Shooting oneself in the foot? Trade war and global value chains

Cecilia Bellora (CEPII)*

Lionel Fontagné (Paris School of Economics – Université Paris I and CEPII)†

Draft: April 10, 2019

Abstract

Since the beginning of 2018, the US administration has announced and implemented several measures limiting trade with their partners, in particular China. This has fueled retaliation and has escalated in high trade tensions at the global level. We address in this paper the trade and welfare effects of the current trade tensions. We rely on the new version of the Computable General Equilibrium model MIRAGE, which differentiates demand of goods according to their use, for final or intermediate consumption. This authorizes tracing the impact of protection along the value chains. We rely on the official lists of additional tariffs, the latter being averaged at the 6 digit levels of the harmonized system (HS6) before being aggregated at the sector level by a reference group weighted method. As for Voluntary Export restraints (VERs), we assume that the negotiated quantities are exported each year; the target in volume is reached using an export tax, endogenously computed, which generates a rent that benefits the exporter. Our results suggest that, because of the measures in place as of early January 2019, China and the United States could experience GDP losses by 0.4% and 0.3% respectively. As a result of vertical linkages along the value chains, 20 out of our 25 sectors decrease their value added, suggesting that with this tariff war the US are shooting themselves in the foot.

Key Words: Trade War, Global Value Chains.

JEL Codes: F13, F17.

*CEPII, 20 avenue de Ségur 75007 Paris. Email: cecilia.bellora@cepii.fr.

†Centre d'Economie de la Sorbonne, 106-112 Bd de l'Hôpital, F-75647 Paris Cedex 13. Email: lionel.fontagne@univ-paris1.fr.

Introduction

Since the beginning of 2018, the US administration has announced and implemented several measures limiting trade with their partners, in particular China. This has fueled retaliation and has escalated in high trade tensions at the global level. In March, the US imposed additional tariffs of 10% and 25% on their imports of aluminum and steel, respectively. They exempted only Australia, while Argentina, Brazil and South Korea negotiated voluntary export restraints (VERs) to avoid, at least partially, the tariff increase. Several countries considered that the invoked national security threat used to impose these measures actually disguised an unjustified protection against imports. As a result, Canada, China, European Union, India, Mexico, Russia and Turkey retaliated increasing their own tariffs on targeted US products. From May onwards, new US trade restrictions mainly targeted China, with an unprecedented intensity. The reason invoked is the retaliation against unfair Chinese trade practices on technology and intellectual property. The US imposed successive waves of additional tariffs on goods they import from China. Between June and July, additional tariffs of 25% affected around 50 bn USD imports. In September, new tariffs on USD 200 bn entered into force, at a rate of 10%. China retaliated against each of these waves, responding with 25% additional tariffs on USD 50 bn of imports from the US and then a 5 to 10 p.p. increase in tariffs on additional USD 60 bn imports. The threat of imposing an increase to 25% of the taxes already imposed on 200 bn Chinese exports was still pending by March 2019, although tensions between the two major economies seemed to be contained. Lastly, a series of tariffs targeting USD 11 bn EU exports has been announced on April 8th 2019, their implementation being conditional on the results of the WTO arbitration on aircrafts expected in summer.

What are the trade and welfare effects of the current trade tensions? What would be the effect of further escalation of the trade tensions? How to model a trade war and what would be the possible trade and welfare effects in presence of internationally fragmented value chains? This paper addresses these questions by combining the most detailed information on protection measures with a consistent modelling of trade and value added at the sectoral and global levels.

The new tariffs have indeed a direct impact on the targeted products and countries, but global value chains, along with general equilibrium effects, trigger consequences also on third sectors and countries. These are the indirect effects possibly contributing to imposing countries doing themselves a disservice. Using an augmented political economy model of trade policy, Blanchard, Bown & Johnson (2016) show that global value chain linkages modify countries' incentives to impose import protection. They develop a theoretical setting in which the optimal tariff depends on the nationality of value-added content embedded in domestic and imported final goods. Tariffs should be decreasing in the domestic content of foreign-produced final goods and in the imported content of domestic production of final goods. Using data on temporary protection for 14 major traders over the period 1995-2009 they confirm that the importance of GVCs is curbing the use of protection, especially against China. However, Bown (2018) provides evidence that, even before the recent escalation, temporary trade barriers have moved away from final goods towards intermediate goods, starting from 2010, following a pattern contrary to the ubiquituous tariff escalation. Closer to our exercise, Koopman, Tsigas, Riker & Powers (2013) investigate the implications of GVCs for trade policy using a Computable General Equilibrium (CGE) framework, embarking (or not) information on the destination of products. They simulate the impact of an homogenous tariff set by the US on Chinese goods (in order to offset the alleged under-appreciation of the renminbi) with the GTAP model and alternatively with the USITC model embodying GVCs, using the same calibration hypotheses.[1]. The overall impact of the tariff increase is halved for China with the model embarking GVCs, and the impact even reverses for Mexico.[2]

CGE modeling is a good candidate to address the effects of this trade war, in particular when the dynamic impacts of the trade war have to be characterized. Sectors adjust their intermediate consumption basket to tariff-induced price changes, labour force and capital accumulate, and the overall setting can be linked to a macroeconomic baseline. One drawback of CGE modelling recently fixed is the way GVCs were modelled. We rely here on MIRAGE, the CGE developed at the CEPII, in a version that integrates imperfect competition and importantly differentiates demand of goods according to their use, for final or intermediate consumption, thus properly representing GVCs. As for tariff increases, we rely on the official lists, but our scenarios differ from the recent literature (i) in the way we aggregate these information and (ii) in how we take into account voluntary export restrictions. Tariffs are aggregated by a simple mean to move from the 8 to the 6 digit levels and then by a reference group weighted mean to reach the level used in our simulations.[3] As far as Voluntary Export Restraints (VERs) are concerned, we assume that the negotiated quantities are exported each year; the target in volume is reached using an export tax, endogenously computed. This solution is appealing in that it generates a rent that accrues to the exporter (contrary to a tariff).

Our results suggest that, because of the measures in place as of early January 2019, China and the United States could experience GDP losses by 0.4% and 0.3% respectively, while GDP could slightly increase in other regions such as Europe or ASEAN. These aggregate numbers hide a large heterogeneity across sectors, but while in China primary sectors as a whole increase the value added they generate, the US primary, manufacture and service sectors all decrease their value added (between -0.03% and -1.86%).

We are not the first to look at the impacts of the measures in place or, more generally, of a broader trade war. Freund, Ferrantino, Maliszewska & Ruta (2018) propose an impact assessment of the first round of tariff increases between the US and China under the section 301 using a CGE model. They also explore a broader trade war scenario with additional bilateral tariffs of 25 p.p. Balistreri, Böhringer & Rutherford (2018) use the

[1] China and Mexico have export processing zones modelled as separated economies in this model

[2] A related literature is examining the impact of tariffs on inputs on productivity. For instance, Miroudot, Rouzet & Spinelli (2013) analyze the effects of the unilateral removal of tariffs on manufacturing inputs carried out by Canada in 2010 and find a sizeable Total Factor Productivity gains for Canadian firms in textiles, transport equipment and chemicals.

