Withering globalization? The Global Value Chain effects of trade decoupling

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Abstract: The paper analyses the interindustry spillover effects of bilateral trade conflicts using the example of the 2018-2019 China-USA bilateral trade war. Empirical results are produced using a new heuristic method based on hypothetical extraction and substitution in an International Input-Output model. This model tracts a series of direct and indirect sectoral effects and provides an intuitive and computationally tractable way of mapping the potential gains and losses affecting other trade partners. It sheds light on some intricate inter-industry implications that are not obvious when considering traditional trade models. A large share of the negative impacts may be felt by third countries through two separate trade channels. Firstly, because the production of a final product in one country relies on importing intermediate goods from other trade partners, who may be negatively impacted by the trade destruction effects of the trade embargo. Secondly, because trade embargoes lead to trade substitution in order to fill the gaps left by embargoed products, and to trade deflection. Deflection occurs when the trade belligerents redeploy their unsold exports towards third countries, increasing competition for market shares. This situation is an additional threat for the Multilateral Trade Governance as large-scale trade deflection may induce a cascade of Tit-for-Tat protectionist measures, in a situation where the COVID-19 pandemics has fanned the industrial nationalism, trade protectionism and geo-political tensions which were already perceptible since the global crisis of 2008-2009.

Keywords: international trade; trade wars; Input-Output analysis; multilateralism

JEL codes : C67, D57, F02, F13, F60.

Contents

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Withering globalization?

The Global Value Chain effects of trade decoupling

1. Introduction

The new production and trade business model that arose in the late 1980's, based on the geographical fragmentation of the value chain, has increased the economic interdependency of most developed and emerging countries. The several transformational steps that a product undertakes between its initial entry in the production process, usually as an unprocessed primary good and the final consumer are called Global Value Chains (GVCs). "Global", because most industrial production today use imported inputs and produce for both domestic and export markets, "Value" because at each step, value-added is created by the industry transforming inputs into output, and "Chain" because these industries are usually organised in a network. In this GVC trade network, the output of one firm in a country is used by another firm in another country to produce a more complex product which, in turn, may be used by another firm for further processing (IDE-JETRO et al. 2019) before being exported or locally consumed as a final product.

If the normal functioning of a bilateral link within a specific value chain is broken, it will affect all the trade partners in this global interindustry chain. The rupture may be caused by natural events that prevent the production and delivery of parts and components; this was the case in 2011 with the earthquake and tsunami in Japan or the shutdown in 2019 of factories in countries affected by the COVID-19 pandemics. Leaving a deep trade agreement may also result in extensive losses from disrupting global value chains, as many observers feared it would be the outcome of a hard Brexit. Global value chains may also be damaged due to bilateral trade conflicts similar to what happened in 2018-2019 between China and the USA. As Fajgelbaum, Goldberg, Kennedy and Khandelwal (2020) mention, trade restrictions and retaliatory tariffs caused large declines in bilateral imports and exports.

Yet the issue goes well beyond trade conflict and has acquired a geo-political nature which is much more worrisome. As early as 2010, when China–US relations appeared generally positive and benign, Yan Xuetong dean of the Institute of International Relations at Tsinghua University already asserted that the China–US relationship constituted a 'superficial friendship' (Wei, 2019). Governments realised that industrial interdependency could be used to promote strategic interests as long as they could control a key intermediate input. In 2010, the threat of supply chain disruption was used in a dispute on maritime territory, when China banned rare earths exports to Japan during a diplomatic standoff between the two countries after the Senkaku boat collision incident. At that time, this threat was not officially recognised as a retaliation by the Chinese authorities: business as usual under WTO rules remained the best international option. But maintaining the status quo ante was mainly wishful thinking, because the global crisis of 2008-2009 had already changed the way the public opinion and many governments considered globalization and its cost/benefit balance. The status quo ante was officially altered in 2018 with the bilateral trade conflict that arose between China and the USA.

While both natural and political causes can both disrupt bilateral value chains, their economic impacts on other trade partners are very different. Natural causes affect the supply side by causing production shortages in a key supplier. If the affected input is in short supply, the resulting drop in GVC trade spreads to many countries, until the situation is normalised or substitutes are found. The effects are more complex when a bilateral trade war affects two major trade partners. Trade spill-overs take the form of lower trade flows between the two belligerents, as before. Additionally, they occasion also a surge of exports towards third countries. This redirection of exports (often referred to as "trade deflection" in the literature) results from exporting firms in the two belligerent countries trying to redirect their production to other markets. This often causes a rise in protectionism in these recipient countries, in order to limit the sudden surge of imports, which may be aggressively priced and even sold under production cost in order to clear unwanted stocks of output.

The objective of the present paper is to explore and measure these trade and production spill-overs, taking as example the inter-industry linkages existing between China, the USA and their main trade partners. The analysis is done in three steps, first looking at trade destruction, then at trade substitution, and finally at export deflection, which is a special case of trade diversion in the face of trade barriers.

After reviewing the relevant literature, the paper proposes a new methodology to evaluate the potential trade creation or trade destruction effects on third countries of bilateral trade restrictions. The measurement looks in detail at hypothetical sectoral impacts of policy-induced changes in market shares of final and intermediate products. The simulation focuses on sectors that were particularly targeted by China or the USA during the 2018-2019 bilateral trade conflict. In a last part, the paper illustrates another application of the methodology. By extending the simulation to a large number of sectors, the simulations generate a large body of sectoral data that reveal the mode of international insertion and the vulnerability of countries to trade shocks. A final section highlights the implications for the multilateral trade system and its governance in the Post-COVID19 new normal. Conclusions synthetize the main results.

2. Review of the literature

One strand of the trade policy literature that is closely related to our subject is the issue of trade deflection, a special case of trade diversion in the face of trade barriers. This redeployment of exports to third countries in the face of trade conflict was first analysed quantitatively by Bown and Crowley (2003) in the context of the United States' use of import restrictions on Japanese exports between 1992 and 2001. Using econometric dynamic modelling, they found that the median antidumping duty against Japan led to a 5-7% average increase in Japanese exports to non-US trading partners. Not only exports were diverted to third countries, but some additional trade destruction took place and Japan imported less from its trade partners.

Evenett and Fritz (2018) look more directly into the recent China-USA trade conflict. They emphasise the fact that the previous situation between China and the USA was far from being a free-trade arrangement. The 2018 tariff hikes compound an already significant stock of Chinese and American trade distortions affecting each other's goods exporters. Besides looking at the trade development, the authors highlights the risks of "multilateralising" the bilateral conflict because of deflection. Gunnella and Quaglietti (2019) provide a thorough factual analysis of the China-USA issue. Then, they discuss the short and long-term trade and macroeconomic implications of rising protectionism and evaluates its effects on the global economy and the euro area. Mattoo and Staiger (2019) look at the same issue from a game theory angle, considering the conflict as an episode of the U.S. Hegemony vs. China Hegemony phases, with trade conflict being a transition during which a power-based regime might look attractive to a dominant country. Then, this phase if followed by a relatively symmetric situation during which the (multilateral WTO) rules-based system is again the equilibrium regime. Their paper shows that the main systemic costs will arise from the damage done by those tactics to the rules-based multilateral trading system. In a paper related to the theoretical modelling of the impacts of trade conflicts on the WTO multilateral system when GVC trade is prevalent, Beshkar and Lashkaripour (2020) concludes that the gains from non-cooperative trade taxation and the externality inflicted by these taxes on the rest of the world have doubled in the presence of GVCs. Choi (2020) argue that the China-USA relationship is not a temporary shock, but shapes a "New Normal" that will last for some time.

Following an input-output approach similar to ours, Hu, Tian, Wu and Yang (2021) analyse the consequences of the China-US trade conflict using two scenarios: complete decoupling and partial decoupling. In the first case, China suffers a 3.65% drop in its GDP, compared to 1.04% for the USA. The decoupling of US-China trade brings collateral damage to other economies besides the US and China. For example, Chinese Taipei's and South Korea's GDP are expected to drop by 1.50% and 0.72%, respectively, under this scenario. The authors do not foresee a complete decoupling as the most probable option, and their preferred scenario is a partial decoupling centred on technology-intensive industries. Using input-output tables disaggregating domestic and multinational firms, they conclude that such a scenario would affect much more the multi-national entities, especially those located in China (their gross value-added would drop -6.53%, compared to -1.90% for domestic firms). The authors conclude that one of China's alternatives is to increase its trade links with Asian and European economies.

Our analysis shares the same input-output philosophy than Hu et al. (2021) but differs on the computation of the trade effects. In particular, we go beyond trade destruction to look also at the substitution and deflection effects affecting third countries. Given the large value of bilateral exports targeted by the belligerents, the extent of trade diversion to other countries is potentially large enough to create additional trade tensions and see these countries responding by raising trade barriers. This would be followed by Tit-for-Tat retaliations and cause further damage to the multilateral trade governance. When looking at the data for 2018, Evenett and Fritz (2018) conclude that, so far, "the fears of massive trade deflection induced by the Sino-US tariff war have yet to materialise".

One of the reasons trade deflection may not be as strong as expected is that global value chains allow firms in targeted countries to move final production to other places. Ma and Van Assche (2014) develop a theoretical model in which this ability to spatially separate manufacturing from headquarter provides the flexibility to circumvent economy-specific tariff changes by switching production location abroad. Tariff shirking increases the elasticity of bilateral trade to economy-specific tariff hikes due to an extra extensive margin effect. Using firm-level and province-level export data from China, they find evidence that the Chinese exports that are part of global value chains are more sensitive to antidumping measures than Chinese exports that rely on domestic value chains.

Tariff shirking actually reduces the effectiveness of economy-specific trade policy barriers when trade is done through global value chains (GVC). This new business model which emerged at the end of the 1980s and the importance of trade in intermediate inputs has modified our understanding of comparative advantages and their measurement (Escaith, 2020). The internationalisation of manufacture production and the growing interdependence and integration of national economies has placed the specialisation of countries within GVCs at the centre stage of industrialisation strategies (Antras and Gortari, 2019).

3. Methodology

The measurement of trade along GVCs is closely associated with Input-Output tables. It builds also on the Leontief model to measure the direct and indirect contribution of all the production nodes that are required for the production of an exported product. It is a relatively new discipline, even if the idea itself is much anterior. Balassa (1967) defined Vertical Specialization as the production process of a commodity when it is divided into a vertical trade chain, each country adding value at each stage of the production process. Hummels, Ishii and Yi (2001) extended Balassa's concept and proposed a measurement method based on national input-output tables. Daudin, Rifflart and Schweisguth (2009) apply this new line of trade analysis to international input-output models, using the "Leontief decomposition".

