we do. It is hard to model FDI in a general equilibrium framework. Very few CGEs have done so (see Markusen, 2002; Latorre, 2009; Tarr, 2012). When FDI and trade are put simultaneously in a general equilibrium framework, there is a trade-off between the variables the model can handle.

In our case, we combine a rich description of the technology of production of firms (their cost structures and output levels) across different sectors together with the demand side of the economies (e.g., how much production of each sector is exported or demanded internally and for which particular use[5]), and the presence of factor markets (labor and capital demanded for production and their corresponding remunerations). The macroeconomic outcomes, arise from the aggregation of all sectoral results. Additionally, the resulting aggregates have to fulfill equations reflecting the national accounts identities. These latter equations reproduce the circular flow of the economy: production, income distribution, and (domestic and foreign) demand.

We use the GAMS (General Algebraic Modeling System) version (Rutherford, 2005) of the Global Trade Analysis Project (GTAP) model (Hertel, 1997). The full description of the equations in the model is available in Zhou and Latorre (2014a). Fig. 3 offers a graphical overview of the model and on how the FDI shock is implemented including first round knock-on effects.

Since we want to explore the role of FDI and its interaction with networks, we simulate a shock of an increase in FDI inflows, which rises the capital stock available for production, as appears in Fig. 3. To be more precise, our simulation consists of a simultaneous increase in the capital stock of the Chinese sectors of Textiles, Chemicals, Electronics and Machinery, which will increase the overall capital stock available for production in the economy and, thus, national income. Capital remuneration will be affected due to the growth in the capital stock. In fact, capital remuneration will fall in the sectors receiving FDI since capital becomes more abundant, but the impact will differ across sectors. On the other hand, the sectors receiving the FDI inflows, will increase their production since they have more productive capital. The rest of adjustments throughout the economy become endogenous after this initial shock and will be discussed in the results explained below.

Based on the data from NBSC (various years), the accumulated FDI inflow, proxied by fixed asset investment funded by foreign capital, in Electronics has nearly doubled during the period from 2004 to 2011, the increase was around 50% in Machinery, and 30% in both Chemicals and Textiles. Thus, we simulate a shock corresponding to those sectoral capital stock increases simultaneously, keeping the capital stock in rest sectors and regions fixed. We do not delve into

[5] See footnote 4.

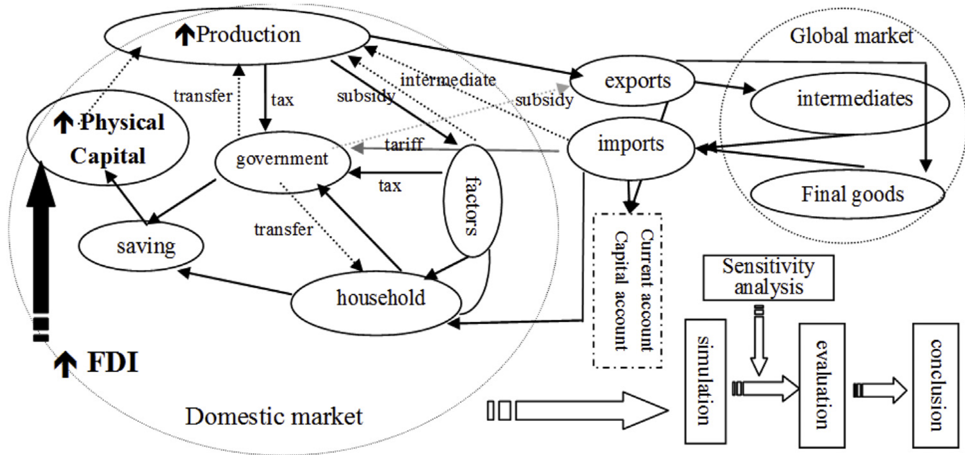

Fig. 3. Causation chain of FDI shock in the open economy.