[3] See Bouet, Decreux, Fontagné, Jean & Laborde (2008) for a justification of the reference group method.

most detailed available information on the measures, i.e. the official tariff lists, compounded by Li, Balistreri, Zhang et al. (2018), in their simulations. They assess their impacts using three alternative model structures and focus their presentation on US sectoral output. Li et al. (2018) also produce CGE simulations of the very detailed tariff scenario, but they do not take into account the VERs and adopt a simpler and more canonical model. Charbonneau & Landry (2018) also use a rather complete and detailed tariff scenario, giving results in terms of trade and value added. Nevertheless, they consider separately the different waves of tariffs, disregarding their non-linear effects. Lastly, Berthou, Jardet, Siena & Szczerbowicz (2018) and Vicard (2018) focus more on a stylized trade war scenario inspired from Ossa (2014) or Nicita, Olarreaga & Silva (2018) and provide impacts by country but not by sector. Felbermayr & Steininger (2019) rely on an input-output gravity approach *à la* Caliendo & Parro (2015) to assess the consequences of the trade war between the US and China on the two countries and on the EU as well. This exercise provides an assessment of the static economic impact of the trade war in general equilibrium featuring global value chains. They show that China loses but the US as well, while the impact of this bilateral trade war is slightly favourable to Europe. However, their exercise neither takes into account US tariffs on EU and subsequent European retaliations nor the specific treatment of the above mentioned countries by the US in the Steel and Aluminum case (e.g.Korea). Amiti, Redding & Weinstein (2019) address the impact of the US–China trade war on prices and welfare, taking stock of the disruption of global value chains. As opposed to most of the exercises in the literature, Amiti et al. (2019) use detailed (HS 10-digit) information on unit values (tariff-inclusive "prices") at the US border. Most of the cost of the war is shown to fall on US consumers due to full pas-trough of the tariffs by foreign exporters and reduced competition on the US market. The magnitude of the price effect in the US is estimated to be one percentage point. Fajgelbaum, Goldberg, Kennedy & Khandelwal (2019) also rely on detailed trade data and compute trade elasticities used in supply-side model of the US economy. The magnitude of welfare losses so computed is one order of magnitude smaller than ours (0.04% for the US).

Our contribution to this strand of literature is to rely on information at the most detailed level on sanctions and retaliations, and to encapsulate this information in a general equilibrium framework featuring imperfect competition and global value chains. Beyond simple trade effects (here distinguishing between intermediate and final goods), we track price changes in general equilibrium and compute value added changes and welfare impacts. The magnitude of the price effect we obtain is in line with Amiti et al. (2019) although we rely on a totally different methodology.

The rest of the paper is organized as follows. In section 1, we present the model and data. In section 2, the scenarios are detailed. Results are discussed in section 3. The last section concludes.

1 Empirical strategy

1.1 The modeling strategy

Our approach is combining three tools: i) a global and sectoral CGE model featuring imperfect competition and recursive dynamics; ii) a database of applied tariffs that can be shocked at the HS6-digit level by aggregating measures enforced at the tariff line level; and iii) a dynamic baseline of the world economy up to 2030. We present sequentially these three elements.

1.1.1 The General Equilibrium model

We rely on version 2 of the CGE MIRAGE-e which innovates by featuring GVCs.[4] This version is fully documented in Bellora & Fouré (2019). MIRAGE-e (Modelling International Relationships in Applied General Equilibrium) is a multi-sector and multi-region computable general equilibrium model dedicated to assess the impact of trade policies and interactions between trade and climate change.

In MIRAGE-e, firms interact either in an oligopolistic competition (a number of identical firms in each sector and region compete one with another and charge a markup over marginal costs) or in a perfect competition framework (a representative firm by sector and region charges the marginal cost). Production combines value-added plus energy and intermediate consumption, while demanding five primary factors (labor with two different skill levels, capital, land, natural resources), fully employed.

In each region, a representative consumer gathers households and the government. It maximizes its intra-temporal utility function under its budget constraint. This representative agent saves a part of his income and spends the rest on commodities, according to a LES-CES functional form.

Trade is represented with two different Armington structures,[5] to separate trade in goods for final consumption and trade in intermediates. This double structure accounts for global value chains better that the standard single one that handles indiscriminately all goods. Trade can be impacted by a wide range of measures, systematically differentiated according to the use of the affected goods. Bilateral protection stems from the MAcMap database, allowing for a fine definition of trade policy scenarios at the HS6-digit level (5000+ products); trade restrictiveness of non-tariff measures, whether generating rents or not, is also taken into account. To deal with the differentiated trade structure, the model relies on the ImpactEcon database (Walmsley & Minor 2016) detailed below.

Every agent in the model emits greenhouse gases (CO_2, CH_4, N_2O, fluorinated gases) by her consumption of fossil energy (coal, crude oil, gas, refined petroleum) and her production (in the case of firms), based on data from the GTAP 9 database. To mitigate these emissions, regions can implement a carbon tax or cap and trade

[4] Version 1 of the model is documented in Fontagné, Fouré & Ramos (2013).

[5] More complex product differentiation by quality zones can also be considered.

mechanism, possibly supplemented by a border carbon adjustment for traded goods.

Finally, MIRAGE-e is a recursive dynamic model, where the baseline is calibrated in close relationship with the MaGE model and the resulting EconMap database (Fouré, Bénassy-Quéré & Fontagné 2013) to deal with world structural change from medium (2030) to very long-run horizon (2100). Structural adjustments come from the inertial reallocation of the stock of capital via depreciation and investment.[6]

1.1.2 Protection data in the baseline

Market Access Map (MAcMap) provides a disaggregated, exhaustive and bilateral measurement of applied tariff duties (Guimbard, Jean, Mimouni & Pichot 2012). It takes regional agreements and trade preferences exhaustively into account. The raw source data is from ITC (UNCTAD-WTO). This data set is constructed by the CEPII for analytical purposes and provides an *ad valorem* equivalent (percentage) of applied protection for each triplet (importer-exporter-product). To minimize endogeneity problems (when computing unit values or when aggregating data), it relies on "reference groups" of countries: bilateral unit values and bilateral trade are replaced by those of the reference group of countries in the weighting scheme (Bouet et al. 2008). MAcMap-HS6 treats specific duties (per unit) as well as TRQs and offers MFN for all WTO members. Tariff equivalents of Non-Tariff Measures on goods are taken from Kee, Nicita & Olarreaga (2008). Tariff equivalents of Non-tariff measures on services are from Fontagné, Mitaritonna & Signoret (2016).

1.1.3 The dynamic baseline

The effects of the trade war are measured in terms of deviation from a dynamic baseline, using a ten years horizon in order to fully capture the dynamic adjustments of the economies. It relies on a macroeconomic model of the world economy, used in projection up to 2030. For each country, the GDP, the savings rate, the current account, and the energy efficiency are consistently projected and used as an exogenous trajectory in our General Equilibrium model. This trajectory is made consistent with the assumptions of the General Equilibrium model by endogenizing the Total Factor Productivity. This is the first step of the construction of our baseline. In a second step, a soft Brexit is imposed.[7]

The macroeconomic baseline of the world economy is constructed with the MaGE model proposed in Fouré et al. (2013). Based on a three-factor (capital, labour, energy) and two-productivity (capital-labour and energy-specific) production function, MaGE is a supply-side oriented macroeconomic growth model, defined at country level for 167 countries. It consists of three steps. First, production factor and productivity data are collected for 1980 to 2010. Second, behavioural relations are estimated econometrically for factor accumulation and productivity growth, based on these data. Third, these relations are used to project the world economy. A

[6] More information is available on the MIRAGE wiki: `https://wiki.mirage-model.eu`

[7] The model used is MIRAGE-VA; the base year is 2011, we rely on GTAP data for SAMs and MAcMap for baseline tariffs.

dataset of production factors and economic growth has been built using World Bank, UN and ILO data for the period 1980-2010. The theoretical framework consists of a CES production function of energy and a Cobb-Douglas bundle of capital and labour. This theoretical framework allows to an energy-specific productivity from the profit-maximization programme of the representative firm, while capital and labour productivity are recovered as a Solow residual. These two different productivities, along with data on GDP and production factors fully describe the world economy in the past (1980 to 2010).

Behavioural relations are estimated from this dataset for population, capital accumulation and productivity. Population projections are given by UN population projections, split across 5-year age bins and the two genders. For each of age groups, we estimate education and then deduce labour force participation. Educational attainment follows a catch-up process to the leaders in primary, secondary and tertiary education, with region-specific convergence speeds[8] Capital accumulates according to a permanent-inventory process with a constant depreciation rate of 6% per annum. On the one hand, investment depends on saving with a non-unitary error-correction relationship which differentiates long-term correlation between saving and investment and annual adjustments around this trend. Because of the significant differences we found between OECD and non-OECD members, both levels of estimation are conducted separately for the two country groups. On the other hand, savings depend on the age structure of the population, consistent with both the life-cycle hypothesis and economic growth. Capital-labour productivity and energy efficiency are assumed to catch-up with the best-performing countries. While the former process is conditional on and fuelled by the education level, the latter follows a U-shape relationship between the level of development proxied by GDP per capita and energy productivity. These behavioural relations provide the dynamics of factor accumulation productivity and energy efficiency that will shape the macroeconomic projections. Adding the theoretical link between energy productivity, price and consumption resulting from the profit maximization program, along with exogenous energy prices projected by the IEA, one can fully describe the world economy in projection.