This "Leontief decomposition" approach has been further refined, leading to the definition of new GVC indicators. Among them, Koopman, Powers, Wang and Wei (2011) decompose GVC trade into several trades in value-added indicators. Pursuing this line of work, Wang, Wei and Zhu (2013) extend the information contained in inter-country input-output tables to decompose GVC trade and derive additional indicators. A paper by Los and Timmer (2018) shows that these new "Trade in VA" measures can be linked to a broader family of Input-Output analysis called "hypothetical extraction". Hypothetical extraction is one of the techniques traditionally used to identify key sectors and has been applied to a wide range of topics. Miller and Lahr (2001) provide a review of the different lines of analysis based on this method; Dietzenbacher and Lahr (2013) generalize the approach.

Our contribution builds on the hypothetical extraction method and add substitution and trade deflection effects. The present methodology is specifically designed to measure the spillovers effects on third countries resulting from a bilateral trade conflict between two large trading partners that trade in both intermediate and final goods. The definition of spillovers in this case are the direct and indirect effects, positive or negative, that may occur to the other trade partners because some bilateral supply chains are disrupted while market access for final goods is blocked. The 'supply-chain contagion' is a negative effect: a supply shock in one nation, or in one industry within a nation, become a supply shock in other industries and in other countries when the product that is no more delivered is an input into the production of something else.

By reducing production in one country, the supply chain contagion reduces also demand for intermediate inputs sourced for other countries. This is a "*trade destruction effect*". On the other hand, when trade conflict rises market access for goods from a specific country, it opens new export opportunities for other trade partners, a "*trade creation*" effect. Finally, the exporting country that faces new market access barriers in one of its major market will try to redeploy the lost export to other countries, creating a "*trade deflection*" effect.

1) Methodological building blocks

Our mapping of these three spillover effects combines two branches of input-output analysis: Hypothetical Extraction and Trade in Value-Added. In both cases, the starting point is an international input output table providing information on the value of demand for domestic and imported final an intermediary goods and services by country and industry as well as the origin and destination of the related trade flows (see Figure 1).

- *Figure 1 International Input-Output matrix*

Outputs / Inputs		Intermediate Use				Final Demand				Total Output
		1	2	…	M=kxn	1	2		M	
Intermediate Inputs	1	Z^{11}	Z^{12}	…	Z^{1m}	Y^{11}	Y^{12}	…	Y^{1m}	X^{1}
	2	Z^{21}	Z^{22}	…	Z^{2m}	Y^{21}	Y^{22}	…	Y^{2m}	X^{2}
	…	…	…	…	…	…	…	…	…	
	M	Z^{m1}	Z^{m2}	…	Z^{mm}	Y^{m1}	Y^{m2}	…	Y^{mm}	X^{m}
Value-added		$(VA^{1})'$	$(VA^{2})'$	…	$(VA^{m})'$					
Total output		$(X^{1})'$	$(X^{2})'$	…	$(X^{m})'$					

Notes: $\boldsymbol{Z}^{sr}$ is an k×k matrix of intermediate input flows that are produced in country *s* and used in country *r*, k being the number of activity sectors (goods and services) and n the number of countries; $\boldsymbol{Y}^{sr}$ is an k×1 vector giving final products produced in country *s* and consumed in country *r*; $\boldsymbol{X}^{s}$ is also an k×1 vector giving gross outputs in country *s*; and $\boldsymbol{VA}^{s}$ denotes an k×1 vector of direct value added in country *s*.
Source: Adapted from Wang, Wei and Zhu (2013)

In input-output modelling, the final demand side is considered exogenous to the model, while demand for intermediate goods and services are endogenous and determined by a Leontief production function. For each industry, this function is described by reading the international input-output matrix vertically, each element $\boldsymbol{Z}^{sr}_{i,j}$ indicating how much input industry "*i*" located in country "*s*" purchased from the sector "*j*" located in country "*r*" in order to produce X^{s}_{i} of output.

The production on one unit of output in a GVC will therefore induce production in a number of other supply chains located in a more upstream situation. The decomposition of the various industrial contribution to the production of a given output starts with the Leontief model:

$$\mathrm{X} = \mathrm{A}\cdot\mathrm{X} + \mathrm{Y} \quad (1)$$

where:

X: is an n·k ×1 vector of the output of k industries within an economy of n countries.

A: is the technical coefficient n·k×n·k matrix describing the interrelationships between industries; with a_{ij} the ratio of inputs from domestic industry i used in the output of industry j.

Y: is an n·k×1 vector of final demand for domestically produced goods and services, including exports.

Direct requirements list the purchases of inputs from other industries that an industrial sector needs to do to produce one unit of output. In a multi-country input-output table, these inputs are identified by the industry supplying them and its country of origin. From a production network perspective, direct requirements indicate the countries and sectors belonging to the domestic and international supply chain contributing to the production of a given output. The direct coefficient coefficients are given by the **A** matrix (1).

Total requirements measure the full extent of purchases of inputs directly required or indirectly induced to produce one unit of output. It derives from the Leontief inverse $(\mathbf{I} - \mathbf{A})^{-1}$, deducting 1 from the main diagonal of the Leontief (the "1" represents the unit of the product produced for final demand).

$$\text{Total Requirements: } (\mathbf{I} - \mathbf{A})^{-1} - \mathbf{I} \quad (2)$$

Where **I**: is an n·k by n·k identity matrix

The contribution of exports to total economy value-added derives from (1) and is equal to:

$$\mathbf{v}\cdot (\mathbf{I}\text{-}\mathbf{A})^{-1}\cdot\mathbf{e} \quad (3)$$

where: **v**:is a 1×n·k vector with components m_j giving the ratio of value-added to output in industry j; and **e**: is a n·k×1 vector of exports by industry.

As explained more in details in Escaith (2019), I extend the hypothetical extraction method (Miller and Lahr, 2001; Dietzenbacher and Lahr, 2013) to measure both trade destruction and trade deflection. The starting point of the method is the same inter-country input-output model we presented in Figure 1. In the traditional hypothetical extraction method, one deletes in the actual input-output matrix the industry that is analysed. A new Leontief model is constructed. The difference between the initial and the modified models indicates the importance of the industry for the entire economy.

In their application to the measure of trade in value-added, Los and Timmer (2018) do not extract entire industries from the system, but only some transactions related to a specific set of industries belonging to a specified country. For example, imagine we want to know the importance of Chinese value chains exporting machinery equipment to the USA. If China is country 1 in Figure 1 and the USA is country 2, Los and Timmer (2018) suggest to set to 0 all the elements in **A** corresponding to Z_m^{12} as well as the output of industry "m" imported by country "2" for its final demand ($\mathbf{Y}_m^{12}$).

A new GDP for country1 is calculated:

$$GDP_1^{*2} = \mathbf{v}_1^{*2} \cdot (\mathbf{I}-\mathbf{A}_1^{*2})^{-1} \cdot \mathbf{Y}_1^{*2} \cdot \mathbf{i} \quad (4)$$

Where:

$\mathbf{v}_1^*$ is the n·k vector as in (1), with all elements not corresponding to the extracted country set to 0;

A_1^{*2} and Y_1^{*2} are the matrices of technical coefficients and final demand after extraction of exports of product "m" from country "1" to country "2";
i: is the summation unit vector of dimension n·m (all elements are equal to 1).

The difference between the actual GDP_1 value of "1" and GDP_1^{*2} gives the value-added created by "1" and consumed by "2" for industry "m".

$$VAXD_{1,2}^m = GDP_1 - GDP_1^{*2} \quad (5)$$

2) Adding trade creation and trade deflection

In commenting their approach, Los and Timmer (2018) state page 10 "We would like to emphasize that GDP_r^{*s} should not be seen as the GDP level that would result if exports to *s* would be prohibitive. In a general setting with more flexible production and demand functions, ***substitution effects will occur*** [*emphasis is mine*]." My methodology follows their excellent advice and complements extraction with substitution.

We extract some transactions (those affected by the trade war), then contemplate for the possibility of replacing the extracted outputs (trade destruction) through trade creation. Full substitution supposes that goods are substitutable and industries can seize the business opportunities created by the withdrawal of a competitor. [1] But substitution may face some

[1] This suppose a deviation from the Leontief production function, which does not contemplate substitution because inputs (intermediate and primary) are complementary. Computable general equilibrium models, at the contrary, do contemplate substitution.

additional costs.

As in Los and Timmer (2018), our initial extraction means we set to 0 all the elements in **A** corresponding to Z_m^{12} as well as the output of industry "m" produced by 1 and imported by country "2" for its final demand ($\mathbf{Y}_m^{12}$) in Figure 1. In the case of final demand (the same reasoning applies to intermediate products), the bilateral flows of products "m" exported by country "i" to country "j" respect the following gravity equation: [2]

$$Y_m^{ij} = \frac{X_m^{i\cdot} X_m^{\cdot j}}{X_m^{\cdot\cdot} d_{ij}^2} \quad (6)$$

where Y_m^{ij} are exports of m from *i* to *j*, $X_m^{i\cdot}$ is *i*'s economic size from the supply-side perspective (the mass of products supplied at origin *i)*, $X_m^{\cdot j}$ is *j*'s market size (the mass of products *m* demanded at destination *j*). At world level, total supply of *m* equals total demand and is noted $X_m^{\cdot\cdot}$; d_{ij} is the economic distance between *i* and *j* (a measure of the bilateral trade frictions that impede pure free trade in the gravity model).

What happens when a productor *s* is excluded from a market *r*? The relative sizes of all other producers for this specific market are artificially increased because *s* has to withdraw from the competition. From the specific viewpoint of the competition on the *r* market, it is "as if" $X_m^{s\cdot}$ had been extracted from the World competition $X_m^{\cdot\cdot}$. The new gravity equation for this specific market is:

$$Y'^{ir}_m = \frac{X_m^{i\cdot} X_m^{\cdot r}}{X'^{\cdot\cdot}_m d_{ij}^2} \quad (7)$$

For all i ≠ s ; with $X'^{\cdot\cdot}_m = (X_m^{\cdot\cdot} - X_m^{s\cdot})$

Keeping final demand $X_m^{\cdot r}$ and d_{ij} constant by hypothesis, the ratio between the new sales from country i ≠ s to country *r* and the previous ones is, after a few substitutions:

$$\frac{Y'^{\ i}_m}{Y_m^{\ i}} = X_m^{\cdot\cdot} / X'^{\cdot\cdot}_m \quad (8)$$

To resume, after extraction and assuming perfect substitution, for the product "m" subjected to trade embargo:

(1) exports of *s* to *r* drop to 0 (extraction)

(2) domestic sales of *r* and exports of country i ≠ s to *r* increases to fill the gap; and

(2) each country i≠s increases its sales in proportion of the *ex-ante* market shares.

Box 1: A parenthesis on substitution

Substitution in our model implies that products are close substitute (no strong differentiation in varieties) so that consumers and firms can swap suppliers. This may not always be the case, especially for specialised intermediate inputs entering into the production function or patented final goods. The substitution elasticities (estimated using multilateral trade data) for the intermediate inputs industries tend to be higher than those for the final consumption goods industries (Saito, 2004). Moreover, elasticity varies greatly from sector to sector (Caliendo and Parro, 2015).