the determinants of FDI accruing to China but rather try to estimate the quantitative impact of the actual flows that have taken place. By using the public data on the exact evolution of foreign assets, we can assure that the model reproduces the FDI inflows China has effectively received. It is difficult to model endogenous adjustments of FDI or investment, in general (Fernández-Pacheco et al., 2018). In the CGE world this has been hardly ever done (see Tarr, 2012; Latorre, 2009 for reviews). The few CGE models that include endogenous FDI do it by having the flows responding to either rentals rates of returns (e.g., Hosoe, 2014) or to Non-Tariff Barriers (NTBs) to the operations of foreign multinationals (e.g., Latorre & Yonezawa, 2017; Latorre et al., 2018). Hosoe (2014) develops an interesting model but note that it is confined to three regions, because dealing with FDI flows among more regions becomes hard to manage. On the other hand, Latorre and Yonezawa (2017) and Latorre et al. (2018, Latorre, Oleksekyuk, & Yonezawa, 2020; Latorre, Oleksekyuk, Yonezawa et al., 2020; Latorre, Olekseyuk et al., 2020) focus on the impact of FDI in services, because there are no estimations of NTBs for goods. This makes it close to impossible to properly apply this latter approach to FDI in manufactures, which is the case in this paper. Ideally, one would prefer to model FDI endogenously, at least to simulate the impact of future events or policies. However, when analyzing past trends, as we do, using FDI series may be safer to get the evolution of FDI right.

One important point about our modeling strategy is that we isolate the impact of FDI in the adjustment of the model. This contrasts with other techniques, which look for causality in data that are the result of a complex interplay of different forces. Our initial dataset is also the result of complex economic forces across regions. However, once it is in place, we *only* introduce in the model a shock that changes capital stocks in the sector to which FDI accrues. This implies that the subsequent adjustments only respond to the change in levels of FDI, as illustrated in Fig. 3. By comparing percent changes across variables of the model with respect to the initial dataset we have isolated the impact of FDI.

Note that FDI (and its related capital) goes to different sectors which use different technologies. This means that 'the same amount of FDI inflows' will have a distinct impact depending on the particular sector involved in the shock (e.g., Latorre et al., 2009; Gómez-Plana & Latorre, 2014; Gómez-Plana & Latorre, 2019; Latorre, 2016). Indeed, in the model capital is assumed to be

sector specific, i.e., the capital used in, say, chemicals will be different to the one used in other sectors. It is true that Multinationals carry with them a rich set of tangible and intangible assets whose effects can hardly be proxied by data on capital stocks. Hymer (1976) and Dunning (1980) draw attention to the peculiarities of the multinational firm and, somehow, turn the analysis of FDI from capital moving across countries into an analysis of special firms (Multinationals). However, trying to model and quantify that process seems an effort in which the profession is still struggling. In addition, we do not have any information on differential costs between national firms and multinationals operating within the same sector and no multiregional general equilibrium model has included those differences in technology within sectors based on real data.[6] Because multinationals focus in China in processing and assembly, rather than on R&D, and many Chinese domestic firms are involved in global production networks (Baldwin, 2016), we expect those differences not to be too drastic. Interestingly, Tian (2007) finds that it is foreign firms' capital in China which has positive effects of technology spillovers on the productivity of domestic firms, rather than their foreign products or employment which are insignificant in his analysis. Tian even identifies that 'the positive effect of FDI technology spillovers through capital comes mainly from foreign participation in tangible assets rather than from foreign participation in intangible assets (Tian, 2007: 153). Furthermore, among developing countries FDI taking the form of greenfield investment is more common than in developed economies. In particular, foreign mergers and acquisitions in China account for 7.3% in the period 1990–2010, compared to a world average of 38.9% (Liu et al., 2015). Therefore, capital is an important element of Multinationals' effects.