In a second step, we update the tariff protection to its level of 2014 and represent the most recently signed or negotiated trade agreements:the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), the EU-Japan Economic Partnership Agreement, the Comprehensive Trade and Economic Agreement between the EU and Canada and a soft Brexit. For all the new trade agreements, we remove all the tariffs but leave the NTMs unchanged; we represent a soft Brexit by leaving the tariffs applied by the UK and the EU unchanged, while increasing their bilateral NTMs to halve the preferential access of the UK to the EU market.

[8]The authors consider 8 regions in the world. While male labour force participation follows the logistic relation determined by the ILO, female participation changes with education level: higher education implies lower participation of the youngest females, while making females of other age groups participate more to the labour force.

1.2 The data

The General Equilibrium model is calibrated using the ImpactECON database featuring a decomposition of trade in goods and services by final or intermediate use that is consistent with GTAP 9.[9] This release of the GTAP data base, features 2011 as the last reference year. The geographic decomposition is 140 regions of the world economy for 57 GTAP sectors. We aggregate this data into 26 sectors and 21 regions or countries of the world economy (see Appendix A.2 for the detailed aggregation).

2 The scenarios

We shock the model in 2018 and examine the deviation from the baseline at each date till 2030, for the variables of interest (trade, sectoral value added, prices, etc.). The two series of events we take on board are the so-called "Section 232" (of the Trade Expansion Act of 1962) on aluminium and steel by the US (including exemptions, quotas and retaliation) and the "Section 301" (of the Trade Act of 1974) applied to US imports from China in two waves.[10] We do not take into account measures not yet implemented by March 1, 2019. Meaning that we neither model the possible deterring impact of the uncertainty surrounding the increase of taxes from 10% to 25% on Chinese exports, nor the impact of the threat over the foreign car industry.[11]

An important part of the work is to recollect the exact information on trade sanctions and retaliation, using original sources. We are not the first to do this, but our recollection differs slightly from tariff lists used in other papers, possibly because we used the updated versions of these lists (we rely on official lists of products as in January 2019, as defined in the Federal register and on the websites of the imposing administrations, taking into account the changes in the list of products, see Appendix A.1).[12]

How are these shocks implemented? When additional tariffs are determined at the 8 or 10 digits level of the nomenclature, we take the simple mean over all the products within the entire HS6 line to compute an additional tariff for the HS6 line. This additional tariff is then applied to the tariff reported in the MAcMap database (base year is 2013). The aggregation at the level of the sectors considered in the simulations is done

[9] The "ImpactECON Global Supply Chain package" allows converting the GTAP 9.0 data into a global supply chain database. Since the goods traded in GTAP are aggregated within sectors over numerous HS-6 products categories, the resulting sector can provide the same category of good to final consumer and to other sectors that use it as an intermediate product. Tariffs or non-tariff measures differ by HS6 category and thus by main use of the output of the sectors, as well as by the source and destination of the good. Combining COMTRADE and the Broad Economic Categories of the UN, ImpactECON fixes this problem: each bilateral flow in a GTAP sector is split into final and intermediate use. The GTAP 9.0 database is thus converted into a "Global Supply Chain Database", a database of value of imports of commodities purchased by sectors (intermediate), households (final), government and investment (final), by source and destination country/region, at market, agent and world prices. Notice that although the database also provides the tariffs aggregated along the same dimensions, we do not rely on the later as we proceed with our own agreggation of the MAcMap HS6 database.

[10] We do not consider more minor sanctions imposed by the US on solar panels and washing machines in January 2018, which resulted from a petition filled by US industries under Section 301. The Chinese government temporarily retaliated on sorghum in April of the same year.

[11] Notice that this could mean a short run underestimation of exports from Europe in the latter case, as European car producers may inflate their US inventories by anticipation.

[12] In particular, the lists used here are different from those proposed by the China Ag Center of the CARD, Iowa State University (Li 2018). See `https://www.card.iastate.edu/china/trade-war-data/`.

using a reference group weighted average, as detailed previously. In some cases, Tariff Rate Quotas (TRQs) have been imposed. We model them as Voluntary Export Restraints (VERs), assuming that quotas are fully used. Therefore, we fix exporting quantities in the simulations, the targeted export quantity being reached using an endogenous export tax. This way the rent of the TRQ is actually captured by the exporter, as it is the case for VERs.

2.1 The Section 232 and retaliation

In April 2017, Commerce Secretary Wilbur Ross was instructed by US President to investigate whether steel and aluminium imports were threatening the US national security. These investigations, covered by Section 232, concluded to a threat, opening the door to a Presidential decision on protection. While, in the past, the US had generally mobilized Section 232 against oil exporters considered as threatening the US security,[13] tariffs were announced in March 2018 against almost all exporters (the main ones being the European Union, Canada and Mexico).

As a result, tariffs on aluminum imposed by the US increased by 10 p.p. A partial exemption was negotiated by Argentina, against a TRQ with a volume equal to the mean volume imported over the period 2015–2017. Australia was exempted from the increase in tariffs. For their part, tariffs on steel increased by 25 p.p. An exemption was again granted to Australia, while Argentina, South Korea and Brazil negotiated TRQs.[14] Turkey also constitutes a special case, in the sense that tariffs on import from this country increased by 50 p.p.

Concerning retaliatory tariffs imposed by Canada, China, the European Union, Mexico, Russia and Turkey, we implement them as indicated from official sources (national legislation or notification to WTO).[15] To the best of our knowledge the present contribution is the only paper offering an impact assessment accounting for retaliation from Russia. We also account for the safeguard on imports of steel imposed by the EU in January 2019.[16]

2.2 The section 301 and the related retaliation

The second series of measures to be taken into account is related to the use of US Section 301 against China, which took place in two rounds after the release of the US administration investigation in March 2018. The argument used for limiting US imports from China is now about violation of intellectual property rights and unfair trade practices.

[13]See BIS (2007) for an analysis of the outcome of all investigations under Section 232 in the US.

[14]The negotiated TRQs are as follows. (i) Argentina: 135% of the average volume exported over 2015 – 2017; (ii) Brazil: the average volume exported over 2015 -2017 for semi-finished product and 70% of the average volume exported over 2015 –2017 for finished products; (iii) South Korea: 70% of the average volume exported over 2015 – 2017.

[15]Based on the notifications made to the WTO, we also consider retaliation from India, even if it has been delayed several times. Retaliation from Turkey is considered after its revision in August 2018.

[16]The official list of products affected and details on the TRQs in place are given by two EU Commission regulations, available at `https://eur-lex.europa.eu/eli/reg_impl/2018/1013/oj` and `http://data.europa.eu/eli/reg_impl/2019/159/oj`.

The first round led to an increase in US tariffs on 50 USD bn of US imports from China in two phases starting July 2018 (16 and then 34 bn). China retaliated with additional 5% to 25 % tariffs (depending on the goods) on 50 USD bn of US exports. As a follow up, the US administration retaliated to the Chinese retaliation with a second round of 10% additional tariffs on USD 200 bn of US imports from China. A further move from +10% to +25%, originally planned for January 2019 was then postponed to March 2019, and has been further postponed, given the "progress" made in bilateral trade talks. China retaliated to this second round by imposing 10 additional percent of tariffs on USD 60 bn imports from the US.