In business practices, the supply elasticity is usually determined by the time frame allowed for

[2] The model is one of the workhorses frequently used by trade analysis. It was initially based on a purely statistical specification following Jan Tinbergen (1903-1994) original formulation. Gravity received a micro-economic foundation with Anderson and van Wincoop (2003).

substitution, by the spare production capacity available to alternative suppliers, their level of stocks and their technical capabilities (including ownership of critical patents). Substituting between sources for standard commodities is easy, and it remains relatively easy for many "referenced" industrial parts like computer hard disks or electronic components. For these standard products, the rise in prices for the additional supplies produced in addition to the previous requirement is probably not permanent. When the supply chain managers renegotiate their long-term procurement contracts with their suppliers, they will ask for the same price for all the inputs supplied. Thus, after some time, our model expects input prices to return to their initial situation.

It may prove more difficult for specialised parts and components, especially when protected by patents. At the limit, when no substitution exists (for example when the initial supplier has a *de facto* monopoly, such as producing a specialised engine or landing gear for a given plane), then all the adjustments along the supply chain have to be done in the quantity space, proportionally to the bottleneck.

While recognising the importance of this extreme case, we exclude it from our simulation and consider that all products are ultimately substitutable. This simplifying assumption is probably not too restrictive, at our level of aggregation, according to the results of Bayoumi, Appendino and Ceredeiro (2018) who find that import elasticities to different types of intermediate inputs are statistically indistinguishable from one another.

Now, let's turn to the extracted industry in country "*s*". The firms affected by the extraction of some of their markets in country "*r*" will try to redeploy the lost sales by selling more on the domestic market and exporting to other markets. This redeployment in the face of trade conflict is known as "deflection" in the trade literature. In order to exclude situations of dumping that would affect final prices (income and prices are supposed to remain constant to keep final demand stable through the analysis), we consider that extracted industries will redeploy their output-gap to other markets by marketing more aggressively their products.

Trade deflection displaces other suppliers. In our gravity model (8), they are displaced in proportion of their previous market share. Yet, it may not be possible for the extracted industry in "*s*" to fully redeploy to third markets the output that was originally destinated for sale in country "*r*", because its competitors will defend their market share. So, the final outcome may rest between the two extreme points of extraction with and without substitution.

In absence of any additional information on the degree of substitutability of the respective product, we will consider three scenarios. Two are extreme solutions: zero or full substitution. The third is a mixed one where only half of the production-gap can be redeployed to other markets. This simple solution is also, from a statistical perspective, the expected value of the redeployed share when no prior information is available, as long as the probability distribution of the possible outcomes is symmetric. If, in addition, the distribution is unimodal, then the expected value is also the most probable.

These scenarios translate into the following simulation sequence, considering that the trade war between country "A" and "B" is initiated by "A" and affect industrial product "q":

- *The first stage* extracts B' manufacturing exports to A for intermediate and final goods. This corresponds to traditional extraction without replacement. The consequences are trade destructions. One example of that was the disruption of automobile international supply chain in 2011 after the Tohoku earthquake and tsunami that struck the northeast coast of Japan (see Escaith, Teh, Keck and Nee, 2011). On a much global scale, it is what occurred also in 2020 with the COVID-19 pandemics. The supply chain disruptions caused by the "Great Lockdown" impacted several industries worldwide and created shortages of many critical goods. But, at the difference of our model, Final Demand was also severely affected in many countries by the economic collapse.

- *In a second stage*, other countries substitute exports of "B" to "A" for both Intermediate and Final Goods but the additional sale of intermediate goods is done at a higher price (the price of final goods remains the same in order to keep Final Demand constant). The input cost for the industries in country "A" that have to substitute for the inputs originating from "B" is now larger and the rate of value-added is smaller.[3]
- *With the passing of time*, the higher procurement cost disappears and the competitors of "B" supply their intermediate products to "A" at the pre-crisis prices. The rate of value-added of the industries in "A" returns to it pre-crisis situation.

But it is not the end of the story. Country "B" aggressively markets its product to third countries in order to compensate for the market losses in "A", without changing the price of its intermediate and final products. There is no change in the volume and structure of final demand. This scenario has two variants:

- *Partial export deflection*: only 50% of the losses can be redeployed. This variant corresponds to the expected value, from a statistical perspective.
- *Full export deflection*: all sales are redeployed, when feasible. [4] This scenario corresponds to an extreme case of trade deflection, when all unsold exports are redirected to third markets where they displace the products of other trade partners. This scenario is also one setting the stage for major multilateral trade tensions.

3) Uses and limitations of the "extraction cum substitution" method

Our heuristic method is purely exploratory. It aims at revealing inter-industrial trade structures that would not be easily identified using standard input-output or network analysis. Needless to say, this level of interactions would be unobservable using official trade statistics. This approach provides an intuitive and computationally tractable way to explore alternative scenarios. It goes beyond indirect requirements by quantifying the extent of the struggle for market share that could follow such a disruption.

This said, this method has limitations and remains exploratory in nature. At the difference of CGE modelling or other macro and multi-sectoral models such as Caliendo and Parro (2015), it does not pretend to "predict" an outcome of a bilateral trade conflict on the World Trade Network of measure its welfare effect. The objective is mainly descriptive, to produce a series of "markers" corresponding to extreme or expected trade patterns that should help mapping what remain largely unchartered waters: the direct and indirect effects of a bilateral trade war between two economic giants. Actually, the simulation is more akin to analysing the shock from a partial

[3] We use an arbitrary 30% additional cost on procuring the new inputs. By construction, the price to final consumers does not change: Value Added in the industries "2" needs to be reduced in proportion of the higher procurement cost, in order to keep the price of the output unchanged.

[4] If the extracted industry is dominant on a given market and its competitors have little market share, it may not be possible to fulfil the redeployment target, even after taking 100% of the competitors' market share.

equilibrium approach. [5] In particular, and except for the short-run scenario, the simulation avoids the issue of price elasticity by keeping prices constant.

The hypothesis that income and prices remain constant means that our substitution effects ignore the gains from trade from the consumers' perspective. Even when looking at the producer side, the surplus (as measured by value-added) is reduced only in the short time. Moreover, the method does not contemplate a situation where the conflict would disrupt an entire supply chain, resulting in the bankruptcy of the firms most dependents of the extracted inputs. As a result, trade disruption in our methodology always results in a net gain for the protectionist country, something that contradicts both theory and practice. For this reason, we recommend to use the method only for what it was developed: mapping the spill-over effects on third countries rather than estimating the impact on the two belligerents.

4. Quantitative Analysis: Application to the China-USA trade conflict

In this section, we map our simulation model to global trade and production data. We use the WIOD input-output database (see Timmer et al., 2015 for an introduction) in its November 2016 edition, with results updated at year 2014. We focus the analysis on 17 countries belonging to the G20 group or to the Asian region.[6] The substitution and redeployment effects will take place in these countries, which represent the largest industrial and developing economies. All other results are aggregated in a new Rest of the World (ROW).

1) Extent of pre-crisis interindustry linkages

The pre-crisis situation is the basis for all further simulations of our partial equilibrium analysis. A first measure of the strength of inter-industry linkages is given by the direct and total requirements.

a) Direct and Indirect Requirements

Direct requirements show the inputs from other industries, at home or abroad, that an industrial sector needs to purchase in order to produce one unit of output. Total requirements measure the full extent of inputs directly required or indirectly induced to produce one unit of output. While direct requirements exported by the targeted industry to the protecting country drop to 0 due to extraction, the corresponding total requirements will remain positive because some of the inputs sourced by the protecting economy from other industries (in the home country or imported) do include value-added originating from the extracted industry. The outcome of the simulations relies heavily on the evolution of total requirements and the distribution of final demand market shares.

We present aggregated results representing four branches of activities that were particularly targeted during the 2018-2019 bilateral trade conflict: Agriculture, Basic Metals, Electronics and Vehicles. The last two ones are involved in GVCs at both intermediate and final stages of production, while the first ones are more upstream.

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[5] From an economic perspective, the ex-ante situation was the product of a general equilibrium and the existing market share represented the relative competitive advantages of the various countries on the extracted market. Reassigning the market shares in proportion of the previous equilibrium means simply the relative competitiveness of the non-extracted industries and the impact of trade frictions as specified in a standard gravity model have remained the same, under a *ceteris paribus* assumption.

[6] WIOD does not cover three of the G20 members: Argentina, Saudi Arabia and South Africa.

- *Agriculture*

Agriculture was a sector targeted by China in retaliation to US increase in tariffs. We note in Table 1 that the US agricultural sector is relying mainly on domestic inputs (it is even more the case for China). The international spill-overs through the supply chain are therefore expected to remain limited.

Table 1 Crop and animal production, hunting and related service activities: Direct and indirect requirements in 2014

	China		USA	
Countries	**Direct**	**Total**	**Direct**	**Total**
AUS	0.001	0.006	0.000	0.002
BRA	0.002	0.008	0.002	0.006
CAN	0.000	0.002	0.009	0.037
CHN	0.382	0.953	0.003	0.029
DEU	0.000	0.004	0.002	0.010
FRA	0.000	0.002	0.001	0.005
GBR	0.000	0.001	0.002	0.008
IDN	0.001	0.003	0.001	0.002
IND	0.000	0.002	0.002	0.005
ITA	0.000	0.001	0.001	0.004
JPN	0.001	0.007	0.002	0.010
KOR	0.001	0.009	0.001	0.007
MEX	0.000	0.000	0.004	0.013
RUS	0.000	0.003	0.001	0.006
TUR	0.000	0.000	0.000	0.001
TWN	0.001	0.006	0.001	0.004
USA	0.002	0.012	0.535	1.000
ROW	0.006	0.059	0.027	0.112
Total	*0.40*	*1.08*	*0.59*	*1.26*
- Domestic	*0.38*	*0.95*	*0.53*	*1.00*
Domestic (%)	*96%*	*88%*	*91%*	*79%*

Note: The columns indicate where is located the productive industry and the lines show the origin of the intermediate inputs that were required to produce one unit of output.
Source: Based on WIOD tables.

- *Basic metals*

Basic metals manufacturing was amongst the first industries targeted by the US administration in 2018.

Table 2 Manufacture of basic metals: Direct and indirect requirements in 2014

	China		USA	
ISO	**Direct**	**Total**	**Direct**	**Total**
AUS	0.009	0.037	0.001	0.006
BRA	0.002	0.010	0.005	0.016
CAN	0.001	0.005	0.034	0.085
CHN	0.754	2.113	0.007	0.061
DEU	0.001	0.013	0.006	0.025
FRA	0.000	0.005	0.002	0.010
GBR	0.001	0.008	0.005	0.017
IDN	0.001	0.005	0.000	0.003
IND	0.001	0.005	0.001	0.007
ITA	0.000	0.004	0.003	0.012
JPN	0.003	0.022	0.005	0.023
KOR	0.003	0.022	0.004	0.018
MEX	0.000	0.002	0.016	0.041
RUS	0.003	0.022	0.004	0.019
TUR	0.000	0.002	0.002	0.006
TWN	0.001	0.013	0.002	0.009
USA	0.001	0.019	0.644	1.217
ROW	0.057	0.299	0.040	0.187
Total	*0.839*	*2.608*	*0.781*	*1.76*
- Domestic	*0.754*	*2.113*	*0.644*	*1.22*
Domestic(%)	*90%*	*81%*	*82%*	*69%*

Note and source: see Table 1

When looking at the direct and total requirements, one notes that the main source of spill-over effects from this trade restriction affecting Chinese industry will be felt by the producers of extractive commodities in the Rest of the World. Australia and Asian trade partners, as well as Europe are expected to suffer from shortfalls in their economic activity.

