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Shooting Oneself in the Foot? Trade War and Global Value Chains

Cecilia Bellora & Lionel Fontagné

Highlights

- By entering into a trade war, the US administration reached its goal to weaken the Chinese economy and protect certain industries, but this comes at a cost for the US economy itself, because GVCs are ubiquitous in most of the protected sectors.

- The increase in producer costs, caused by increased tariffs on goods for intermediate consumption, is detrimental to the competitiveness of US producers. This translates into losses of US market shares on export markets, adding to the toll of retaliation by China and other affected countries. Overall, US exports to the world post a 7.5% decrease.

- Because of the measures in place as of August 2019, in our General Equilibrium setup, three quarters of the sectors decrease their value added in the US.

- Consistent with political economy determinants, these twists of value added are transmitted to production factors, leading to sizeable creation and destruction of jobs, and reallocation of capital to the benefit of protected sectors, mostly at the expense of their clients, i.e. downstream industries.

Abstract

Since the beginning of 2018, the US administration has announced and implemented several measures limiting US trade, in particular with China. This has fueled retaliation and has escalated in high trade tensions at the global level. We address in this paper the effects of the current trade tensions on trade, sectoral value added and welfare, in General Equilibrium under imperfect competition. We rely on a set-up differentiating demand of goods according to their use, for final or intermediate consumption. This authorizes tracing the impact of protection, along the value chains, on prices, value added and factor income. Additional tariffs from official lists are averaged at the 6 digit level of the Harmonized System (HS6), before being aggregated at the sector level with a reference group weighted method. Negotiated quantities in Voluntary Export Restraints are also taken into account at the product level. Beyond the direct toll of sanctions, US exports to the world post a 7.5% decrease as a result of reduced competitiveness led by vertical linkages along the value chains. Because of the measures in place as of August 2019, three quarters of the sectors decrease their value added in the US, suggesting that with this tariff war the US are shooting themselves in the foot. The quantification of job destructions and creations in the different sectors is consistent with effects channeling through prices and demand along the value chains detrimental to downstream industries.

Keywords

Trade War, Global Value Chains.

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RESEARCH AND EXPERTISE
ON THE WORLD ECONOMY

Shooting Oneself in the Foot? Trade War and Global Value Chains

Cecilia Bellora* and Lionel Fontagné†

Introduction

Since the beginning of 2018, the US administration has announced and implemented several measures limiting trade with its partners, in particular China. This has fueled retaliation and has escalated in high trade tensions at the global level. This episode of trade war is providing a valuable experiment to assess the consequences on trade, sectoral value added and welfare of a return to protectionism. It has initiated in-depth economic analysis of the effects on trade and welfare for the US economy (Amiti, Redding and Weinstein, 2019*a*, Fajgelbaum, Goldberg, Kennedy and Khandelwal, 2019); on the pass-through of tariffs into prices (Cavallo, Gopinath, Neiman and Tang, 2019); and on consumption at the county level (Waugh, 2019).

Interestingly, this return to protectionism is taking place in a world economy characterized by Global Value Chains (GVCs). Fragmented production should discourage tariffs on imports of final goods embarking previously exported domestic value added, and on imports of intermediate goods entering into the domestic production process (Blanchard, Bown and Johnson, 2016, Koopman, Tsigas, Riker and Powers, 2013).[1] Is it how US and China proceeded, or did the two countries engage in a tariff escalation detrimental to their own value added and hence factor income?[2] To answer these questions requires combining the most detailed information on protection measures (in order to spot the final versus intermediate use of imports) with a consistent modeling of trade and value added, both at the sectoral and global levels.

The new tariffs have indeed a direct impact on the targeted products and countries, but GVCs, along with General Equilibrium (GE) effects, trigger additional consequences worth investigating. From the US perspective, exports of final and intermediate goods are directly affected by Chinese retaliation. But US exports also suffer a loss of competitiveness on all markets (including the domestic one), as production costs increase in industries using taxed imported goods as inputs. Using micro level data, Handley, Kamal and Monarch (2019) show that the induced drop in US exports is equivalent to a 2% tariff imposed on US exports. By the same token, restricting Chinese exports to the US market that contain previously exported US intermediate inputs also hurts

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[1] Using an augmented political economy model of trade policy, Blanchard et al. (2016) show that GVC linkages modify countries' incentives to impose import protection. 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.

[2] 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 ubiquitous tariff escalation.

the US value added. We should expect from these mechanisms an overall negative impact of US tariffs on US value added in numerous sectors, either directly or indirectly. And since value added is split among production factors, such as skilled and unskilled labor, capital or land owners, the final outcome of this trade war has indeed resonance in terms of political economy. These are the effects that will be tackled in this paper.