2.3 Targeted sectors

The shocks identified at the tariff line level are introduced in our baseline protection at the sectoral level of the General Equilibrium model. Table 1 shows what could potentially be the main impacted sectors in the US–China bilateral trade. Sectors are ranked using the simple criterion of the impacted tariff revenue (initial imports times tariff increase) which is indeed not the expected tariff change (imports will decrease, conditional on the trade elasticity).[17]

Starting with Chinese exports, Electronics is potentially the main impacted sector: USD 167 bn of exports will face an average tariff increasing from 0.3% to 9.3%. In such sector where the *ad valorem* equivalent of NTMs is limited, this is a dramatic change in market conditions. Machinery is the second impacted sector, with a 11.7 percentage points inrease in tariffs applied by the US on USD 103 bn of Chinese exports. Among all other sectors, tariff changes can be even larger, but trade is more limited. The best illustration of this is the automotive sector (here mainly parts and components, see Appendix A.3, Table A3), where a 14.6 percentage points increase in protection will only affect USD 18 bn of Chinese exports.

The potentially most impacted US sector is the car industry. The 5.8 percentage points increase in tariffs will curb USD 32 bn of US exports to China, with a huge toll on exports to China of German plants located in the US. Machinery, Non Ferrous Metals and Oilseeds will be the other US sectors impacted by Chinese retaliation.

As described above, the trade war initiated by the US admnistration is also impacting other exporters: USD 7 bn of Iron and steel exported by EU27 to the US are facing a 19.5 percentage points increase, while another USD 7bn of Canadian exports shift from free access to the US market to a 17.1 % tariff.

Retaliation from countries other than China have much smaller impacts since they affect smaller flows. Indeed, Fetzer & Schwarz (2019) recall that products affected by retaliation are mainly chosen in order to affect areas that supported D. Trump in the 2016 presidential election, i.e. based on political considerations. This targeting pattern, combined with smaller amount of trade affected for countries other than China, results in retaliatory lists containing several small trade flows rather than concentrated on a very large few ones.

[17] We make here the assumption of a full pass through of tariffs into prices, as suggested by the recent literature (Amiti et al. 2019).

Table 1: Trade value and protection – Most impacted bilateral flows

Sector	Exporter	Importer	NTMs	Tariffs		Trade	Ch. in prot. rev.	
			(AVE, %)	Ref.	Scen.	(USD Bn)	(USD Bn)	(%)
Electronic	China	USA	0.4	0.3	9.3	167	15.1	1359
Machinery	China	USA	6.8	1.5	13.2	103	12.0	141
Chemistry	China	USA	2.6	2.7	10.6	36	2.8	146
Vehicles	China	USA	22.0	1.2	15.8	18	2.7	63
Oth. manuf.	China	USA	3.6	1.5	5.0	69	2.4	68
Vehicles	USA	China	3.1	7.2	13.0	32	1.9	57
Metal prod.	China	USA	0.5	2.1	11.2	19	1.7	356
Machinery	USA	China	7.5	4.1	9.6	29	1.6	47
Non ferrous met.	USA	China	5.0	0.7	15.2	10	1.5	252
Oilseeds	USA	China	0.0	1.5	13.6	13	1.5	799
Iron steel	EU27	USA	0.0	0.2	19.7	7	1.4	9148
Textile	China	USA	25.0	11.4	13.4	65	1.3	5
Chemistry	USA	China	5.6	4.9	10.4	23	1.3	52
Iron steel	Canada	USA	0.0	0.0	17.1	7	1.2	

Note: Sectors are ranked by decreasing impacted tariff revenue.

Sources: BACI (2016), MAcMap-HS6 and Kee et al. (2008), authors' calculations.

3 Results

The trade war will reduce drastically bilateral trade between the two main actors of the conflict, and will lead to a reorientation of exports (although in the case of steel and aluminium, EU safeguards will block this mechanism), ultimately reducing world trade by -0.76% and world GDP by -0.08%. These expected mechanisms are indeed present in our results, and the more so that we have a global General Equilibrium model taking stock of all relative price changes and third country effects. Table 2 gives an overview of these results (we present the results for Germany instead of EU27 in order to avoid obvious problems of aggregation, e.g. on wages).

3.1 Aggregate impacts

The first aggregate impact of the trade war is to dramatically increase US tariff revenues: they actually double. The improvement in US terms of trade is negligible (+0.06%) as opposed to the usual optimal tariff agreement. US exports to the world post a 6% decrease as a result of sanctions and reduced competitiveness: the cost of imported intermediate inputs increase which translates into increases in producer prices. We detail this mechanism below. American farmers are adversely affected by Chinese sanctions (return to land reduced by −4.48%) and workers are also negatively affected in real terms, although white collar suffer more than blue collar. Ultimately, limited benefits accrue to the capital owners as a result of the reduced competition on the US market (return to capital increases by 0.07%). All in all the US GDP is facing a USD 64 bn decrease (−0.28%).[18]

[18] In volume.

Overall Chinese exports are hit by a modest −3.09% decrease, meaning that China manages to compensate reduced access to the US market by redirecting exports, although be it at the expense of reduced producer prices. Chinese terms of trade decrease as a consequence (−0.75%), while workers and capital owners lose to the benefits of farmers. Overall the Chinese GDP is facing a USD 92 bn (−0.39%) reduction.

Korea and Japan are hardly affected while Canada and Mexico, despite the application of the 231 section, do not see their value added negatively impacted.

More interestingly, certain bilateral relationships or certain sectors in China, in the US or in Europe will be severely affected. Chinese exports to the US record a −34.9% drop.[19] China however reorients its exports firstly towards Canada (+8.8%) and Mexico (+8.0%), less substantially towards Europe (e.g. +2.9% towards Germany or France). US exporters record a −29.4% decrease in their exports to China but, contrary to their Chinese competitors, do not compensate these losses on other markets. US exporters lose ground on all markets in the world due to competitiveness losses and retaliation by certain destination countries. Losses amount to e.g. −2.6% in Korea and Japan, or to −4% in Germany and France.

Chinese exports of Electronics record a −46.1%. And with the exception of the resilient Mexican market, this is not compensated elsewhere: Chinese exporters loose ground everywhere in this sector, as a result of the disruption of global value chains. Losses range from −2.2% on the Brazilian market, to −2.9% in Canada, −2.9% in Japan and −3.1% in Germany or France. This situation contrasts with Machinery where the drop in Chinese exports to the US market (−46.8%) is cushioned by a 4 to 5% increase in Chinese exports on other markets (and +8% to Canada and Mexico). In the car industry, the toll on Chinese exports to the US is important also (−46.9%), but here again cushioned by a redirection of exports to other markets (especially Canada and Mexico). The same reasoning applies to Chemistry, although the magnitude of the losses on the US market is more limited (−28.3%).

US exports of vehicles to China are severely hit (−28.6%). There is no compensation associated with any redirection of exports. Producers located in the US suffer an increase in their production costs and bear market losses everywhere. Cuts in exports reach two digits towards Germany (−10.9%). In Machinery, Chinese retaliations are effective, imposing a −38.4% drop in US exports. As for the car industry, competitiveness losses do not authorize US exporters to compensate these losses elsewhere. The same mechanism is observed for Non ferrous metals, but here magnified as a result of retaliations: US exports to China record a −71.1% drop, and two-digit losses elsewhere are frequent (on the Canadian market, in the CIS countries, in France and Germany. Export losses are also at least 9% towards Brazil, India, Japan or Korea).

[19] All figures are percentage deviations from the baseline in 2030, in volume.

Table 2: Main aggregate results for selected countries

	USA	China	Germany	Canada	Japan	Korea	Mexico
Total tariff revenue	103.05	8.62	2.11	22.80	0.71	0.08	10.07
Exports	−5.97	−3.09	0.24	−0.20	0.66	0.00	2.27
GDP	−0.28	−0.39	0.02	0.11	0.08	−0.01	0.20
Terms of trade	0.06	−0.75	0.05	0.12	0.10	0.24	0.65
Real return to capital	0.07	−0.14	−0.03	−0.18	−0.01	0.01	0.11
Real return to land	−4.49	0.99	0.12	0.22	0.00	−0.05	−0.90
Skilled real wages	−0.30	−0.78	0.05	0.18	0.08	0.03	0.23
Unskilled real wages	−0.18	−0.54	0.05	0.10	0.09	0.02	0.18

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index.
Source: MIRAGE-VA, authors' calculation.