Note that the indirect effects on the Chinese economy are ten time larger than what direct requirements would suggest. The USA would also be indirectly affected by trade restrictions affecting Chinese products: US industries provide inputs (goods and services) to third countries being more directly exposed to a slow-down in Chinese production of basic metals. Among the foreign suppliers of inputs to the USA, Canada is the trade partner most affected country. Mexico, the other NAFTA trade partner, is not particularly concerned by the negative spill-overs.

- *Computer, electronics and optical equipment*

This segment of manufacture relies heavily on GVC arrangements and is part of the bilateral trade flows to be restricted by the USA. Contrary to expectations, China is not particularly dependent on imported inputs for this sector, at least when looking at the industrial average. 84% of the inputs directly required for the production of electronics and optical equipment is sourced locally (Table 3). The picture is even more striking for total requirements, as 74% of the shock affecting this line of production would be felt domestically. The Rest of the World is particularly exposed to a slow-down in this branch of activity in China (much more than what would happen if the shock affected the US electronic industry). Among the individual foreign suppliers to the Chinese electronic industry, Korean economy would be most affected, followed by Chinese Taipei and Japan. The USA arrives in fourth position in the list of the foreign suppliers, if we exclude the Rest of the World aggregate.

Table 3 Manufacture of computer, electronic and optical products: Direct and indirect requirements in 2014

	China		USA	
ISO	**Direct**	**Total**	**Direct**	**Total**
AUS	0.000	0.012	0.000	0.002
BRA	0.000	0.005	0.000	0.003
CAN	0.000	0.004	0.005	0.014
CHN	0.691	2.061	0.017	0.080
DEU	0.002	0.020	0.003	0.010
FRA	0.001	0.008	0.001	0.004
GBR	0.000	0.007	0.002	0.006
IDN	0.000	0.005	0.000	0.001
IND	0.000	0.005	0.000	0.002
ITA	0.000	0.005	0.001	0.003
JPN	0.010	0.063	0.005	0.018
KOR	0.023	0.102	0.005	0.017
MEX	0.000	0.002	0.008	0.015
RUS	0.000	0.011	0.000	0.003
TUR	0.000	0.002	0.000	0.001
TWN	0.025	0.081	0.003	0.010
USA	0.003	0.030	0.225	0.383
ROW	0.067	0.376	0.025	0.091
Total	*0.823*	*2.798*	*0.302*	*0.664*
- Domestic	*0.691*	*2.061*	*0.225*	*0.383*
(%)	*84%*	*74%*	*74%*	*58%*

Note and source: see Table 1

- *Automotive industry*

This is another branch of industry that relies on the international fragmentation of its supply chain. The US exports are part of the products targeted by China in the 2018 trade conflict. Mexico, Canada and China are the main direct suppliers of foreign inputs to the USA (Table 4). Interestingly, China would be the principal foreign country affected by its embargo on US cars, when estimating the impact in terms of total requirements.

Table 4 Manufacture of motor vehicles, trailers and semi-trailers: Direct and indirect requirements in 2014

	China		USA	
ISO	Direct	Total	Direct	Total
AUS	0.001	0.014	0.000	0.005
BRA	0.000	0.005	0.002	0.010
CAN	0.000	0.003	0.022	0.062
CHN	0.780	2.439	0.021	0.133
DEU	0.007	0.032	0.013	0.045
FRA	0.001	0.007	0.002	0.011
GBR	0.001	0.006	0.003	0.014
IDN	0.000	0.004	0.001	0.004
IND	0.000	0.004	0.002	0.009
ITA	0.000	0.005	0.003	0.015
JPN	0.006	0.040	0.017	0.066
KOR	0.004	0.033	0.009	0.036
MEX	0.000	0.002	0.033	0.073
RUS	0.000	0.009	0.001	0.009
TUR	0.000	0.002	0.001	0.005
TWN	0.002	0.017	0.005	0.018
USA	0.002	0.020	0.596	1.161
ROW	0.011	0.177	0.026	0.162
Total	*0.82*	*2.82*	*0.76*	*1.84*
- Domestic	*0.78*	*2.44*	*0.60*	*1.16*
(%)	*96%*	*87%*	*79%*	*63%*

Note and source: see Table 1

The self-inflicted accumulated impact on its domestic economy is almost twice what is registered by Mexico (0.133 vs. 0.073), despite the fact that the latter is the main foreign direct provider according to Table 4. This surprising result is due to the high domestic value-added content of China's automobile industry (84% of the total effects are domestic) compared to only 36% in the case of Mexico or the even lower 28% registered for Canada: a shortfall in Chinese production due to lower demand from the US automotive industry will mainly be felt domestically.

2) Trade in Value-Added indicators

While the direct and indirect requirements provide an aggregate view of the spill-over effects, additional information on the GVC arrangements can be gathered when looking at some specific indicators specially defined to analyse trade in value-added. The Wang, Wei and Zhu (2013) decomposition disaggregates gross exports and provides, among other indicators, information on the final destination/use of the domestic value-added embodied in the exports of an industry to a country of destination. This country can be the final destination or only an intermediate link for further processing along the value chains.

Table 5 presents results for the top 30 industries most likely exposed to a slow-down of China's exports due to the bilateral trade conflict. Asian exporters of electronics rank high on the list. Chinese Taipei is particularly exposed to GVC disruption, not only because of leading the list with the highest value, but also because most of its exports are made of intermediate goods, the most closely associated with the concept of value-chain. Spill-over effects in the branch of electronics would not stop at Chinese Taipei, because of the large amount of foreign value-added embodied in the products it exports to China. Korea and Japan are also large exporters, but are less exposed to GVC disruption because a significant proportion of their exports is made of final goods absorbed by the Chinese consumers. Germany is also a main trading partner in Machinery equipment (other than electrical and electronics). Most of the German value-added is embodied into final products, probably investment goods such as machine tools.

Table 5 Top 30 exporters of Value-Added for intermediate production to China, 2014

Exporting Country	Exporting Industry	DVA_FIN	DVA_INT	DVA_IN Trex	DVA_IN TrexI1	DVA_IN TrexF	DVA_IN TrexI2	RDV _tot	FVA_tot
TWN	Electronics	7,547	16,580	16,328	4,857	9,828	1,642	186	15,368
KOR	Electronics	18,861	15,043	14,146	4,200	8,595	1,351	456	18,112
JPN	Electronics	11,031	7,599	6,569	2,039	3,854	677	613	4,997
JPN	Electrical	4,658	4,970	1,817	657	995	165	152	3,218
DEU	Machinery n.e.s	14,422	4,534	1,507	584	804	119	58	7,199
USA	Electronics	4,713	1,598	1,192	352	718	121	314	647
DEU	Electrical	3,240	3,488	1,260	458	697	105	55	2,515
JPN	Bas. Metal	110	4,647	1,304	552	633	119	102	3,886
JPN	Machinery n.e.s	8,538	3,467	1,168	443	625	100	84	2,894
AUS	Bas. Metal	16	4,161	1,221	513	592	117	29	2,057
KOR	Electrical	2,124	2,626	1,008	356	564	88	30	2,123
DEU	Vehicle	13,481	5,498	1,057	460	499	98	44	8,393
DEU	Electronics	3,627	959	815	251	488	77	37	1,517
JPN	Vehicle	5,810	4,412	845	365	398	82	48	2,928
KOR	Machinery n.e.s	4,990	2,115	713	271	383	59	23	3,039
USA	Machinery n.e.s	4,984	2,188	623	236	335	51	132	1,562
JPN	Metalproducts	824	2,183	592	240	298	53	47	893
KOR	Bas. Metal	29	2,082	602	252	298	52	20	1,655
GBR	Bas. Metal	5	1,857	543	229	264	50	14	1,300
TWN	Bas. Metal	-	1,550	458	193	222	43	6	1,982
KOR	Vehicle	1,414	2,126	417	179	198	40	12	1,429
ITA	Machinery n.e.s	3,077	1,029	353	135	188	30	5	1,442
RUS	Bas. Metal	1	1,248	368	155	178	35	8	126
IND	Bas. Metal	12	1,198	350	146	171	33	9	667
DEU	Bas. Metal	39	1,109	319	137	155	27	13	904
DEU	Metalproducts	404	1,045	284	118	143	23	12	450
BRA	Bas. Metal	2	1,002	295	124	143	28	7	215
TWN	Machinery n.e.s	3,172	761	261	100	139	22	3	3,122
FRA	Electronics	595	229	224	66	135	22	5	317
FRA	Machinery n.e.s	1,249	712	243	93	130	20	5	918

Note: GVC partners ranked on their value-added re-exported by the USA to third countries (DVA_INTrexI2). DVA_FIN: Domestic value added in final exports; DVA_INT: Domestic value added in intermediate exports absorbed by importers, or (DVA_INTrex) re-exported to third countries. This value is further split into the value-added re-exported to third countries as intermediate inputs to produce final goods (DVA_INTrexI1), re-exported to third countries as final goods (DVA_INTrexF) or re-exported to third countries as intermediate inputs to produce exports (DVA_INTrexI2). Other indicators provide information on the domestic value-added returning home, either as intermediate or final goods (RDV_tot) and the foreign value-added content (FVA_tot).

Source: Based on WIOD data, using the R package Decompr (Quast and Kummritz, 2015)

Asian exporters of electronics rank high on the list of trade partners most likely to be exposed to a slow-down of China's exports due to the bilateral trade conflict. Chinese Taipei is particularly exposed to GVC disruption, not only because of leading the list with the highest value, but also because most of its exports are made of intermediate goods, the most closely associated with the concept of value-chain. Spill-over effects in the branch of electronics would not stop at Chinese Taipei, because of the large amount of foreign value-added embodied in the products it exports to China. Korea and Japan are also large exporters, but are less exposed to GVC disruption because a significant proportion of their exports is made of final goods absorbed by the Chinese consumers. Germany is also a main trading partner in Machinery equipment (other than electrical and electronics). Most of the German value-added is embodied into final products, probably investment goods such as machine tools.