We add to the literature by relying on information at the most detailed level on sanctions and retaliations, and by encapsulating this information in a GE framework featuring imperfect competition and GVCs. Importantly, beyond trade effects (here distinguishing between intermediate and final goods), we track impacts of the trade war on prices, value added, and factor incomes, stressing their heterogeneity across sectors and countries. 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 Restraints (VERs). Our results suggest that, in the long run, because of the measures in place as of August 2019, China and the United States could experience GDP losses by 0.55% and 0.4% respectively.[3] Beyond such aggregated effects, as a result of vertical linkages along the value chains, we show that 20 out of 26 sectors[4] decrease their value added, indicating that with this tariff war the US are shooting themselves in the foot.

The final outcome in terms of tariff escalation is a moving target. In March 2018, the US imposed additional tariffs of 10% and 25% on their imports of aluminium and steel, respectively. Exceptions to these tariffs were only a few and took the form of exemption or negotiated VERs. As a result, several countries retaliated increasing their own tariffs on targeted US products. From May 2018 onwards, new US trade restrictions mainly targeted China, with an unprecedented intensity. The reason invoked this time is the retaliation against unfair Chinese trade practices on technology transfers and intellectual property. Additional tariffs entered into force in different waves: US imports from China worth USD 50 bn were affected between June and July 2018, further USD 200 bn in September 2018. In the first months of 2019, tensions seemed to be contained; the two opponents tried to negotiate a truce, but without success, at least in the first instance. As a result, taxes already imposed on 200 bn Chinese exports moved from 10 to 25 p.p. in May 2019. China retaliated against each of these waves, responding with 5% to 25% additional tariffs. By early June 2019, additional tariffs affected more than 51% of the goods imported by the US from China, in value, while Chinese retorsions applied on more than 72% of imports from the US. China and the US finally reached a "phase one" deal, announced in December 2019, but only after a last wave of additional tariffs took effect in September 2019. The deal avoids the last wave of tariff initially expected by mid-December but seems to freeze the protection on US imports from China at unprecedent levels. Accordingly, instead of providing the last update of the war – well documented on dedicated web pages – we concentrate on the apex of this trade war by the end of August

[3] Amiti, Redding and Weinstein (2019*b*) show that the impact of tariffs on US imports is increasing over time, confirming that reorganizing global value chains takes time. We focus here on long term impacts accounting for such firms' adjustments to trade tensions.

[4] We actually rely on a 27-sector aggregation but there is no US value added in the petroleum sector in our database, its base year being 2011.

2019, on the mechanisms at stake, and on two possible exits (sanctions on cars *versus* phasing out of remaining industrial tariffs in transatlantic commercial relationships).[5]

As said, we are not the first to look at the impacts of the measures in place or, more generally, of a broader trade war. Amiti et al. (2019*a*) address the impact of the US–China trade war on prices and welfare, taking stock of the disruption of GVCs. As opposed to most of the exercises in the literature, they use detailed (at the 10-digit level of the US Harmonized Tariff Schedule) 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 almost full pass-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 et al. (2019) also rely on detailed trade data and compute trade elasticities used in supply-side model of the US economy.[6]

Structural gravity and new quantitative trade models have also been mobilized to assess the consequences of a trade war. Berthou, Jardet, Siena and Szczerbowicz (2018) and Vicard (2018) focus more on a stylized trade war scenario inspired from Ossa (2014) or Nicita, Olarreaga and Silva (2018) and provide impacts by country but not by sector. Felbermayr and Steininger (2019) rely on an input-output gravity approach *à la* Caliendo and Parro (2015) to assess the static economic impact of the trade war between the US and China on the two countries and on the EU as well. 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 countries that negotiated VERs in the US in the Steel and Aluminum case (e.g. Korea).

A related strand of literature is relying on Computable General Equilibrium (CGE) modelling. Freund, Ferrantino, Maliszewska and Ruta (2018) propose an impact assessment of the first round of tariff increases between the US and China under the section 301. Balistreri, Böhringer and Rutherford (2018) use the 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) produce 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 and 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. Koopman et al. (2013) investigate the implications of GVCs for trade policy, embarking (or not) information on the destination of products. They simulate the impact of an homogenous tariff set by the US on Chinese goods

[5]Other expected changes in US protection or Chinese retaliatory policies still pending are disregarded in our exercise: a series of tariffs targeting USD 11 bn EU exports had been announced on April 8th 2019, and finally implemented based on the results of the WTO arbitration on aircrafts, while a series of tariffs is expected during the Spring 2020 after the arbitration of another file of the Airbus-Boeing dispute.

[6]International organizations also performed impact assessments in GE, e.g. Caceres, Cerdeiro and Mano (2019), Bekkers and Teh (2019).

(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.[7] [8]

The rest of the paper is organized as follows. In section 1, we present the model and data. We then develop two sets of scenarios in Section 2: our central scenario presents the measures in force as of August 2019 and analyze their long term impacts, while two additional scenarios rather explore alternative routes, namely a further trade liberalization between the US and the European Union and on the opposite, a further escalation, in particular on the automobile sector. Beyond trade impacts, our focus is on the impact of this shift to protectionism on value added, prices, factor income and factor reallocation across sectors. We then discuss the political economy of the trade war from the US point of view in section 3. The last section concludes.