3.2 Impact of the trade war on global value chains

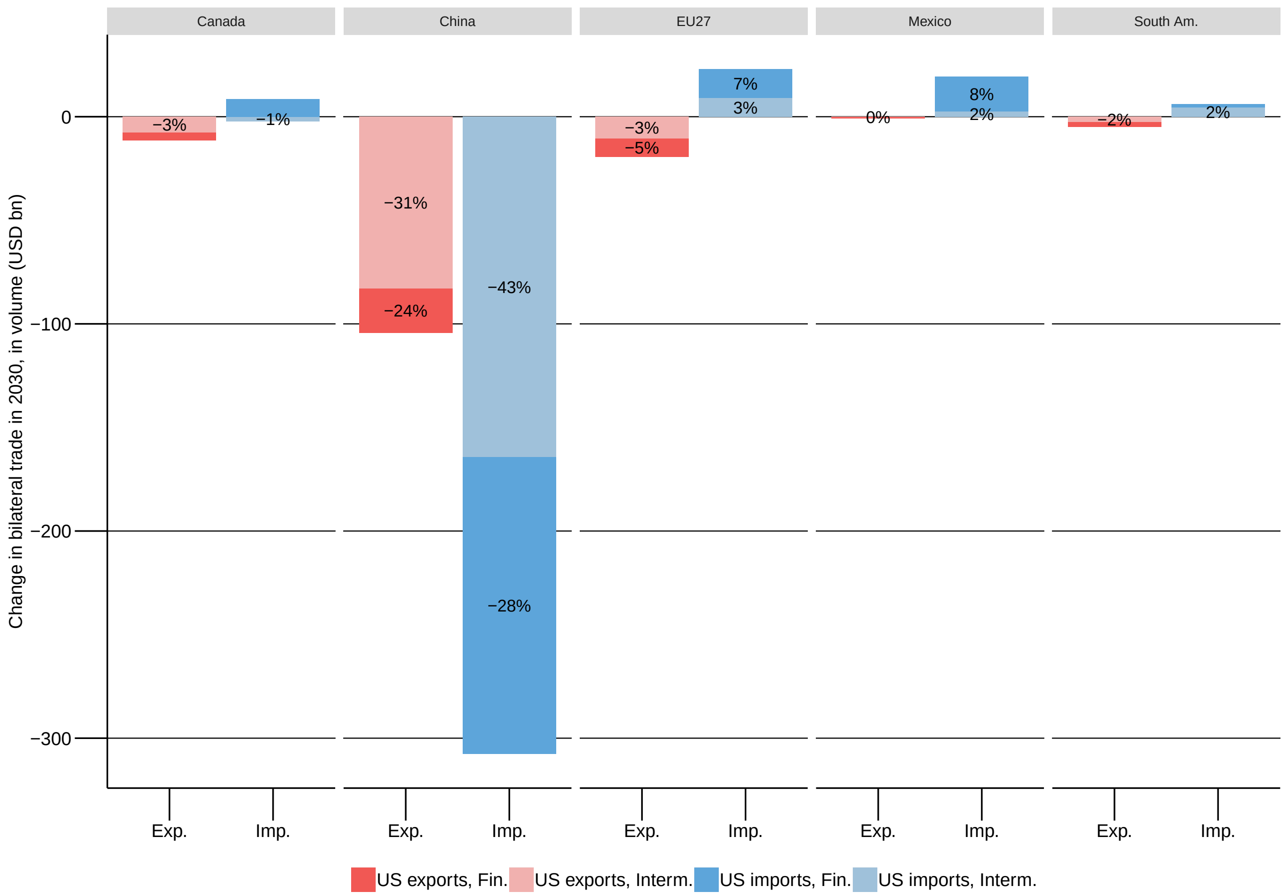
We now turn to the core argument of this paper. By imposing tariffs on imported inputs and by taxing domestic value added contained in imports of final goods, the trade war not only hurts the targeted countries but also the country imposing the tariffs.

The first insight in this complex chain of effects is provided by the outcome of protection in terms of trade in final goods versus in intermediate goods. Figure 1 reports the impacts on US bilateral trade flows with major trading partners, distinguishing between trade in final and intermediate products.[20] We firstly observe a massive cut in US imports of intermediate inputs, parts and components from China (i.e. a −43% drop). A similar value of imports of final goods disappear, but this represents "only" −28% of US imports of final goods from China. The difference here observed reflects the attempt of the US to disrupt global value chains while limiting the direct cost of the trade war beard by the US consumer. The Chinese cut in imports from the US is much more limited but most of it is intermediate products, with a −31% cut (−24% for final goods). We finally observe that US imports of final goods somehow diversify their origin, to the benefit of Mexico, EU27, Canada and Latin America to a lesser extent. This pattern is not observed for intermediate goods, or to a much lesser extent, because reorganizing value chains is difficult.

The second piece of the puzzle on the US side is how producer prices react to (i) the increase in the price of intermediate input, (ii) the drop in demand on export markets due to retaliations and (iii) the reduced competition in the US market due to border protection. This is shown in the right panel of table 3, at the sectoral level. The evidence is clear-cut. Farm products seriously hit by retaliations respond to reduced market access by producer prices cuts. This affects negatively US terms of trade and partially explains why the usual tariff optimal argument did not show up in our aggregate results. The drop in producer prices reaches −2.9% for oilseeds, a sector targeted by the Chinese retaliations. For all other sectors, the net effect of the three mechanism listed here is an increase in the producer price: +1% in the electronics sector, 1% in aluminium,

[20] Appendix A.3 provides a more complete version of Figure 1.

Figure 1: Impacts on US trade flows (variations with respect to the baseline, in 2030)



0.9% for steel, 0.5% in chemistry. This has indeed cascading effects on machinery (+0.8%), automotive (+0.8%) or metal products (+0.8%) and other manufacturing (+0.4%).

China offers in the left panel the mirror image of the US: producer prices increase in sectors benefiting from Chinese retaliation (e.g. oilseeds +1.1%) or fiber crops (+0.4%). In other sectors, Chinese producers have to reduce their prices (machinery −0.8%, chemistry −0.8%, electronics −0.5%). This indeed contributes to the observed deterioration of the Chinese terms of trade. In contrast, as expected, we observe in Appendix Table A5 that no significant change in prices could be observed in Germany.

The last piece of evidence is the outcome of these adjustments in terms of value added (in volume, i.e. at constant prices). The aggregate negative effect on US GDP (hence on US aggregate value added) is the result of very diverse impacts of the trade war at the sectoral level. First, sectors hit by retaliation suffer, as expected. We record a −10.5% drop in the value added in the oilseeds sector, and similarly a −7.1% drop in the value added of the fiber crops sector. At the other extreme, iron and steel protected by article 232 exhibit a +10.7% increase in their value added. The electronics sector also records a +7.3% in its value added. For machinery and metal products, the increase is more modest (resp. +1.7% and +1.8%). Provided that these sectors reduce their exports, it means that the domestic market is protected enough to pass the increase in production costs to the final consumer. The car industry is in a more adverse situation, combining increased costs for steel and aluminium, increased costs on components imported from China and lastly Chinese retaliations on final products.

In China, the electronics sector is the most affected in terms of value added (−9.3%). Machinery and metal products are affected to a lesser extent (−1.3% and −1% respectively). Sectors benefiting from the retaliation enjoy an increase in their value added (oilseed +9.1%, fiber crops + 7.6%).

These results are summed up in Figure 2, where we plot the percentage changes in the value added of sectors in the US and China. The upper-right quadrant corresponds to sectors winning in both countries. Not surprisingly, this quadrant is empty, meaning that the trade war fails to create value.

Turning clockwise, the bottom right quadrant shows industries winning in the US at the expense of their competitors in China. Clearly, most of the action is in the electronics sector, where the Chinese value added records a 9% decrease, while the US gain 7%. In dollar terms, and in the long run, Chinese losses are even more impressive, with a USD 40 bn drop, while US gains reach only USD 4.2 bn. Accordingly, this industry will record a massive destruction of value. In the Iron and steel sector US gains are also sizeable (almost 11% of value added, or a USD 8.5 bn increase) but the impact on China is negligible, even taking on board as we did European safeguards. China was already barred from the US market with anti-dumping before the trade war, and the new measures have little impact. Finally, Machinery and Metal products post modest gains for the US and modest losses for China.