The USA, despite its economic size, appears only twice in the list of the Top30 providers to China, first for its electronics industry, with the 6th rank, and second as supplier of machinery equipment (16th). In comparison, Germany and Japan appear 6 times and Korea in 5 occasions. Apparently, US value-added are under-represented in the Chinese market for the selected industries listed in Table 5. This low ranking is not totally unexpected when considering the relatively high Chinese content of US exports to China: the above-mentioned US industries rank 3rd and 6th for their content of Chinese repatriated value-added. This impression is confirmed when looking at the same indicators seen from the US perspective (Table 6).

Table 6 Top 30 exporters of Value-Added for intermediate production to the USA, 2014

Exporting Country	Exporting Industry	DVA_FIN	DVA_INT	DVA_INT rex	DVA_INT rexI1	DVA_INT rexF	DVA_INT rexI2	RDV_tot	FVA_tot
CHN	Electronics	54,249	20,157	4,166	1,683	1,848	634	429	25,765
CAN	Bas.Metal	31	12,949	3,523	1,745	1,276	501	782	4,003
MEX	Vehicle	20,810	10,592	1,986	633	1,066	287	236	20,870
JPN	Vehicle	30,307	7,825	1,667	568	833	265	35	10,905
CHN	Machinery,nes	13,759	9,107	1,914	842	809	263	195	4,375
MEX	Bas.Metal	-	5,305	1,717	783	705	229	196	1,411
CHN	Vehicle	3,636	6,802	1,310	474	619	217	136	1,732
CHN	Electrical	15,963	8,561	1,459	623	624	212	147	5,434
JPN	Electronics	3,912	5,866	1,290	509	582	199	55	2,637
DEU	Vehicle	21,929	5,388	1,089	392	527	170	56	12,026
KOR	Electronics	3,788	4,618	1,038	410	471	158	22	4,522
CHN	Metalproducts	5,009	5,762	1,104	480	468	157	109	2,075
BRA	Bas.Metal	22	2,626	957	431	377	149	22	560
RUS	Bas.Metal	36	2,498	926	420	364	142	10	252
MEX	Machinery,nes	6,336	5,341	1,106	485	482	139	121	5,356
KOR	Vehicle	11,143	3,270	698	240	347	111	10	5,807
CHN	Bas.Metal	2,275	2,536	728	334	283	111	70	1,213
TWN	Electronics	1,218	3,064	703	277	317	109	5	2,757
DEU	Machinery,nes	7,508	3,756	823	364	352	106	37	4,278
MEX	Electrical	5,394	4,946	819	351	364	104	81	8,696
JPN	Machinery,nes	4,985	3,308	753	323	327	103	26	1,996
MEX	Electronics	9,920	3,530	742	299	345	99	49	28,405
JPN	Metalproducts	1,211	3,242	675	286	293	96	27	1,320
MEX	Metalproducts	1,032	3,964	752	321	335	95	78	2,391
CAN	Metalproducts	1,436	3,000	597	269	244	84	140	2,025
CAN	Electronics	1,852	2,732	522	211	230	81	93	2,178
CAN	Machinery,nes	4,364	3,078	591	261	251	79	125	3,626
CAN	Vehicle	15,660	3,546	536	202	267	67	193	20,901
DEU	Electronics	2,101	2,022	427	173	192	62	22	1,369
JPN	Electrical	2,574	2,195	407	169	178	60	15	1,594

Notes and source: see Table 5

"Factory Asia" --China in particular-- emerges prominently as supplier of intermediate products to the USA, together with the two other "NAFTA" countries, Canada and Mexico. China appears three times in the Top-5 providers. The first European provider, Germany, classifies only for the 10th position. On the other hand, imports of electronics from China –as for Mexican vehicles-- include a lot of US content returning home. This denotes close inter-industry supply chain arrangements that would be jeopardised by a bilateral trade conflict affecting these products.

5. Extraction and simulation results

The core simulation focuses on the above mentioned four sectors, looking first at the impact of US's restrictions on two Chinese industrial products: Basic Metals and Computers and electronics. Then, the impacts of China's retaliations on USA Agriculture and Automobile sectors are assessed. The individual sector analysis is completed by a wider multi-sectoral simulation.

1) Individual sector simulations

a) China exports of basic metals to USA

The loss of the US market in final and intermediate goods (not shown here) would represent a shortfall of about $7 070 million for the Chinese Manufacture of basic metals industry (WIOD industry code r15). Most of the spill-over impacts, as measured by total requirements in the pre-crisis situation, are expected to fall on other Chinese industries.

When looking at the expected impacts on the 10 worst affected foreign suppliers (Table 7), Mining and Quarrying (industry code r4) ranks first, particularly in Australia, Russia and Brazil. Similarly, foreign Basic Metal manufacturers (r15) are losing big, especially in Japan, Australia and Korea. In Korea, the chemical sector (r11) and the electronic industry (r17) are also among the most impacted industries, as well as Taiwanese electronic manufacturers.

Table 7 Expected losses to third countries due to extraction of basic metals: top ten sectors (million dollars, 2014)

ISO3	Sector [a]	Total Requirements [b]	Losses [c]
AUS	AUS_r4	1.7	123.4
RUS	RUS_r4	0.8	56.3
JPN	JPN_r15	0.7	50.7
BRA	BRA_r4	0.4	31.4
KOR	KOR_r11	0.4	25.2
KOR	KOR_r17	0.3	21.3
TWN	TWN_r17	0.3	21.2
AUS	AUS_r15	0.3	21.1
KOR	KOR_r15	0.3	20.1
RUS	RUS_r29	0.3	20.0

Notes: a/ see nomenclature in Annex; b/ pre-crisis total requirements from foreign suppliers for 100 million output; c/ expected production shortfall due to the fall in demand for intermediate inputs
Source: Authors' elaboration based on WIOT data

China tries in the next phase of our simulation to redeploy to other markets (domestic and export) the products previously sold to the USA. After this export deflection, the distribution of gains and losses results also, for non-US industries, from the exposure to increased Chinese competition on their markets. It should be noted that this redeployment will also affect their exports of value-added to the US market through the Global Value Chain effect. These value-added exports induced by US demand of basic metal cover not only the bilateral exports, but also the basic metal products exported to third countries' industries and reprocessed to be eventually consumed to satisfy US sectoral demand. Because China will sell more of these intermediate inputs to third countries after redeployment, it will be able to indirectly recoup some of the losses even on the US market. Table 8 shows the changes in the sectoral value-added resulting from theses simulations.

Table 8 Basic metal: Evolution of the Sectoral Value Added, selected countries (Mn dollar and percentages)

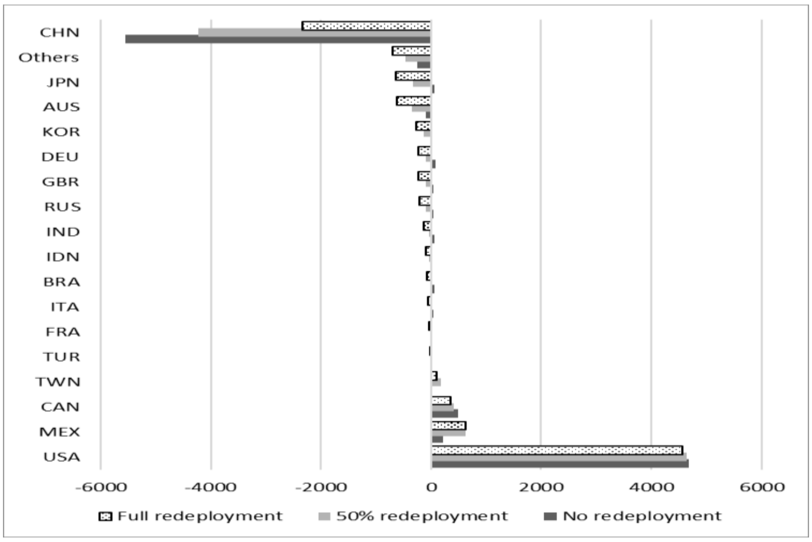
Country	1: Initial	2: Short term	3: Long term	4: Full Substitution	Difference (4-1)	
AUS	6 249	6 253	6 252	6 128	-121	-1.9%
BRA	18 521	18 562	18 554	18 494	-27	-0.1%
CAN	27 231	27 478	27 428	27 360	128	0.5%
CHN	291 395	289 712	289 711	290 689	-706	-0.2%
DEU	32 061	32 100	32 093	31 944	-117	-0.4%
FRA	7 378	7 384	7 383	7 366	-11	-0.2%
GBR	7 806	7 819	7 817	7 709	-97	-1.2%
IDN	7 220	7 223	7 223	7 191	-29	-0.4%
IND	38 616	38 649	38 645	38 557	-59	-0.2%
ITA	10 819	10 834	10 832	10 802	-17	-0.2%
JPN	65 122	65 171	65 163	64 748	-375	-0.6%
KOR	34 762	34 796	34 790	34 615	-147	-0.4%
MEX	12 716	12 813	12 793	12 993	276	2.2%
RUS	45 919	45 970	45 961	45 861	-58	-0.1%
TUR	8 628	8 646	8 643	8 627	-1	0.0%
TWN	10 097	10 106	10 103	10 157	60	0.6%
USA	61 643	63 388	63 355	63 321	1 677	2.7%

Note: Long term and Full Substitution correspond to no redeployment and 100% redeployment, respectively. The most expected outcome of 50% lies in-between these two extreme points.
Source: Authors' elaboration based on WIOD data

The US industry is expected to gain most, both in monetary or in relative terms, but we know that our method may overestimate these gains. Mexico – a country very dependent on the USA for its exports—gains almost in the same proportion relative to its pre-crisis situation, but only after Chinese redeployment: this indicates that the China-Mexico intra-industry trade is large enough to balance in part the Mexico-US dependency. China's losses are large in monetary value, but almost nil when reported to its initial production. It is Australia who is the biggest losers in relative terms (-2%), due to increased competition of Chinese products on its non-US markets.

The impact on sectoral value-added is not limited to the sector of basic metal (r15) and other industries gain or lose in the process. The rate of sectoral value-added and the World value of Final Demand remaining constant by construction, the net impact for each industry is the resultant of two effects: the first one is the change in markets shares and in technical coefficients, the second one is due to the changes in the geographical distribution of Final Demand. The end-result in terms of Gross Domestic Product is given in Figure 2.

Figure 2 Basic metals: Total impact on GDP, as a difference from the initial situation (Mn dollar)



Source: Authors' elaboration based on WIOD data

By construction, the substitution is a zero-sum game and total gains equal total losses. Gains are concentrated on the NAFTA members, with the USA as main beneficiary, and in Taiwan, but only marginally so (less than 100 million dollar). Besides China and the Rest of the World, the main losers are located in the Asia-Pacific region. Both results show the importance of the regional dimension in the Global Value Chains: be they positive or negative, the impacts are usually stronger on immediate neighbours.

Another interesting result relates to the redistribution of gains and losses when redeployment takes place. The extracted industry (here, Chinese manufacture of basic metal) would be able to significantly reduce its losses if it is able to redeploy all its lost sales, but it does so at the expense of other trade partners. Trade deflection means trade creation, on the one hand, because China increases its exports to third countries; it also means trade destruction because China reduces its imports from the same countries. This trade destruction proceeds from two effects. One is the lower level of activity of China's basic metal industry; the second results from the substitution of imports due to the redeployment of some of the US exports towards the domestic market.