1. Empirical strategy

GE modeling is a good candidate to address the effects of a trade war, in particular when the dynamic impacts of the conflict have to be characterized and when changes in prices have to be tracked along the value chains. Sectors adjust their intermediate consumption basket to tariff-induced price changes, labor force and capital accumulate, and the overall setting can be linked to a macroeconomic baseline. We rely here on MIRAGE, the CGE model 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 explicitly representing GVCs. Therefore, our approach combines three tools: (i) a global and sectoral GE 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. The General Equilibrium model

MIRAGE-e (Modelling International Relationships in Applied General Equilibrium) is a multi-sector and multi-region model dedicated to assess the impact of trade policies and interactions between trade and climate change. We rely on version 2 of MIRAGE-e which innovates by featuring GVCs.[9]

In MIRAGE-e, firms interact either in a monopolistic 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

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

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

[9] Version 1 of the model is documented in Fontagné, Fouré and Ramos (2013). More information on the version used here is available on the MIRAGE wiki: https://wiki.mirage-model.eu.

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 her income and spends the rest on commodities, according to a LES-CES functional form.

Trade is represented with two different Armington structures, to separate trade in goods for final consumption and trade in intermediates. This double structure explicitly accounts for GVCs. Trade can be impacted by a wide range of measures, systematically differentiated according to the use of the affected goods. Beyond detailed bilateral protection (trade policy scenarios are defined at the HS 6-digit level, *i.e.* considering more than 5,000 products), trade restrictiveness of non-tariff measures, whether generating rents or not, is also taken into account, for goods as well as for services (details given in section 1.2).

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 and Fontagné, 2013) to deal with world structural change at medium-run horizon (2030). Structural adjustments come from the inertial reallocation of the stock of capital via depreciation and investment.

The General Equilibrium model is calibrated using the ImpactECON database (Walmsley and Minor, 2016) featuring a decomposition of trade in goods and services by final or intermediate use that is consistent with GTAP 9.[10] This release of the GTAP database features 2011 as the last reference year. The geographic decomposition is 140 regions of the world economy for 57 sectors. We aggregate this data into 27 sectors and 21 regions or countries (see Appendix C for the detailed aggregation).

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, factor income, etc.). The two series of events we take on board are the so-called "Section 232" (of the Trade Expansion Act of 1962) on US imports of aluminium and steel (including exemptions, quotas and retaliation) and the "Section 301" (of the Trade Act of 1974) applied to US imports from China in several waves.[11] We do not take into account measures not yet implemented by September 1, 2019. This means that, on the one hand, we do model the lists 1 to 3 of Section 301, as

[10]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, a given resulting sector can provide the same category of good to final consumer and to other sectors that use it as an intermediate product. Tariffs 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 latter as we proceed with our own aggregation of the MAcMap HS6 database.

[11]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.

defined by the US Trade Representative,[12] including the increase of taxes from 10% to 25% on Chinese exports occurred in June 2019 (and the following Chinese retaliation). On the other hand, we do not model the impact of the additional 15% tariffs imposed on a subset, worth around USD 100 bn of US imports from China, of list 4 entered into force in September 1, 2019. Following the so called "phase one" deal between US and China, announced on December 13, 2019, these last tariffs are expected to be reduced by half in the 30 days following the signature of the deal, planned in January 2020. Neither do we take into account Chinese retaliation to this last wave of tariffs.[13] We also don't take into account the impact of the threat over the foreign car industry.[14]

1.2. Protection data

Market Access Map (MAcMap) provides a disaggregated, exhaustive and bilateral measurement of applied tariff duties at the product or tariff line level. It takes regional agreements and trade preferences exhaustively into account. The raw source data is from ITC (UNCTAD-WTO). The HS6 data set used here was constructed by the CEPII (Guimbard, Jean, Mimouni and Pichot, 2012) 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, Decreux, Fontagné, Jean and Laborde, 2008). MAcMap-HS6 treats specific duties (per unit) as well as TRQs and offers MFN for all WTO members. The last two years reported in MAcMap are 2011 and 2013, both considered in the following exercise. Tariff equivalents of Non-Tariff Measures on goods are taken from Kee, Nicita and Olarreaga (2008). Tariff equivalents of Non-tariff measures on services are from Fontagné, Mitaritonna and Signoret (2016).

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 August 2019, as defined in the Federal register and on the web sites of the imposing administrations, taking into account the changes in the list of products, see Appendix B).[15]

How are the tariff 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

[12] https://ustr.gov/issue-areas/enforcement/section-301-investigations/tariff-actions

[13] In 2018, China imposed retaliatory tariffs on autos and parts imported from the US. It then suspended them on January 2019, but announced on August 2019 that the suspension would end on December 15, 2019. On December 13, in the latest twist, China decided to suspend the return into force of tariffs on autos, as a sign of good will in the context of the upcoming signature of "phase one" deal. Confronted to this uncertainty, we embed in our scenarios additional tariffs imposed by China on its imports of autos and parts from the US. This lead to a possible overestimation of the impacts but does not alter the analysis of the mechanisms at stake along value chains, that constitutes the core of our paper.