Table 3: Changes in production price and value added, by sector

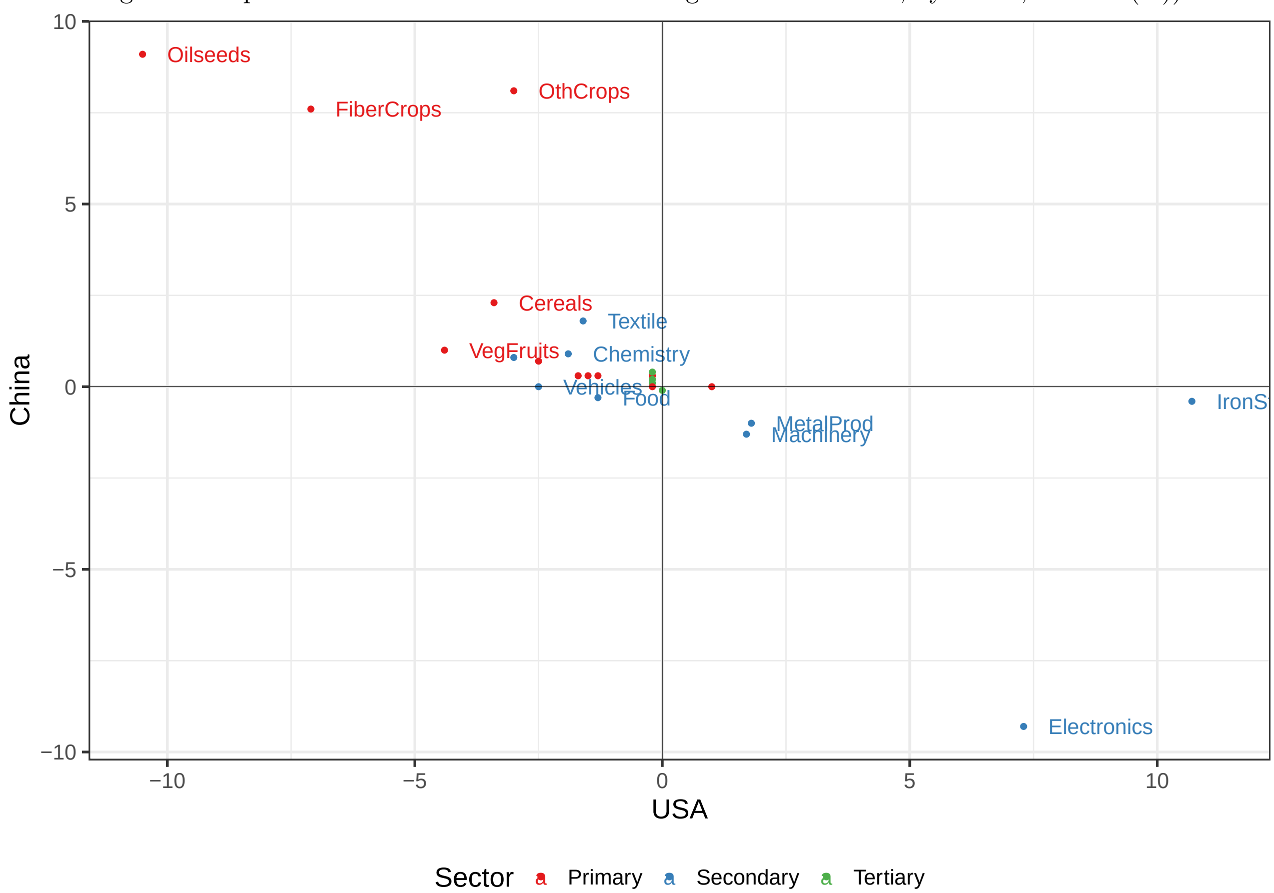
	China			USA		
	Prod. price	Value Added		Prod. price	Value Added	
Sector	(%)	(USD bn)	(%)	(%)	(USD bn)	(%)
AnimAgri	−0.8	1.7	0.3	0.3	−0.6	−1.7
Cereals	−0.5	7.1	2.3	−0.0	−3.1	−3.4
FiberCrops	0.4	1.4	7.6	−1.4	−1.1	−7.1
Food	−0.3	−0.9	−0.3	0.3	−4.2	−1.3
Oilseeds	1.1	3.3	9.1	−2.9	−6.5	−10.5
OthCrops	0.1	0.3	8.1	−0.0	−1.0	−3.0
OtherAgri	−0.4	1.0	0.3	−2.0	−0.4	−1.5
Sugar	−1.2	0.1	0.3	0.5	−0.0	−1.3
VegFruits	−1.0	6.4	1.0	−0.3	−2.5	−4.4
Chemistry	−0.8	6.1	0.9	0.5	−10.6	−1.9
Coal	−0.8	1.2	0.7	0.2	−0.5	−2.5
Elec	−0.8	0.2	0.1	0.5	−0.4	−0.2
Electronics	−0.5	−40.0	−9.3	1.0	4.2	7.3
Gas	−0.4	0.5	0.0	1.7	2.4	1.0
IronSteel	−0.8	−1.4	−0.4	0.9	8.5	10.7
Machinery	−0.8	−16.0	−1.3	0.8	11.6	1.7
MetalProd	−0.9	−2.5	−1.0	0.8	3.4	1.8
Minerals	−0.9	2.0	0.3	0.4	−0.3	−0.2
NonFer	−0.8	1.6	0.8	1.0	−1.5	−3.0
OthManuf	−0.8	2.0	0.4	0.4	−1.1	−0.2
Petroleum	−0.4	0.0	0.0	0.2	−0.7	−0.2
Textile	−0.8	6.0	1.8	0.5	−2.5	−1.6
Vehicles	−0.8	−0.2	−0.0	0.8	−8.2	−2.5
Serv	−1.1	−11.2	−0.1	0.3	−5.2	−0.0
Transport	−0.9	1.9	0.2	0.3	−1.4	−0.2

Note: Variations in the policy scenario, in volume, with respect to the reference scenario, based on a Fisher index.
Source: MIRAGE-VA, authors' calculations.

In the quadrant where the two countries loose only the Food sector shows up, but for tiny changes.

Lastly, the quadrant where the US loose and China gains is very populated. Firstly, the US are hit heavily in Oilseeds by Chinese retaliations: US value added records a -10.5 % drop (or USD 6.5 bn), which is in the order of magnitude of US gains in the Iron and steel sector. US producers of Fiber crops, Other crops, Cereals, Vegetable and fruits also pay their tribute. Among industrial sectors Chemistry is hit by a 1.9% drop in value added, representing more than USD 10 bn given the size of this sector. The same remark pertains to the US car industry, posting a 2.5% and USD 8.2 bn drop in value added. The latter sector suffers from reduced competitiveness due to increased prices of steel and aluminium, as well as other imported Chinese car components.

Figure 2: Impacts on US trade flows Relative changes in value added, by sector, in 2030 (%))



4 Conclusion

The main contribution of this paper is to use the most detailed information related to the trade war, at the tariff line level, and to embed this information in a recursive dynamic general equilibrium model of the world economy featuring global value chains. The channels of the price changes are fully described accordingly, i.e. the increase in the cost of imported intermediate consumption and the increase in the consumer price of final goods.

Our results confirm that the trade war is hitting seriously China, while the US economy is not exempt from adverse consequences. The increase in producer costs in the US is detrimental to the competitiveness of US producers, and translates into price increases and losses of market shares on export markets. This adds to the consequences of retaliation by China and other affected countries.

By entering into a trade war, the US administration reached its goal to weaken the Chinese economy, but this comes at a cost for the US economy itself. The order of magnitude that we obtain, taking stocks on competition on third countries markets, is not negligible: -0.3% of GDP at the horizon of our simulation, 2030.

These results confirm the theoretical intuition that trade wars are costly for all trading partners jointly involved in global value chains.

Bibliography

Amiti, M., Redding, S. & Weinstein, D. (2019), The impact of the 2018 trade war on U.S. prices and welfare, Discussion Paper 13564, Centre for Economic Policy Research (CEPR).