This assumption of specific capital also implies that capital is fixed and cannot move across sectors. It is a common assumption in the CGE literature (e.g., Latorre, Oleksekyuk, & Yonezawa, 2020; Latorre, Oleksekyuk, Yonezawa, et al., 2020; Ortiz-Valverde & Latorre, 2019, 2020). As a consequence, our results should be interpreted as the short run outcome, i.e., the impact after two or three years. Further, the assumption of specific capital also involves that its remuneration will differ across sectors. Labor, by contrast, is fully mobile within regions and its endowments are fixed. Therefore, the wage will be the same within each of the regions considered in the model.

After the simulation, factor remunerations in the sectors receiving a shock will be changed (i.e., the rental rate of capital is impacted directly by the FDI increase). As a consequence, those sectors will readjust their production, factor demands, intermediate inputs, prices, exports and imports. The rest of sectors respond to the shock as well, changing their inputs, production and price. National income changes due to the change of capital stock and its remuneration and also due to the adjustment of the overall wage. Domestic demand for private consumption and intermediates adjusts to national income and output changes, respectively.

The export orientation, domestic/imported intermediate intensity and private consumption orientation vary largely in the four sectors studied. Zhou & Latorre (2014a; 2014b) have analyzed this in detail. Given the division and collaboration through production networks and other trade patterns, the rest of regions respond differently to the changes of Chinese FDI and trade. As a result, they will also adjust production, imports, and exports, as well as other variables.

[6] There is a trade-off in the modelling approach. A model that covers the entire economy and derives several sectoral and macroeconomic results for different countries and regions, as the one in this paper, cannot differentiate those technologies. If one wants to differentiate technology between firm types within sectors one would probably have to do case studies. But case studies miss the overall picture at the macroeconomic level and the impact on all of the remaining sectors in the economies of the model.

Table 3
Impact on aggregate variables (% change).

Aggregate variables	China	Japan	East Asia	United States	Europe	Emerging&Developing Economies
Wage	0.42	−0.36	−0.58	−0.18	−0.33	−0.22
Rental rate of Capital	−1.99	−0.32	−0.31	0.06	−0.22	0.48
National income (Welfare)	11.54	−0.32	−0.41	−0.07	−0.81	0.51
Capital stock	7.36	0.00	0.00	0.00	0.00	0.00
Imports	7.86	−0.19	−0.25	−0.04	−0.44	0.56
Exports	2.90	0.60	0.02	0.25	0.63	−0.47
GDP	2.68	−0.26	−0.40	−0.10	−0.26	0.18

Source: Authors' simulations.

4. Results

Table 3 presents the percentage change in wages, the rental rate of capital, national income, which is a proxy for welfare, the capital stock, aggregate imports and exports, as well as GDP across regions.

The FDI flows accruing to China increase its capital stock by 7.36%. This would improve labor productivity and therefore wages by 0.42%[7] . An accumulation of capital causes a reduction in its remuneration of 1.99%. The increase in wages, together with a higher capital stock, leads to a strong expansion of national income and welfare (11.54%)[8] . As a result, aggregate imports rise heavily (7.84%), propelled by higher demand and production, while exports also rise although less intensively by 2.90%. Recall that the sectors receiving the FDI increase heavily their exports but due to the rise of national income and production, exports in other sectors will be reduced. Finally, all these forces drive up GDP in China by 2.68%. As happened with national income, the reductions in the rental rate of capital are more than compensated by the increase in wages and in the capital stock available for production. The causation chain we have described and the findings we have derived are in accordance with previous studies on the impact of FDI on host economies (Latorre, 2012, 2013; Latorre & Hosoe, 2016).