[14] 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.

[15] 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/.

additional tariff for the HS6 line. This additional tariff is then applied to the tariff reported in the MAcMap database. The aggregation at the level of the sectors considered in the simulations is done using a reference group weighted average (Bouet et al., 2008), as detailed previously. We make here the assumption of a full pass through of tariffs into prices, as suggested by the recent literature (Amiti et al., 2019*a*). The shocks identified at the tariff line level are added to the baseline protection, at the sectoral level of the GE model. Some trading partners of the US have negotiated TRQs instead of tariffs. We model them as VERs, assuming that quotas are filled. Therefore, we constrain quantities exported in the simulations, the targeted 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.

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. The baseline is build in two steps. First, it relies on a macroeconomic model of the world economy, used in projection up to 2030 (Fouré et al., 2013, Appendix A provides details on the macroeconomic model). For each country, the GDP, the savings rate, the current account, and the energy efficiency are consistently projected. They are then used as an exogenous trajectory for the GE model, the consistency of the assumptions between the two models being ensured by endogenizing the Total Factor Productivity. This is the first step of the construction of our baseline.

In a second step, we update the tariff protection to its level of 2013 (the most recent available in the MAcMap-HS6 database)[16] and represent – in a stylized way – 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 Economic and Trade 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.

To sum up, the GE model is first run to calibrate the TFPs; a second run, updating trade protection, then constitutes what we consider our baseline. We then build policy scenarios, in which we implement the trade policies we are interested in. The only element that differs between the baseline and a policy scenario is the policy of interest. Then, comparing the economic outcomes of the policy scenario to those of the baseline allows to assess the impact of the trade policy implemented in the scenario.

[16] We do not consider changes in the MFN rates following 2013. In particular, the decreases in MFN tariffs implemented by China in 2018 and 2019 are not taken into account in either the baseline or the policy scenarios.

2. Impact of the trade war on trade, value added and prices

The purpose of our exercise is to quantify how exports, imports, value added, factor income and prices deviate from their baseline value as a result of the trade war, with a focus on belligerents. We consider a central scenario comprising the Section 232 and retaliation, as well as the Section 301 and retaliation. In this central scenario we model the actual shock of the sanctions and retaliation, with the finest level of detail. Two alternative scenarios are modelled in less detail, given the uncertainty surrounding the sanctions that could be enforced: a further US escalation, through section 232 on automobile, versus the removal of bilateral tariffs on industrial goods between the US and the EU (agriculture and vehicles excluded). Beyond the possible outcomes of alternative policies, these two additional, and somehow extreme, scenarios allow us to further detail the mechanisms impacting GVCs. The three scenarios are detailed in this section, before discussing the aggregate impact of the trade war and, importantly for our purpose, the impact of the trade war on GVCs, producer prices, trade and value added.

2.1. The scenarios

The first component of our central scenario is the Section 232 and the related retaliation. In April 2017, the US President instructed Commerce Secretary Wilbur Ross 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,[17] tariffs were announced in March 2018 against almost all exporters of aluminium and steel to the US (the main ones being the European Union, Canada and Mexico). As a result, tariffs on aluminium 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.[18] Turkey also constitutes a special case, in the sense that tariffs on imports from this country increased by 50 p.p. from August 2018 to May 2019.[19]

Retaliatory tariffs were 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).[20] India notified

[17] See BIS (2007) for an analysis of the outcome of all investigations under Section 232 in the US.
[18] The negotiated TRQs for steel 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.
[19] For the sake of simplicity, and because the tariffs are applied annually in our setup, we do not consider the temporary increase in the duties applied to Turkish steel exports. In the same vein, we do not take into account the removal of US GSP preferences to Turkey and India entered into force in May and June 2019, respectively.
[20] After the conclusion of the re-negotiation of the North American Free Trade Agreement, the additional duties between the US and Canada and Mexico (those imposed under Section 232 by the US and the following retaliations) were canceled in May 2019. We do not consider them in our scenarios. Retaliation from Turkey is considered after its revision in August 2018.

to WTO retorsions in early 2018, but their entry into force was delayed several times and finally applied in June 2019. Aware of the uncertainty surrounding these retaliations, we nevertheless consider them in our scenario. 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.[21]

The second series of measures to be taken into account under scenario 1 is related to the use of US Section 301 against China, which took place in several 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. 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, in September 2018, 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. However, after these first talks broke down, the increase finally took place in June 2019. China retaliated to this second round by imposing 10 additional percent (and then 25) of tariffs on USD 60 bn imports from the US.