Balistreri, E. J., Böhringer, C. & Rutherford, T. F. (2018), Quantifying disruptive trade policies, Technical report, CESifo Working Paper.

Bellora, C. & Fouré, J. (2019), Trade, global value chains and the Paris Agreement. mimeo.

Berthou, A., Jardet, C., Siena, D. & Szczerbowicz, U. (2018), 'Quantifying the losses from a global trade war', *Banque de France ECO Notepad* **19**.

BIS (2007), The effect of imports on the national security, Technical report, US Department of Commerce, Bureau of Industry and Security Office of Technology Evaluation.

Blanchard, E. J., Bown, C. P. & Johnson, R. C. (2016), Global supply chains and trade policy, Working Paper 21883, National Bureau of Economic Research.

Bouet, A., Decreux, Y., Fontagné, L., Jean, S. & Laborde, D. (2008), 'Assessing applied protection across the World', *Review of International Economics* **16**(5), 850–863.

Bown, C. P. (2018), 'Trade policy toward supply chains after the great recession', *IMF Economic Review* **66**(3), 602–616.

Caliendo, L. & Parro, F. (2015), 'Estimates of the trade and welfare effects of NAFTA', *The Review of Economic Studies* **82**(1), 1–44.

Charbonneau, K. B. & Landry, A. (2018), The trade war in numbers, Technical report, Bank of Canada.

Fajgelbaum, P. D., Goldberg, P. K., Kennedy, P. J. & Khandelwal, A. K. (2019), The return to protectionism, Working Paper 25638, National Bureau of Economic Research.

Felbermayr, G. & Steininger, M. (2019), 'Trump's trade attack on China – Who laughs last?', *CESIFO Policy Brief* **3**(13).

Fetzer, T. & Schwarz, C. (2019), Tariffs and politics: evidence from Trump's trade wars, Discussion Paper 13579, CEPR.

Fontagné, L., Fouré, J. & Ramos, M. P. (2013), MIRAGE-e: A general equilibrium long-term path of the world economy, Working Paper 2013-39, CEPII.

Fontagné, L., Mitaritonna, C. & Signoret, J. E. (2016), Estimated tariff equivalents of services NTMs, Working Papers 2016-20, CEPII.

Fouré, J., Bénassy-Quéré, A. & Fontagné, L. (2013), 'Modelling the world economy at the 2050 horizon', *Economics of Transition* **21**(4), 617–654.

Freund, C., Ferrantino, M., Maliszewska, M. & Ruta, M. (2018), Impacts on global trade and income of current trade disputes, MTI Practice Notes 2, World Bank Group.

Guimbard, H., Jean, S., Mimouni, M. & Pichot, X. (2012), 'MAcMap-HS6 2007, An exhaustive and consistent measure of applied protection in 2007', *International Economics* **130**, 99–121.

Kee, H. L., Nicita, A. & Olarreaga, M. (2008), 'Estimating trade restrictiveness indices', *The Economic Journal* **119**(534), 172–199.

Koopman, R. B., Tsigas, M., Riker, D. & Powers, W. (2013), The implications of using value-added trade data for applied trade policy analysis, *in* D. K. Elms & P. Low, eds, 'Global Value Chains in a Changing World', WTO, chapter 4, pp. 109–134.

Li, M. (2018), CARD trade war tariffs database., Technical report, Iowa State University.

Li, M., Balistreri, E., Zhang, W. et al. (2018), The 2018 trade war: Data and nascent general equilibrium analysis, Technical report, Food and Agricultural Policy Research Institute (FAPRI) at Iowa State University.

Miroudot, S., Rouzet, D. & Spinelli, F. (2013), Trade policy implications of global value chains, Trade Policy Papers 161, OECD.

Nicita, A., Olarreaga, M. & Silva, P. (2018), 'Cooperation in WTO's tariff waters?', *Journal of Political Economy* **126**(3), 1302–1338.

Ossa, R. (2014), 'Trade wars and trade talks with data', *American Economic Review* **104**(12), 4104–46.

Vicard, V. (2018), 'Une estimation de l'impact des politiques commerciales sur le pib par les nouveaux modèles quantitatifs de commerce', *Focus du CAE* **22**.

Walmsley, T. & Minor, P. (2016), ImpactECON 002 rev. 2 Supply chain database, data and model documentation, Technical report, ImpactECON.

A Appendix

A.1 Sources for the tariff scenario

A.1.1 Section 232

The first lists of aluminum and steel products affected by additional tariffs under section 232 of the US Trade Expansion Act, as well as the magnitude of these tariffs, have been made public on 8 March 2015 by two Presidential proclamations (one for aluminum and one for steel), published in the Federal Register on March, 15. Canada and Mexico were initally exempted. In the following days, negotiations went on; waiting for their final outcome, exemptions were extended to Argentina, Australia, Brazil, the European Union and South Korea, as stated in the Presidential proclamations of 22 March 2018, published on March, 28. At the end of April, two new proclamations updated and detailed these exemptions (proclamations made public on April, 30 and published on the Federal Register on May, 5). In particular, tariffs on imports from Canada, Mexico and the EU finally increased, starting from June, 1; Argentina, Brazil and South Korea negotiated volountary export restrictions (for steel; for aluminum, only Argentina obtained a tariff rate quota, Brazil and South Korea facing increased tariffs), while Australia remained exempted from any trade restriction.[21]

Below, we give the references of the official documents mentionned above, with which we build the scenarios. For aluminum:

- 8 March 2018 : `https://www.govinfo.gov/content/pkg/FR-2018-03-15/pdf/2018-05477.pdf`;
- 22 March 2018 : `https://www.govinfo.gov/content/pkg/FR-2018-03-28/pdf/2018-06420.pdf` concerning the exemptions;
- 30 April 2018: `https://www.govinfo.gov/content/pkg/FR-2018-05-07/pdf/2018-09841.pdf` concerning quotas and detailed schedule, when needed.

For steel:

- 8 March 2018: `https://www.govinfo.gov/content/pkg/FR-2018-03-15/pdf/2018-05478.pdf`
- 22 March 2018: `https://www.govinfo.gov/content/pkg/FR-2018-03-28/pdf/2018-06425.pdf` concerning one missing HS6 product category and exemptions;
- 30 April 2018: `https://www.govinfo.gov/content/pkg/FR-2018-05-07/pdf/2018-09841.pdf` concerning quotas and detailed schedule, when needed.

[21] An up-to-date timeline is available at `https://piie.com/blogs/trade-investment-policy-watch/trump-trade-war-china-date-guide`

A.1.2 Section 301

Additional tariffs taken against China under section 301 of the US Trade Act, and the resulting retaliations from China, went into force in several waves. The US administration first imposed a 25 p.p. additional tariff on around USD 46 billion of imports from China. Tariffs covering around 70% of these imports went into effect on July 6, the others on August 23.

As China retaliated against these measures with equivalent additional tariffs on similar import values from the US, the US imposed additional duties of 10 p.p. on approximately USD 200 billion imports from China that entered into force on September 24. These duties were initially set to increase to 25 p.p. on March 1, 2019. This increase has nevertheless been postponed *sine die* since negotiations between the US and China started in December 2018.[22]

Below, we give the references of the official documents mentionned above, with which we build the scenarios. For the US:

- List of products covered by additional duties entered into force on July 6: `https://www.govinfo.gov/content/pkg/FR-2018-06-20/pdf/2018-13248.pdf`
- List of products covered by additional duties entered into force on August 23: `https://www.govinfo.gov/content/pkg/FR-2018-08-16/pdf/2018-17709.pdf`
- List of products covered by additional duties entered into force on September, 24: `https://www.govinfo.gov/content/pkg/FR-2018-09-21/pdf/2018-20610.pdf`

For China:

- List of products covered by additional duties entered into force on July 6: `http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201806/P020180616034361843828.pdf`
- List of products covered by additional duties entered into force on August 23: `http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201806/P020180616034362364988.pdf`
- Lists of products covered by additional duties entered into force on September, 24: `http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803_2980950.html`