The adjustments are logically of smaller magnitude in the rest of regions. Because production shrinks slightly in all of them (Zhou & Latorre, 2015), wages, and often the rental rate of capital, will diminish. According to GDP outcomes, the decrease in value added is most intense in East Asia, Japan and Europe. In these regions, the weight in GDP of the three sectors in which Chinese exports increase most (Electronics, Machinery and Chemical) is the largest (Table 1). Chinese competition crowds out exports of the rest of regions in these sectors, thus, reducing their output (Zhou & Latorre, 2015). As shown in Table 1, East Asia is the region in which these sectors account for the largest share in GDP (13.3%)[9] . That is why East Asia experiences the most intense decreases in wages and in the rental rate of capital. In the opposite extreme, EMD and the U.S. exhibit the lowest weight of GDP in these three sectors (5.3% and 6.6%, respectively). This explains why the fall in wages is the smallest in these two regions and the capital rental

[7] This increase in wages falls short of the overall rises they have experienced in China, but note that our model focuses on FDI, while other forces are pushing up wages in China simultaneously.

[8] This may seem a very high impact for welfare. Ramondo and Rodríguez-Clare (2013) have derived that the gains from trade are much larger once FDI is included in the analysis, than in trade-only models.

[9] This result is in line with the one derived by Wang (2003), who had pointed out that countries with an endowment structure similar to China like those in South and South East Asia would experience keener competition in labor-intensive exports.

even increases[10] . This evolution of factor's remunerations lies behind the outcomes on national income and GDP. GDP, indeed, decreases most in East Asia, followed by Japan and Europe. The U.S. also undergoes a reduction in national income and GDP, while EMD, whose capital rental increases heavily, exhibits rises in both national income and GDP. Recall the GDP structure in EMD is quite protected from Chinese competition, since it heavily relies on Mining, Agriculture and Services in which Chinese exports are going down[11] .

The fall in national income, which drives down private consumption across all regions (except in China and EMD), explains the reduction in aggregate imports. Aggregate exports, by contrast, rise slightly due to the higher exports in the sectors in which China competes less.

All in all, China benefits from FDI inflows. EMD also benefits because its economic structure differs from the one in China. The contrary applies to East Asia, whose GDP manufacturing structure closely follows that of the Asiatic giant. As a result, East Asia is heavily crowed out in important sectors that coincide with the ones in which China becomes very aggressive. Japan and Europe are intermediate cases in the sense that they are crowded out in some sectors but are able to compensate that by exporting more in others. Finally, the U.S. is less harmed than Japan or Europe due to its low exposure to Chinese competition.

Our Unconditional Systematic Sensitivity Analysis (Harrison et al., 1993) indicates that percentages adjustments in GDP are negligible across regions, even though for China the higher the elasticities the slightly higher the GDP turns. This implies that more flexible technologies facilitate a more efficient use of resources leading to more growth. Across the rest of variables changes are very small with the different elasticities. The causation chain behind the results which has already been explained clearly remains applicable. EMD and China would be the only regions that win after the shock.

The results of the sensitivity analysis, as well as sectoral outcomes on output, exports and imports across regions can be found in an earlier version of this paper, namely, Zhou and Latorre (2015).

5. Conclusions

We have simulated the real FDI increases that have taken place in Chinese Electronics, Machinery, Chemicals and Textiles from 2004 to 2011. We have shown that these four sectors account for 64.5% and 53.5% of Chinese overall exports and imports, respectively, while their weight is of 38.1% in total world exports (or imports) in 2007. The use of a CGE model allows us to provide a thorough quantitative estimation of the impact for a wide range of variables for several regions and sectors. This should be of interest for the policy makers, who need to analyze the overall macroeconomic impact of different phenomena, as well as their differential results across sectors in the economies involved. The results from our CGE model may be helpful to illustrate several policy-oriented lessons:

First, policies to attract FDI have been very beneficial for the Chinese economy and explain to a great extent its export competitiveness. China has benefitted from FDI inflows, since it has

[10] The reductions in US wages we derive are in accordance with the bad outcomes for the US labor market derived by Autor et al., 2016), following the increase in competition from China. However, the latter authors have used econometric techniques and focused on manufacturing sectors.