Mexico exhibits a very peculiar pattern. The answer to this riddle is to be found in the input-output tables: China is also a main market for Mexico's exports of primary products (mining and quarrying) with sales to the Chinese industry of basic metals at above 550 million in 2014, quite a sizable amount for the Mexican industry. Therefore, Mexico's gains can only fully concretise when the Chinese industry of basic metal picks-up again after its initial losses.

Even the protected industry (US' basic metals) sees its initial gains reduced when it loses some of its export markets. These differences remain marginal when related to the total pre-crisis GDP: in the case of full redeployment, the biggest relative gain is found in Mexico (0.05% of GDP) and the largest loss in Australia (-0.04%).

Full redeployment is an extreme outcome that is mainly useful for illustrative purpose. In absence of additional information, the most probable outcome is the 50% redeployment option. In this case, China's losses remain significant (about 4, 230 million dollars, see Figure 2).

b) China exports of computer, electronic and optical products to USA

The loss of the US market for final and intermediate goods would represent a large shortfall of $ 107 billion in sales of final and intermediate products for the Chinese Manufacture of computer, electronic and optical products (industry code r17). For foreign suppliers, most of the losses are concentrated in the same industrial branch and in the Asia-Pacific region, indicating the strength of intra-industry trade in a closely integrated regional value chain (Table 9). Chinese Taipei and Korea suppliers of electronics inputs are exposed to losses exceeding 5 million dollars, while the Japanese industry would face a shortfall larger than 2 million. Manufacturers of chemicals and chemical products (industry code r11) in these countries are also at risk. The US industry benefitting from the protectionist measures at home would face also a drop close to 600 thousand dollars in its sales of electronics inputs to China. Australia is affected as upstream supplier of mineral inputs (r4) while the Korean downstream sector of retail trade (r30) will also be indirectly affected by the embargo.

Table 9 Expected losses to third countries due to extraction of China's electronic and optical products: top ten foreign suppliers (million dollars, 2014)

Country	Sector [a]	Total Requirement Index [b]	Losses [c]
TWN	TWN_r17	5.5	5 858
KOR	KOR_r17	4.7	5 033
JPN	JPN_r17	2.2	2 327
KOR	KOR_r11	0.8	904
TWN	TWN_r11	0.6	624
JPN	JPN_r15	0.6	596
USA	USA_r17	0.5	575
JPN	JPN_r11	0.5	491
AUS	AUS_r4	0.5	490
KOR	KOR_r30	0.4	402

Notes and sources: see Table 8

The global effects after considering substitution and redeployment effects, are presented in Table 10.

Table 10 Electronics: Evolution of the Sectoral Value Added, selected countries (Mn dollar and percentages)

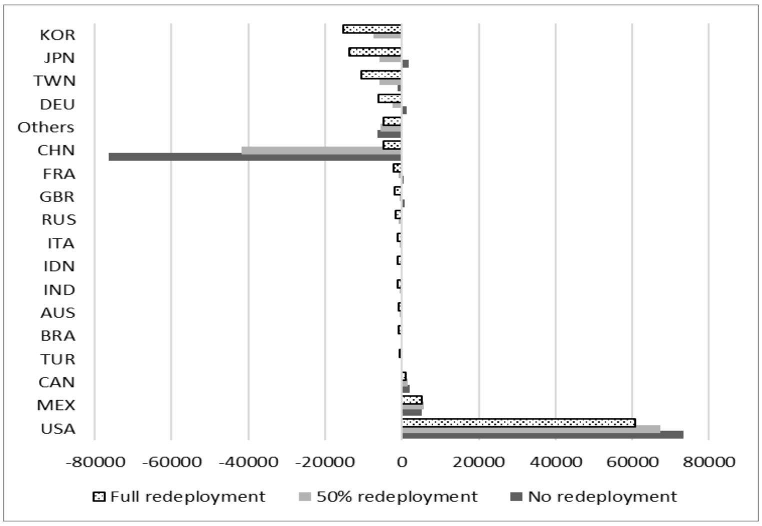
Country	1: Initial	2: Short term	3: Long term	4: Full Substitution	Difference (4-1)	
AUS	4 105	4 155	4 150	3 564	-541	-13.2%
BRA	12 166	12 195	12 192	11 782	-384	-3.2%
CAN	9 609	10 893	10 732	10 109	500	5.2%
CHN	280 295	249 557	249 484	278 786	-1 509	-0.5%
DEU	47 589	48 564	48 451	43 785	-3 804	-8.0%
FRA	14 281	14 550	14 512	12 955	-1 326	-9.3%
GBR	19 539	19 999	19 951	18 260	-1 279	-6.5%
IDN	6 055	6 244	6 235	5 566	-489	-8.1%
IND	7 140	7 187	7 182	6 702	-438	-6.1%
ITA	10 993	11 105	11 091	10 350	-643	-5.9%
JPN	96 431	98 032	97 720	88 395	-8 035	-8.3%
KOR	92 780	93 491	93 236	83 495	-9 284	-10.0%
MEX	11 331	14 367	14 204	14 277	2 946	26.0%
RUS	14 053	14 063	14 061	13 422	-631	-4.5%
TUR	2 883	2 888	2 888	2 540	-343	-11.9%
TWN	81 028	80 350	80 102	71 867	-9 161	-11.3%
USA	270 128	332 400	328 582	318 569	48 442	17.9%

Notes and sources: see Table 8

Chinese electronic industry is able to compensate most of its losses through redeployment to other markets for both final and intermediate products. The US industry registers an increase in its value-added close to 50 billion dollars, representing a 18% increase on the pre-crisis situation. These gains pale in comparison to the relative improvement of 26% that would register Mexico, one of the main competitors of China in the processing of exports to the US market. In the NAFTA region, Canada's gains are much more modest (5%). All other G20 countries as well as Chinese Taipei register losses, due to the increased competition of Chinese products on their domestic and export markets after full redeployment. Australia, Turkey, Chinese Taipei and Korea are the most affected, with losses ranging from 13% to 10% of their pre-crisis sectoral value added.

The above table tells only part of the story, because other industries may gain or lose in relation to their exposure to changes in the activity of the electronics industry. The distribution of gains and loses is, again, conditional on the capacity for China to redeploy part or totality of its losses suffered on the US market. The mean value corresponding to a 50% redeployment, indicates a potential loss of USD 41.9 billion for China's GDP. In case of full redeployment, the main regional trade partners of China are expected to suffer most from the changes in their market shares (Figure 3). Germany, one of the main non-regional trade partners of China, would also suffer from the crisis. On the positive side of the graph, only the three NAFTA countries would register increases in their GDP; but the gains in Canada and Mexico remain modest. Even the large US gains would be dented in the event of China's full export redeployment, depriving it from part of its foreign markets with an overall GDP impact of about -12.5 billion compared to zero redeployment.

Figure 3 Electronics: Total impact on GDP, as a difference from the initial situation (Mn dollar)



Source: Authors' elaboration based on WIOD data

c) US agriculture exports to China

We turn now to the consequences of China excluding the US agricultural sector (sector code r1) from its market. Comparing the total requirement index of Table 11 with similar indicators in the previous cases, it appears that the US agricultural sector is clearly an upstream sector loosely integrated with foreign suppliers. On the other hand, China is an important export market with USD 11 billion (7% of US sectoral exports) according to the 2014 WIOD tables.

Canada is particularly exposed to a slump in this US sector, especially through its primary sectors of mining (r4) and agriculture (r1). Interestingly, the Chinese chemical industry (r11) would be the second most adversely impacted, with losses greater than 5 billion. Chinese industry of electronics (r17) and machinery equipment (r19) would also be exposed, either through their direct exports to the US market or by the way of their sales to other countries supplying the US agricultural sector with inputs.

Table 11 Expected losses to third countries due to extraction of US agricultural products: top ten foreign suppliers (million dollars, 2014)

ISO3	Sector [a]	Total Requirement Index [b]	Losses [c]
CAN	CAN_r4	0.9	10 430
CHN	CHN_r11	0.5	5 121
CAN	CAN_r1	0.4	4 519
MEX	MEX_r4	0.3	3 252
CAN	CAN_r10	0.3	2 977
JPN	JPN_r11	0.3	2 948
DEU	DEU_r11	0.2	2 380
CHN	CHN_r17	0.2	2 197
CAN	CAN_r11	0.2	2 188
CHN	CHN_r19	0.2	2 173

Notes and sources: see Table 8

Considering the size of the US agricultural sector, redeploying its Chinese exports to other markets will also have large effects on third countries. Table 12 presents the simulation results on the agricultural value-added on our selection of countries. The US agricultural sector is barely affected by the loss of the Chinese market, but displace in its redeployment Canadian and Mexican outputs, resulting in drops of their sectoral value-added of 4% and 9%, respectively. Brazil is also on the losing side, but only marginally (-1%). Chinese gains are also marginal (1%), all other sectors remain largely unaffected.

If the US agricultural sector itself was relatively unaffected by the embargo after redeployment, the lower activity observed for the Canadian and Mexican agricultural sector affects other US industries that are providers of inputs to these countries.

Table 12 Agriculture: Evolution of the Sectoral Value Added, selected countries (Mn dollar and percentages)

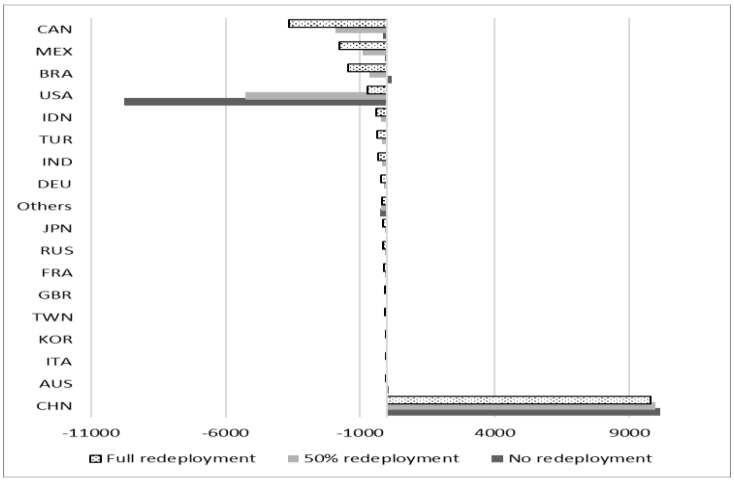
Country	1: Initial	2: Short term	3: Long term	4: Full Substitution	Difference (4-1)	
AUS	31 253	31 281	31 272	31 221	-32	-0.1%
BRA	107 124	107 294	107 247	106 046	-1 078	-1.0%
CAN	20 878	20 876	20 838	18 982	-1 897	-9.1%
CHN	841 725	851 314	849 590	849 344	7 619	0.9%
DEU	23 093	23 093	23 091	23 007	-86	-0.4%
FRA	41 051	41 053	41 048	40 988	-64	-0.2%
GBR	18 304	18 304	18 303	18 276	-28	-0.2%
IDN	92 080	92 081	92 079	91 703	-377	-0.4%
IND	267 242	267 260	267 239	266 955	-288	-0.1%
ITA	40 206	40 206	40 202	40 183	-23	-0.1%
JPN	47 904	47 905	47 901	47 813	-91	-0.2%
KOR	26 010	26 010	26 007	25 969	-41	-0.2%
MEX	38 249	38 241	38 027	36 861	-1 388	-3.6%
RUS	54 013	54 015	54 013	53 933	-80	-0.1%
TUR	58 418	58 416	58 409	58 099	-320	-0.5%
TWN	8 432	8 432	8 431	8 381	-51	-0.6%
USA	178 344	172 835	173 076	178 289	-55	0.0%