[22] Federal register freezing the additional duties: `https://www.govinfo.gov/content/pkg/FR-2019-03-05/pdf/2019-03935.pdf`

A.2 Aggregations

Table A1: Sectoral aggregation

Sector	Aggregation label	GTAP 9 sector
AnimAgri	AnimAgri	ctl, oap, rmk, wol
Cereals	Cereals	pdr, wht, gro
Chemistry	Chemistry	crp
Coal	Coal	coa
Elec	Elec	ely
Electronic	Electronic	ele
FiberCrops	FiberCrops	pfb
Food	Food	cmt, omt, vol, mil, pcr, sgr, ofd, b_t
Gas	Gas	gas, gdt
IronSteel	IronSteel	i_s
Machinery	Machinery	ome
MetalProd	MetalProd	fmp
Minerals	Minerals	omn, nmm
NonFer	NonFer	nfm
Oil	Oil	oil
Oilseeds	Oilseeds	osd
OthCrops	OthCrops	ocr
OtherAgri	OtherAgri	frs, fsh
OthManuf	OthManuf	lum, ppp, omf
Petroleum	Petroleum	p_c
Serv	Serv	wtr, cns, trd, cmn, ofi, isr, obs, ros, osg, dwe
Sugar	Sugar	c_b
Textile	Textile	tex, wap, lea
Transport	Transport	otp, wtp, atp
VegFruits	VegFruits	v_f
Vehicles	Vehicles	mvh, otn

Table A2: Regional aggregation

Region	Aggregation label	GTAP 9 region
Argentina	Argentina	ARG
Australia	Australia	AUS
Brazil	Brazil	BRA
Canada	Canada	CAN
China and Hong-Kong	ChinaHK	CHN, HKG
CIS countries	CIS	BLR, RUS, UKR, XEE, KAZ, KGZ, XSU, ARM, AZE, GEO
EFTA	EFTA	CHE, NOR, XEF
France	France	FRA
Germany	Germany	DEU
India	India	IND
Japan	Japan	JPN
Korea	Korea	KOR
Latin America	LAC	BOL, CHL, COL, ECU, PRY, PER, URY, VEN, XSM, CRI, GTM, HND, NIC, PAN, SLV, XCA, DOM, JAM, PRI, TTO, XCB
Mexico	Mexico	MEX
Other Oceania	OthOceania	NZL, XOC
Rest of ASEAN	RoASEAN	KHM, IDN, LAO, MYS, PHL, SGP, THA, VNM, XSE
Rest of Asia	RoAsia	MNG, TWN, XEA, BRN, BGD, NPL, PAK, LKA, XSA, XTW
Rest of European Union	EU26	AUT, BEL, CYP, CZE, DNK, EST, FIN, GRC, HUN, IRL, ITA, LVA, LTU, LUX, MLT, NLD, POL, PRT, SVK, SVN, ESP, SWE, BGR, HRV, ROU
RoW	RoW	XNA, ALB, XER, BHR, IRN, ISR, JOR, KWT, OMN, QAT, SAU, TUR, ARE, XWS, EGY, MAR, TUN, XNF, BEN, BFA, CMR, CIV, GHA, GIN, NGA, SEN, TGO, XWF, XCF, XAC, ETH, KEN, MDG, MWI, MUS, MOZ, RWA, TZA, UGA, ZMB, ZWE, XEC, BWA, NAM, ZAF, XSC
UK	UK	GBR
USA	USA	USA

A.3 Additional results

Table A3: Trade value and protection – Most impacted bilateral flows of goods for intermediate consumption

Sector	Exporter	Importer	NTMs	Tariffs		Trade	Ch. in prot. rev.	
			(AVE, %)	Ref.	Scen.	(USD Bn)	(USD Bn)	(%)
Machinery	China	USA	2.5	1.6	14.9	44	5.8	322
Electronic	China	USA	0.1	0.3	12.3	25	3.0	3470
Chemistry	China	USA	3.1	2.7	11.7	24	2.2	156
Vehicles	China	USA	15.5	1.0	11.7	15	1.6	66
Vehicles	USA	China	1.6	10.0	19.1	18	1.6	78
Non ferrous met.	USA	China	5.0	0.7	15.2	10	1.5	252
Oilseeds	USA	China	0.0	1.5	13.6	13	1.5	799
Iron steel	EU28	USA	0.0	0.2	19.7	7	1.4	9148
Metal prod.	China	USA	0.5	1.8	13.0	12	1.3	490
Iron steel	Canada	USA	0.0	0.0	17.1	7	1.2	
Chemistry	USA	China	4.6	5.1	11.2	19	1.1	63
Iron steel	USA	Canada	12.3	0.0	12.6	6	0.8	103
OthManuf	USA	China	24.0	2.0	10.6	9	0.8	33
Iron steel	Mexico	USA	0.0	0.0	20.7	3	0.6	
Machinery	USA	China	3.3	3.8	9.2	10	0.6	77
Petroleum	USA	China	9.9	4.4	26.2	3	0.6	152

Sources: BACI (2016), MAcMap-HS6 and Kee et al. (2008), authors' calculations

Table A4: Trade value and protection – Most impacted bilateral flows of goods for final consumption

Sector	Exporter	Importer	NTMs	Tariffs		Trade	Ch. in prot. rev.	
			(AVE, %)	Ref.	Scen.	(USD Bn)	(USD Bn)	(%)
Electronic	China	USA	0.6	0.3	7.8	142	10.7	911
Machinery	China	USA	10.2	1.4	11.8	59	6.1	90
Oth. manuf.	China	USA	3.4	1.6	4.9	59	1.9	66
Machinery	USA	China	10.2	4.4	9.8	18	1.0	37
Food	USA	China	11.3	10.4	24.6	5	0.7	65
Textile	China	USA	27.0	11.8	12.9	61	0.7	3
Vehicles	China	USA	29.8	1.5	20.5	3	0.6	61
Chemistry	China	USA	1.0	2.9	6.7	13	0.5	99
Food	China	USA	31.1	5.0	12.8	5	0.4	22
Veg. and fruits	USA	China	0.0	6.6	27.2	2	0.4	313
Electronic	USA	China	4.7	2.3	6.7	6	0.3	63
Metal prod.	China	USA	0.0	2.7	7.0	7	0.3	156
Vehicles	USA	EU28	1.6	5.7	7.2	23	0.3	20
Food	USA	Canada	14.6	20.0	21.3	13	0.2	4
Food	USA	Mexico	60.2	1.8	4.6	7	0.2	4
Vehicles	USA	China	5.2	3.4	5.1	14	0.2	20

Sources: BACI (2016), MAcMap-HS6 and Kee et al. (2008), authors' calculations

Table A5: Changes in production price and value added, by sector, in Germany

	Prod. price	Value Added	
Sector	(%)	(USD bn)	(%)
AnimAgri	0.1	0.0	0.0
Cereals	0.1	0.0	0.5
FiberCrops	−0.0	−0.0	−0.7
Food	0.1	0.0	0.1
Oilseeds	0.0	−0.0	−0.2
OthCrops	0.1	0.0	0.2
OtherAgri	−0.0	−0.0	−0.1
Sugar	0.1	0.0	0.1
VegFruits	0.1	−0.0	−0.0
Chemistry	0.1	0.3	0.2
Coal	0.0	−0.0	−0.1
Elec	0.0	−0.0	−0.1
Electronics	0.0	0.2	1.0
Gas	−0.2	−0.0	−0.4
Iron and steel	−0.2	−0.7	−4.4
Machinery	0.0	1.0	0.4
MetalProd	0.0	0.1	0.2
Minerals	0.0	−0.0	−0.1
NonFer	0.1	0.1	1.1
Oil	−0.0	−0.0	−0.1
OthManuf	0.1	−0.3	−0.4
Petroleum	−0.0	−0.0	−0.2
Textile	0.1	−0.1	−0.7
Vehicles	0.0	0.4	0.5
Serv	0.1	0.2	0.0
Transport	0.0	−0.7	−0.4

Sources: Variations in the policy scenario, in volume, with respect to the reference scenario, based on a Fisher index.

Figure 3: Impacts on US trade flows (variations with respect to the baseline, in 2030