[11] The reductions in GDP experienced by East Asia, Japan, Europe and the US, would be smaller if flows of profit repatriation from their affiliates operating in China were substantial. We have no data on the importance of this phenomenon that would benefit the home economies.

experienced a rise in wages, GDP and national income. Our results show, that the Chinese export competitiveness increases very heavily in Electronics, Machinery and Chemicals. FDI inflows have contributed to the outstanding role of China as the "factory of the world".

Second, being an intermediate supplier may not be enough to succeed in your integration in a global network. This is the case of East Asia and Japan, which are important intermediate suppliers for China, as we have shown with the data that underlie our CGE model. However, these economies are displaced by Chinese competitiveness in third markets. East Asia is the region that is most negatively affected in terms of GDP across all the regions considered. After the FDI increase in China, East Asia will, generally, supply more imported intermediates for the sectors in which China increases production, but it will be displaced by China in the rest of markets. The main negative outcomes for East Asia arise from its decrease in production in the sectors in which China is more aggressive (Electronics, Machinery and Chemicals). The problem for East Asia is that its GDP structure is very similar to the one of China and it suffers Chinese growing competition precisely in the sectors that are more important for its own growth. In Japan the weight in GDP of Electronics, Machinery and Chemicals is considerably smaller than in East Asia. Therefore, the negative outcomes are considerably dampened for this latter economy.

Third, having a big final market in a network may not be enough to benefit from your participation in the network. Policy makers could *a priori* expect that economies would benefit from cheaper Chinese imports. Europe, the U.S. and EMD are the main destinations of Chinese exports in the sectors we consider. Imports may become cheaper, but the point is that Europe and the U.S. are also important producers in the world and the outcomes show that workers and firms suffer from losses in wages and rentals rates of return.

All in all, the arrival of FDI inflows to Chinese manufacturing seems to have produced rather small but still negative effects in other regions of the world, except for the US and EMD. Engaging in a network with China may be the only way of survival, but it does not guarantee profitable outcomes, as Baldwin (2011, 2016) suggests. Those firms failing to combine their capital with Chinese still low, although increasing, wages, will very probably be unable to compete with other firms that do so. However, China is the main winner by combining advanced technology coming from foreign multinationals with its own cheap factors of production.

A final policy implication is that the extent of the (positive or negative) effects is very much related to the structure of production (i.e., sectors' weight in GDP) of the different economies considered. As we have noted, in Japan and Europe, the weight in GDP of Electronics, Machinery and Chemicals is considerably smaller than in East Asia. In fact, European and Japanese Chemicals are the only case of survival to Chinese competition in sectors that have received FDI. Despite this virtuous evolution of Chemicals, overall production still shrinks in Japan and Europe, driving their GDP down slightly in both regions. In the U.S., the weight in GDP of the three sectors, in which Chinese competition rises strongly, is lower than in East Asia, Europe and Japan. This, together with its smaller openness to trade and the relevant role of services (in which China export less), considerably reduces its negative outcomes in GDP. In addition, the group of Emerging and Developing Economies (EMD) is the only region that we have analyzed that is positively affected by the Chinese booming economy. EMD is protected from Chinese competition because in its GDP sectors like Mining and Agriculture account for very important shares. In fact, EMD's exports from these sectors are primarily going to satisfy Chinese rising demand for Agricultural products and Mining resources.

Nevertheless, note that this trend of FDI leading to strong increases in Chinese exports is to a great extent explained by the fact that we have focused on FDI accruing to manufactures that have dominated Chinese FDI inflows for a long time. Had we analyzed FDI arriving to services

sectors, the impact on Chinese exports (and its associated potential crowding out effects) would be milder, because services production is more oriented to the national market due to the fact that many services cannot be exported (e.g., Latorre et al., 2018, Latorre, Olekseyuk, et al., 2020). Therefore, the best industrial policies outside China involve maintaining the lead in services sectors and skilled jobs, in which China is competing less, at the moment.

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