Notes and sources: see Table 8

The overall impact on the whole US economy is measured through its GDP (In absence of redeployment, the impact on the USA is large (a loss of about 9,800 million) and it remains significant (minus 730 million) in case of full redeployment: even if the agricultural sector was able to recoup its losses, US suppliers will lose some of the sales to their foreign customers, in particular to other NAFTA partners and to Brazil, which suffer most from this redeployment. On the winning side, there is only one country, China, which captures all the benefits with gains close to ten billion (remember that, by construction, this is a zero-sum game), but we know that our method overestimates these gains. If we compare with the previous case on electronics (Figure 3), US' export redeployment does not affect much China's gains, a sign that China does not compete against the USA on this line of products.

Figure 4). In absence of redeployment, the impact on the USA is large (a loss of about 9,800 million) and it remains significant (minus 730 million) in case of full redeployment: even if the agricultural sector was able to recoup its losses, US suppliers will lose some of the sales to their foreign customers, in particular to other NAFTA partners and to Brazil, which suffer most from this redeployment. On the winning side, there is only one country, China, which captures all the benefits with gains close to ten billion (remember that, by construction, this is a zero-sum game), but we know that our method overestimates these gains. If we compare with the previous case on electronics (Figure 3), US' export redeployment does not affect much China's gains, a sign that China does not compete against the USA on this line of products.

Figure 4 Agriculture: Total impact on GDP, as a difference from the initial situation (Mn dollar)



Source: Authors' elaboration based on WIOD data

d) US exports of motor vehicles, trailers and semi-trailers to China

With less than 9 billion dollars, the Chinese market represents only 1.5% of the US output of motor vehicles according to WIOD's 2014 tables (sector code r_20). The Mexican automobile industry would be on the first line to suffer from a recession in this US industry, with losses of USD 270 million. Interestingly, China itself would feel the pain, as it is a large supplier of value-added to the US industry. It appears five time in the list of the ten most affected industry by the size of the total requirements in the initial pre-crisis situation (see Table 13).

Table 13 Expected losses to third countries due to extraction of US automotive products: top ten foreign suppliers (million dollars, 2014)

ISO3	Sector [a]	Total Requirement Index [b]	Losses [c]
MEX	MEX_r20	3.0	270
JPN	JPN_r20	2.5	217
CHN	CHN_r20	2.1	182
CHN	CHN_r17	1.7	150
DEU	DEU_r20	1.4	127
CHN	CHN_r15	1.2	108
CAN	CAN_r20	1.2	106
KOR	KOR_r20	1.0	85
CHN	CHN_r11	0.9	77
CHN	CHN_r19	0.9	76

Notes and sources: see Table 8

The five most exposed Mexican industries would suffer potential losses of 416 million, compared to 593 million in the case of China. This indicates that China, even if it is not a main exporter of final products to the US like Japan or Germany automobile industries, is an important provider of intermediate inputs. All in all, the US automotive industry would not suffer much if it is able to compensate its losses by redeploying its exports to third markets (Table 14).

Canada (-3%) and Mexico (-2%) would be most affected in both monetary and relative terms. Germany and Japan would also suffer high monetary losses, but they would be relatively marginal compared to their overall output. The Chinese industry could expect gains in value-added bordering 2.5 billion (1% above the pre-crisis situation).

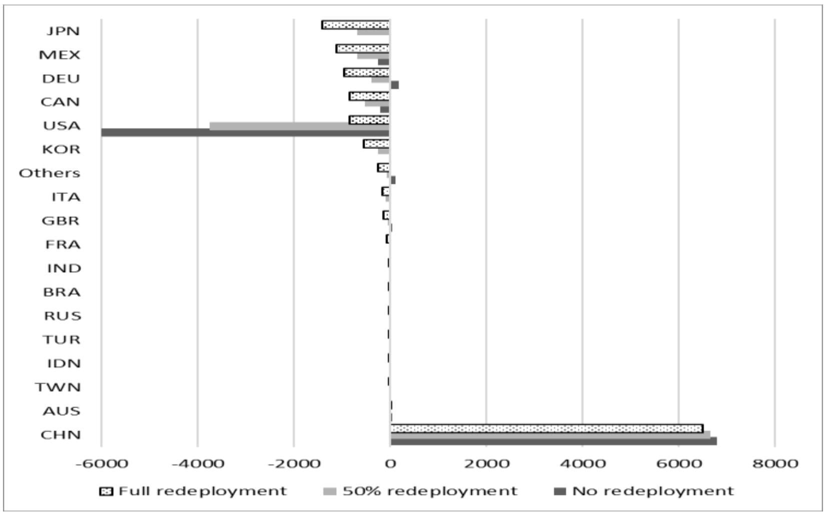
Table 14 Automotive sector: Evolution of the Sectoral Value Added, selected countries (Mn dollar and percentages)

Countries	1: Initial	2: Short term	3: Long term	4: Full Substitution	Difference (4-1)	
AUS	3 516	3 516	3 511	3 510	-6	-0.2%
BRA	36 746	36 744	36 735	36 732	-14	0.0%
CAN	16 322	16 298	15 896	15 859	-463	-2.8%
CHN	229 990	232 439	232 488	232 457	2 467	1.1%
DEU	147 491	147 607	147 013	146 973	-517	-0.4%
FRA	15 118	15 120	15 106	15 103	-14	-0.1%
GBR	20 926	20 950	20 885	20 882	-44	-0.2%
IDN	16 767	16 766	16 759	16 757	-10	-0.1%
IND	23 822	23 820	23 815	23 812	-10	0.0%
ITA	14 900	14 902	14 860	14 856	-44	-0.3%
JPN	93 109	93 130	92 415	92 360	-749	-0.8%
KOR	37 997	38 000	37 751	37 731	-266	-0.7%
MEX	40 112	40 039	39 559	39 479	-633	-1.6%
RUS	16 616	16 616	16 610	16 609	-7	0.0%
TUR	6 023	6 022	6 017	6 015	-7	-0.1%
TWN	4 752	4 744	4 743	4 735	-17	-0.4%
USA	145 059	142 444	144 630	144 875	-184	-0.1%

Notes and sources: see Table 8

As before, the possibility of redeploying the losses to other markets changes dramatically the simulation results. If full redeployment of US exports takes place after the Chinese embargo on US automotive products, Japan, Mexico, Germany and Canada are expected to suffer more in terms of total GDP than the USA itself (Figure 5). Korean GDP is also expected to drop by about 550 million.

Figure 5 Automotive sector: Total impact on GDP, as a difference from the initial situation (Mn dollar)



Source: Authors' elaboration based on WIOD data

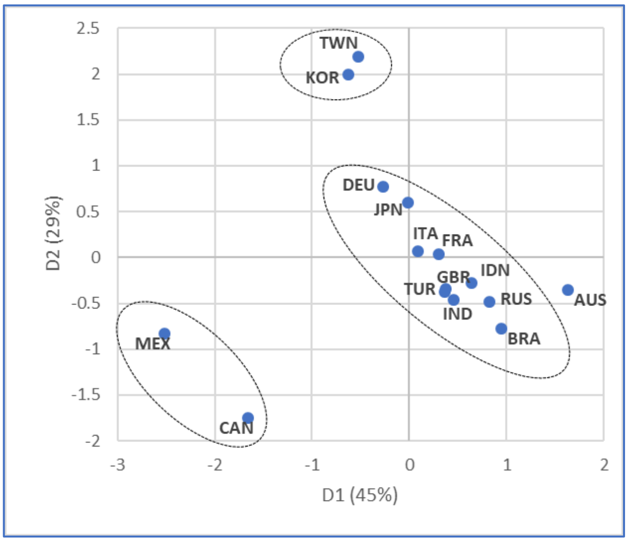
2) Third countries exposure to a wider China-USA trade conflict

To conclude this empirical exploration of the spillover effects on third countries, we consider the impacts caused on their economy if the bilateral trade conflict extends to other key export sectors. To this aim, we simulate "in silico" a series of bilateral shocks, affecting 12 good producing sectors, emanating alternatively from China and from the USA, giving a total of 24 simulations. For each sector, we consider only the impact on GDP of the two extreme scenarios (without and with full redeployment) of extraction-substitution. The first scenario gives the gains or losses accruing to third countries from the exclusion of Chinese products on the US market or, symmetrically, the exclusion of US products from China. The second one indicates the vulnerability of these third countries to China and USA being successful in fully redeploying the excluded exports to other markets.

The simulation generates a total of 720 observations: 24 sectoral shocks on 15 G20 countries (excluding China and the USA) and two datapoints per simulation. The statistical treatment is conducted using principal component analysis, a multi-dimensional exploratory tool particularly well suited in this context where many results are strongly correlated.

Figure 6 shows the results obtained for the first two components, after a varimax rotation. These two components represent about 75 percent of the total information (or variance) provided by the 720 datapoints. As usual with this type of exploratory analysis, the interpretation of the components requires a separate analysis of the correlations of the variables (the sectoral shocks) and the observations (the 15 countries).

Figure 6 Principal Component Analysis of the GDP responses to bilateral China-USA shocks



Source: Authors' elaboration based on WIOD data

The first component, on the horizontal axis, explains 45% of the total variance. Its interpretation is relatively straightforward: on the left-hand side of the diagram, we find countries that register, in average of the sectors, a positive gain when China exports are targeted by the USA while the right side of the graph corresponds to countries that tend to gain when US exports are targeted by China. Interpreting the vertical axis (29% of the total variance) is more complex: On the top side of the graph, we find countries that (i) lose market share when China is able to redeploy 100% of its extracted exports or (ii) gain when the US exports are blocked by China and the USA is not able to redeploy its lost exports.