Table 1 shows what could potentially be the main impacted sectors in the US–China bilateral trade in this scenario. Sectors are ranked using the simple criterion of the impacted tariff revenue (initial imports times tariff increase), which is indeed not the expected change (imports will decrease, conditional on the trade elasticity).

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 13.7%. Machinery is the second impacted sector, with a 17 percentage points increase 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 D, table D.3), where a 21.2 percentage points increase in protection will only affect USD 14 bn of Chinese exports.

The potentially most impacted US sector is the Machinery industry, facing a 9.4 percentage point increase in Chinese tariffs on 29 bn of US exports. The Chemistry, Car and Electronics industries are also potentially seriously hit with a change in protection revenue of around 1.8 bn. Interestingly, in the car industry, the 12.1 percentage points increase in tariffs will curb USD 15 bn of US exports to China, with a huge toll on exports of German-branded cars assembled in the US. Non Ferrous Metals, Oilseeds and Iron and steel will be the other US sectors impacted by Chinese retaliation.

[21] 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.

Table 1 – Scenario 1 – Trade value and protection: most impacted bilateral flows

Sector	Exporter	Importer	Tariffs (in %)		Trade	Change in prot. rev.
			Reference	Scenario	(USD bn.)	(USD bn.)
Electronics	China	USA	0.3	13.7	167	22.4
Machinery	China	USA	1.5	18.5	103	17.5
Oth. manuf.	China	USA	1.5	10.3	69	6.0
Chemistry	China	USA	2.7	18.9	36	5.9
Metal prod.	China	USA	2.1	20.4	19	3.5
Textile	China	USA	11.4	16.3	65	3.2
Vehicles	China	USA	1.0	22.2	14	3.0
Machinery	USA	China	4.1	13.5	29	2.7
Chemistry	USA	China	4.9	13.0	23	1.8
Vehicles	USA	China	13.1	25.2	15	1.8
Electronics	USA	China	1.3	9.4	21	1.7
Non ferrous met.	USA	China	0.7	16.9	10	1.6
Oilseeds	USA	China	1.5	13.7	13	1.5
Iron and steel	EU 27	USA	0.2	19.8	6	1.3
Oth. manuf.	USA	China	2.8	12.5	13	1.3
Food	China	USA	5.0	23.7	6	1.1
Minerals	China	USA	4.2	18.7	7	1.1

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index. Sectors are ranked by decreasing impact on tariff revenue.
Source: BACI (2017), MAcMap-HS6, authors' calculation.

As described above, the trade war initiated by the US administration is also impacting other exporters, in particular under section 232: USD 6 bn of Iron and steel exported by EU 27 to the US are facing a 19.6 percentage points increase

Retaliation from countries other than China has much smaller impacts since it affects smaller flows. Indeed, Fetzer and 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.[22] 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.

It is difficult to figure out how commercial tensions will evolve between Europe and the US. We will however consider two alternative scenarios; the purpose, here again, is to illustrate how the involvement of belligerents in GVCs is shaping the adjustment of sectors and potentially leading to value added – and thus income – losses. As we do not have the details of the sanctions and retaliations, we adopt a series of simple, although sensible, assumptions on targeted products.

Two additional, and somehow contradictory, elements could constitute the next episode of the current trade tensions. On the one hand, further escalation, through section 232 on automobile: the argument invoked is that

[22] Blanchard, Bown and Chor (2019) confirm that retaliation indeed had an impact on US 2018 elections. Republican candidates lost ground in counties most exposed to retaliatory tariffs, without significant gains in counties protected by US tariffs. However, their results suggest that the most efficient retaliatory pattern should target politically competitive counties, where D. Trump narrowly lost the 2016 vote, instead of aiming at counties that clearly supported the Republican candidate.

massive imports of autos and their parts, in particular from the EU, are threatening US security. The decision on whether to apply additional tariffs to US imports (from all over the world, with the probable exception of Canada and Mexico) was initially due in March 2019. It has been postponed to November 2019. By the end of 2019, no decision had been taken. In the US, whether it was still legally possible to implement additional tariffs without opening a new investigation was debated, while the EU trade representative, in the days following the absence of the announcement of new tariffs, still considered that the threat was not entirely gone. With this respect, the EU announced that if the US apply additional tariffs, she would retaliate with sanctions on USD 50 bn of exports from the US to the EU.

In parallel, the EU and the US announced they would launch negotiations to eliminate tariffs on their bilateral trade of industrial goods, excluding automobile (as well as agriculture) according to the Joint EU-US Statement following J.C. Juncker's visit to the White House, in July 2018. Here again, the situation is close to a status quo.

Scenario 2 tentatively adds the possible measures on imports of automobiles and their parts, to be taken under section 232 (i.e. invoking national security to motivate them), to scenario 1. We assume that the US increase their tariffs by 25% for all the exporters, with the exception of Canada and Mexico, and that the main exporters of autos to the US retaliate, increasing by 25 p.p. the tariffs on the main products they imports from the US (excluding energy and pharmaceutical products). The value of imports affected by retaliation is equivalent to the value of exports targeted by the section 232.