The combination of these two components identifies three groups of countries, with Australia being in a separate category. Mexico and Canada make a first group of countries that gain when China is excluded from the US market and are not much affected by China's increased competition on other markets. This situation reflects their strong export-orientation to the US market. The second group (Chinese Taipei and Korea) gains also when China is excluded from the

US market, but are very vulnerable to a redeployment of Chinese exports to other markets. The third group, more numerous, is arranged along the first diagonal of the graph. We find here countries like Germany and Japan that share some of the Taipei and Korea characteristic, and other, at the lower end of the diagonal, that are suppliers of primary goods to China (Brazil, Russia) and are not much affected by Chinese competition on their other export markets. Australia is relatively close to this situation, but with some specificities that puts it in a special case. In particular, Australia is more vulnerable to the redeployment of Chinese exports in some sectors such as basic metal.

6. Post-COVID19 Implications for the Multilateral Trade System

The above-mentioned results are probably conservative. In particular, the simulations do not take into account the probable drop in demand caused by the reduced activity in several industrial sectors. Moreover, uncertainty is often accompanied by trade destruction. And indeed, the 2018-2019 trade conflict between China and the USA brought severe impacts on global economy. WTO (2019) had to lower its estimate of world trade growth in 2018 from 4.7% in 2017. The revised figure was a low 2.9% for 2018, and a flat 0.2% in 2019, weighed down by trade tensions and slowing economic growth (WTO, 2020). This shortfall was mostly explained by the high degree of uncertainty associated with World trade, including new tariffs and retaliatory measures. They weighted on the overall business climate, resulting in weaker global economic growth. The COVID-19 pandemics affected both trade volumes (-5.3%) and international prices (-8.0%). As a result of the crisis, merchandise trade in nominal dollar terms fell in 2020 by about 8%.

Multilateral trade governance was also affected. Despite the “phase one” trade deal of January 2020 between China and the USA, economic and geopolitical bilateral tensions have continued to escalate. The COVID-19 crisis put in evidence the risks of depending on unreliable sources of key inputs, and in September 2020, the US administration declared that it “will end our reliance on China” through “decoupling” or “massive tariffs”. In 2015, China had already declared that the objective of its “Made in China 2025” was to gain domestic autonomy and world leadership in a series of key value chains. However, it is not just China and the US that are pulling away. In February 2019, the EU announced that steel imports will be subject to quotas to counter the concerns of trade deflection and fears that Europe could be flooded with steel that is no longer being imported into the United States. Then, the EU adopted a series of measure to control foreign direct investment, especially from State-sponsored firms and investment funds.

The trend accelerated due to the COVID-19 crisis and concerns for securing critical inputs through foreign suppliers, highlighting the risks of supply chain disruption. By restricting shipments of merchandises between countries, the crisis impacted many industries worldwide and created shortages of several critical goods, in particular medicines and health-related equipment. The EU published in 2020 a paper on industrial strategy, which is seen as a drive towards reducing the reliance on the outside world. Ms von der Leyen, EU Commission president, has called for Europe to have "mastery and ownership of key technology" (G. Rachman, Financial Times 10/05/2020).

2020 was also the year when the final phase of Brexit was implemented, increasing GVC trade costs within Europe. In the process, the UK authorities published in 2021 a plan for a “Global Britain”, to benefit from the increased degree of economic-diplomacy freedom, to respond more effectively to the changing world order and to prepare for a new age of trade competition. It is perceived that the post-Brexit strategy aims at rebalancing trade relationships with EU and with North America, and looks at diversifying GVC dependencies away from China.

The COVID-19 crisis has also further damaged the idea that the globalization of production was a win-win situation. Many governments in developed and emerging countries have been anxious about issues of food and medical supply security, and launched initiatives to promote national production, the reshoring of manufacturing at home or its near-shoring closer to home. This nervousness is also observable in the business community, especially the managers of large global supply chains because of 'supply-chain contagion'. As Baldwin and Tomiura (2020) conclude, the reaction of governments and firms to repatriate production and increase protectionism is a danger of permanent damage to the trade system. All these actions may have far-reaching implications on the structure of global value chains and on global trade governance.

In the Post COVID era, the cost/benefit balance of international trade is being increasingly assessed from the perspective of national security and geopolitical strategy. This is a huge departure from the pre-COVID19 situation where the debates on the costs and benefits of globalization were mainly set in terms of welfare, economic growth and job creation or destruction. In the process, the role of the World Trade Organization as the institution embodying multilateral trade governance and providing a dispute settlement mechanism has been put in jeopardy. For Hoekman (2020), the WTO has not played a significant role in defusing trade conflicts between the US and other trading partners.

In addition to supply chain disruptions, the present paper highlights the risk of trade deflection attached to trade conflicts. Deflection, as mentioned by Evenett and Fritz (2018), increases the chance of "multilateralising" the bilateral conflict. The redeployment of exports when a large market is blockaded inflicts potentially large losses to third countries and would probably induce them to take their own protectionist measures to shield their industries from the increased trade competition.

Such decoupling from the competitive collaboration between USA and China that characterised the late 1990s and early 2000s, leading to a disruption and re-ordering of global value chains, is one of the three scenarios mentioned by Choi (2020). As a result, GVC trade may split into two spheres competing for influence, one being US/EU-centred and the other China-centred. The end-result would prove disastrous for the multilateral trade governance, mimicking the spiralling protectionism that followed the Smoot-Hawley Tariff Act in 1930, which raised U.S. tariffs on over 20,000 imported goods to record levels and was reciprocated by many countries, deepening the global recession.

7. Conclusions

The analysis of the spill-over effects of a bilateral trade war between China and the USA shows that a large share of the negative impact is felt by third countries. They are affected first as suppliers of inputs to the industries that are targeted by the trade conflict. They also suffer, and to a larger extent, from the increased competition that may prevail when the targeted industry tries redeploying part or totality of its losses to other markets in other countries.

The mapping of the gains and losses arising from the bilateral China-USA conflict shows that the spill-over effects are usually higher in neighbouring countries, and confirms that global value chains are principally regional ones. But it would be wrong to assume that geography alone explains the results: for some suppliers, the gains that could be expected on their regional market are balanced by the indirect losses due to the lower activity suffered by the targeted industry.

The monetary value of the expected gains and losses for foreign suppliers is significant in many cases. In our simulation, the largest impacts were found when the USA apply protectionist measures against China. The spill-over effects of an embargo on US products by China do not generate similarly large economic effects. Hu et al. (2021) reach similar conclusions. Nevertheless, it should be noted that the simulation measures quantities on aggregate sectors. At the micro level, US firms dependent upon China for key inputs or for their export market may have to exit the market, with significant qualitative implications. First, because exporting firms are usually more innovative than domestic-oriented ones; second because international trade, besides the monetary dimension, has qualitative impacts on learning and sharing technologies and know-how that cannot be measured in our simulation but is probably larger than a simple count of dollars.

The current paper examined trade conflicts that are limited to shocks affecting just one single product at a time. Even if the monetary value of the losses and gains for third countries are important, they remain small in proportion of their total trade. But a more widespread conflict affecting a wider range of merchandises and industries would have far reaching implications, including on other countries.

The COVID-19 pandemic accelerated a trend towards a return of economic protectionism, which was already perceptible since the 2008-2009 global crisis. The deglobalization trend has been exacerbated by rising geo-political tensions in the Indo-Pacific region and the China-USA trade conflict that erupted in 2018. The Brexit saga reinforces this deglobalization movement. In only five years, from 2015 to 2020, the three main trading actors (China, USA and Europe) have shifted towards industrial nationalism in a Tit-for-Tat escalation. The risk here is to see other affected countries to follow the same strategy, taking unilateral measures to protect their industries, either by increasing tariffs or by providing exposed industries with subsidies to enhance their cost competitiveness in the face of increased international competition.

As suggested in our paper, the damage on World Trade governance should not be minimized. Indeed, it is important to make the difference between a pure trade dispute, as in our example, and a wider geo-political confrontation between two super-powers. In this case, third countries may not be able to remain neutral by-standers and would have to choose their camp. Hue et al. (2021) warn that trade decoupling of the world's two leading economies is likely to trigger worldwide a "tsunami" in transnational investment, global financial markets, science and technology fields. A similar situation occurred in 18th and 19th century Europe, where trade was mainly an instrument at the service of geo-political objectives, a situation that returned in the 1920s and 1930s, with dire implications.

The re-shoring and near-shoring of international supply chains within realigned regional trading blocs may reduce systemic geo-political risks and increase GVC resilience. But this is a second-best solution compared to the first-best option of preserving and modernising global trade governance under multilateral rules. A fair and free trading environment is essential for global development. The main challenge for the future of globalisation is institutional and political in nature. Trade conflicts must be solved and disputes settled at WTO. But the WTO is also in crisis, it needs to find a new modus operandi, in particular to adapt to the new trade environment and defuse trade tensions in the form of better trade and industrial policy monitoring.

Thanks for reading…

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Annex: sectors in the WIOD tables

Label	Code	Label	Code
Crop and animal production, hunting and related service activities	r1	Wholesale and retail trade and repair of motor vehicles and motorcycles	r28
Forestry and logging	r2	Wholesale trade, except of motor vehicles and motorcycles	r29
Fishing and aquaculture	r3	Retail trade, except of motor vehicles and motorcycles	r30
Mining and quarrying	r4	Land transport and transport via pipelines	r31
Manufacture of food products, beverages and tobacco products	r5	Water transport	r32
Manufacture of textiles, wearing apparel and leather products	r6	Air transport	r33
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	r7	Warehousing and support activities for transportation	r34
Manufacture of paper and paper products	r8	Postal and courier activities	r35
Printing and reproduction of recorded media	r9	Accommodation and food service activities	r36
Manufacture of coke and refined petroleum products	r10	Publishing activities	r37
Manufacture of chemicals and chemical products	r11	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	r38
Manufacture of basic pharmaceutical products and pharmaceutical preparations	r12	Telecommunications	r39
Manufacture of rubber and plastic products	r13	Computer programming, consultancy and related activities; information service activities	r40
Manufacture of other non-metallic mineral products	r14	Financial service activities, except insurance and pension funding	r41
Manufacture of basic metals	r15	Insurance, reinsurance and pension funding, except compulsory social security	r42
Manufacture of fabricated metal products, except machinery and equipment	r16	Activities auxiliary to financial services and insurance activities	r43
Manufacture of computer, electronic and optical products	r17	Real estate activities	r44
Manufacture of electrical equipment	r18	Legal and accounting activities; activities of head offices; management consultancy activities	r45
Manufacture of machinery and equipment n.e.c.	r19	Architectural and engineering activities; technical testing and analysis	r46
Manufacture of motor vehicles, trailers and semi-trailers	r20	Scientific research and development	r47
Manufacture of other transport equipment	r21	Advertising and market research	r48
Manufacture of furniture; other manufacturing	r22	Other professional, scientific and technical activities; veterinary activities	r49
Repair and installation of machinery and equipment	r23	Administrative and support service activities	r50
Electricity, gas, steam and air conditioning supply	r24	Public administration and defence; compulsory social security	r51
Water collection, treatment and supply	r25	Education	r52
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	r26	Human health and social work activities	r53
Construction	r27	Other service activities	r54
		Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	r55
		Activities of extraterritorial organizations and bodies	r56