Finally, scenario 3 simulates the removal of bilateral tariffs on industrial goods between the US and the EU (agriculture and vehicles are excluded), while measures related to section 232 on steel and aluminium against partners other than the EU and to section 301 against China remain in place.

We show in table 2 what are the sectors targeted by these pending policies: either a trade war extended to the automobile sector, or a negotiation aiming to phase out the industrial tariffs between the EU and the US. In the upper panel, American sanctions on automobile show up as a very important issue for the USD 49 bn EU 27 exports.[23] Using the simple metric of tariff revenue, the order of magnitude is approximatively half of what we observed in Electronics for China in table 1 (here: USD 11.7 bn for Automobile). Japan would be even more impacted (resp. 13.1 bn). The EU should retaliate in the same sector or in a similar one, such as Other transport equipment, but the damage to the US would be much lower.[24]

In the bottom panel of table 2, we show what would be the impact on tariff revenues of a phasing out of industrial tariffs between EU and the US. Not surprisingly, given the initial low level of tariffs, there is not much

[23] If we consider EU28 instead, exports of the automobile industry are larger than those of Japan, amounting to USD 59 bn.

[24] Given the current dispute regarding the aircraft subsidies, one might guess that the EU would not introduce this sector in the retaliation to the automobile battle. But we disregard this question mark here and the sector Other transport equipment is hit by retaliation in our exercise.

Table 2 – Scenarios 2 and 3 – Trade value and protection: most impacted bilateral flows

Sector	Exporter	Importer	Tariffs (in %)		Trade	Change in prot. rev.
			Reference	Scenario	(USD bn.)	(USD bn.)
Scenario 2: Sanctions on automobile and retaliations						
Vehicles	Japan	USA	1.5	26.4	52	13.1
Vehicles	EU 27	USA	1.8	25.7	49	11.7
Oth. transp. eq.	USA	EU 27	1.5	20.0	36	6.7
Vehicles	Korea	USA	0.9	25.9	21	5.2
Vehicles	UK	USA	1.6	26.2	10	2.4
Machinery	USA	Japan	0.2	16.1	15	2.4
Oth. transp. eq.	USA	Japan	0.0	22.9	7	1.6
Chemistry	USA	Japan	1.5	11.8	14	1.4
Food	USA	Japan	22.9	40.2	7	1.3
Scenario 3: Phasing out of industrial tariffs between the EU and the US						
Chemistry	EU 27	USA	2.0	0	95	−1.9
Chemistry	USA	EU 27	3.0	0	56	−1.6
Machinery	EU 27	USA	1.0	0	90	−0.9
Textile	EU 27	USA	9.0	0	9	−0.8
Machinery	USA	EU 27	1.5	0	52	−0.8

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index. Sectors are ranked by decreasing impact on tariff revenue.
Source: BACI (2017), MAcMap-HS6, authors' calculation.

action there. The largest impact is on Chemistry and the magnitude of it is below USD 2 bn of tariff revenue on both sides of the Atlantic. Other sectors potentially impacted would be Machinery and Textile, for even lower amounts. Accordingly, this negotiation is worth having just for sake of cooling the protectionist tensions, but it would not deliver much in case of success.

2.2. Aggregate impacts of the trade war

What is the overall impact of detailed scenario 1 in our model featuring GVCs and imperfect competition? 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 −0.92% and world GDP by −0.11%. 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 3 gives an overview of these results (we present the results for Germany instead of EU 27 in order to avoid obvious problems of aggregation, e.g. on wages).

The first aggregate impact of the trade war is to dramatically increase US tariff revenues: they actually double (+103.55%).[25] The improvement in US terms of trade is limited (+0.23%) as opposed to the usual optimal tariff agreement. US exports to the world post a 7.53% *decrease* as a result of sanctions and reduced competitiveness: the cost of imported intermediate inputs increase which translates into increases in producer

[25] All figures are percentage deviations from the baseline in 2030, in volume, i.e. not taking into account price effects.

Table 3 – Scenario 1 – Main aggregate results for selected countries

	USA	China	Canada	Germany	Japan	Korea	Mexico
Total tariff revenue	103.55	8.27	3.94	1.96	0.99	0.09	8.38
Exports	−7.53	−4.10	1.34	0.30	1.05	0.06	3.43
GDP	−0.40	−0.55	0.29	0.04	0.12	−0.01	0.36
Terms of trade	0.23	−1.11	−0.01	0.06	0.05	0.28	0.93
Real return to capital	0.13	−0.13	−0.22	−0.03	−0.01	0.01	0.18
Real return to land	−4.83	1.10	−0.93	0.16	0.03	−0.06	−1.37
Skilled real wages	−0.42	−1.08	0.51	0.07	0.12	0.04	0.45
Unskilled real wages	−0.24	−0.73	0.30	0.06	0.13	0.02	0.38

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

prices. We detail this mechanism below. American farmers are adversely affected by Chinese sanctions (return to land reduced by −4.83%) and workers are also negatively affected in real terms, although white collars suffer more than blue collars. Ultimately, limited benefits accrue to the capital owners as a result of the reduced competition on the US market (return to capital increases by 0.13%). All in all, the US GDP is facing a USD 91 bn decrease (−0.40%).

Overall Chinese exports are hit by a modest −4.01% decrease,[26] 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 (−1.11%), while workers and capital owners lose to the benefits of farmers. Overall the Chinese GDP is facing a USD 130 bn (−0.55%) reduction.

Korea and Japan are hardly affected. Beyond the standard trade diversion argument (these two countries still benefit from the NAFTA preferential access), the presence of GVCs introduces a potential additional benefit in relation with reallocation of production in assembly lines located in Canada and Mexico, since the latter countries are not targeted by Section 232.

More interestingly, certain bilateral relationships or certain sectors in China, in the US or in Europe will be severely affected (see details for China and the US in Appendix D, tables D.5 and D.6, resp.). Chinese exports to the US record a −48.3% drop. China however reorients its exports firstly towards Canada (+12.6%) and Mexico (+11.6%), less substantially towards Europe (e.g. +6.1% towards the UK or +4.5% towards Germany). US exporters record a −36.7% 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. −4.0% in Korea and Japan, and to −5.2% in Germany.

Consistently with the elements on the increase in protection given in table 1, Chinese exports of Electronics to

[26]In the simulation exercises, the regional aggregation gathers China and Hong Kong. For the ease of the exposition, we write about impacts for China when referring to the results for the region *China and Hong Kong*. See Appendix C for details on the aggregation.

the US market suffer a −58.9% drop. This is even worse for intermediate products targeted by US sanctions (−71.3%). And with the exception of the resilient Mexican market (+6.2% in total, driven by a +10.8% increase in exports of intermediate products), 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 −1.0% on the Brazilian market, to −2.1% in Japan and −2.6% in Germany. This situation contrasts with Machinery where the drop in Chinese exports to the US market (−59.9%) is cushioned by an increase in Chinese exports on other markets (and +12% to Canada and Mexico). In the car industry, the toll on Chinese exports to the US is important also (−53.4%), but here again cushioned by a redirection of exports to other markets (especially Canada +13.3% and Mexico +7.3%). The same reasoning applies to Chemistry, although the magnitude of the Chinese losses on the US market is more limited (−28.3%).

US exports of vehicles to China are severely hit (−37.4% for assembled cars and −51.8% for parts and components). 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 are sizeable towards Japan (−9.5%), Korea (−9.1%) or Germany (−8.2%). In Machinery, Chinese retaliations are effective, imposing a −55.4% drop in US exports. As for the car industry, competitiveness losses in Machinery 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 −75.6% drop, and two-digit losses are observed everywhere but on the Canadian and Latin America markets.

2.3. Impact of the trade war on GVCs and producer prices

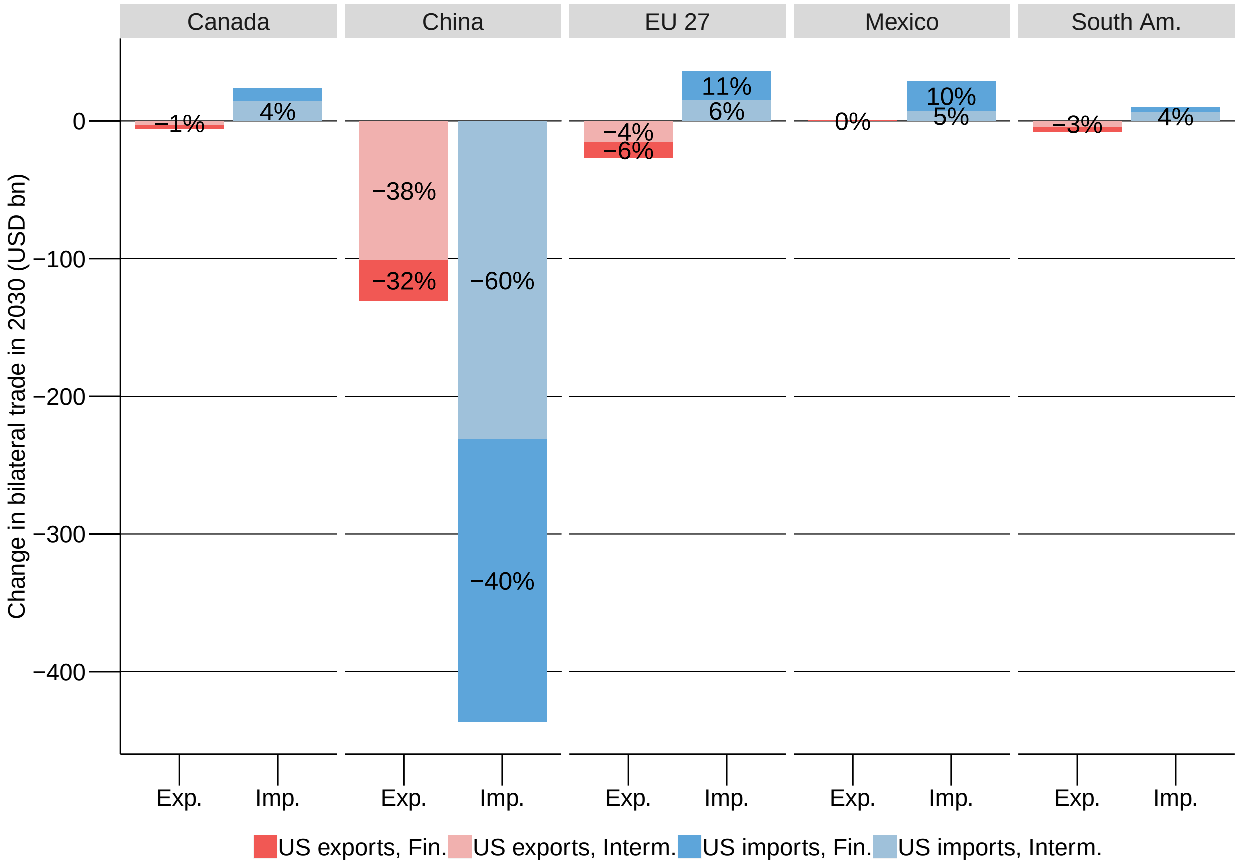
We now turn to the core argument of this paper. By imposing tariffs on imported inputs and by taxing domestic value added contained in imports of final goods, the trade war not only hurts the targeted countries but also the country imposing the tariffs.

The first insight in this complex chain of effects is provided by the outcome of protection in terms of trade in final versus intermediate goods. Figure 1 reports the impacts on US bilateral trade flows with major trading partners, distinguishing between trade in final and intermediate products.[27] We firstly observe a massive cut in US imports of intermediate inputs, parts and components from China (i.e. a −60% drop, USD −231 bn). An almost equivalent value of imports of final goods disappear (USD −205 bn), but this represents "only" −40% of US imports of final goods from China. The difference here observed reflects the attempt of the US administration to disrupt GVCs while limiting the direct cost of the trade war beard by US consumers. The Chinese cut in imports from the US is much more limited, but most of it is intermediate products (around three quarters of the impact in dollar terms, 77%) despite relative changes of similar magnitude (−38.1% for intermediate and

[27] In Appendix D, figure D.1 provides a more complete version of figure 1 and table D.7 shows the detailed results for all US trade partners.

−32.5% for final goods). We finally observe that US imports of final goods somehow diversify their origin, to the benefit of Korea, Japan, Mexico, Germany and France, Brazil or Canada to a lesser extent. This pattern is not observed for intermediate goods, or to a much lesser extent, because reorganizing value chains is difficult.

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



The second piece of the puzzle on the US side is how producer prices react to (i) the increase in the price of intermediate inputs, (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 4, 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 is of −2.8% for Oilseeds, the agricultural sector most affected by the Chinese retaliations. For the sectors most protected by the tariffs, the net effect of the three mechanism listed here is an increase in the producer price: +1.3% in the Electronics sector, 1% in Aluminum and for Iron and steel, 0.8% in Chemistry. This has indeed cascading effects on automotive (+1.2%) or Metal products (+1.0%) and Other manufacturing (+0.6%).

China offers in the left panel the mirror image of the US: producer prices increase in sectors benefiting from Chinese retaliation (e.g. Oilseeds +0.8%) or Fiber crops (+0.2%). In other sectors, Chinese producers have

Table 4 – 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	−1.3	2.2	0.4	0.5	−0.8	−2.2
Cereals	−0.9	7.8	2.5	0.2	−3.5	−3.9
FiberCrops	0.2	1.6	8.4	−1.3	−1.1	−7.6
Food	−0.7	−0.9	−0.3	0.5	−4.5	−1.4
Oilseeds	0.8	3.6	10.0	−2.8	−6.8	−11.0
OthCrops	−0.1	0.4	9.6	0.1	−1.1	−3.4
OtherAgri	−0.8	1.1	0.3	−3.3	−0.7	−2.6
Sugar	−1.7	0.1	0.4	0.8	−0.0	−1.4
VegFruits	−1.5	7.3	1.2	−0.1	−2.6	−4.6
Chemistry	−1.1	6.0	0.9	0.8	−12.3	−2.2
Coal	−1.2	1.4	0.9	0.4	−0.6	−2.8
Elec	−1.1	0.2	0.1	0.8	−0.7	−0.3
Electronics	−0.8	−47.7	−11.1	1.3	4.8	8.3
Gas	−0.5	0.7	0.0	2.6	3.4	1.4
IronSteel	−1.1	−1.4	−0.4	1.0	7.3	9.2
Machinery	−1.2	−16.5	−1.3	1.0	13.3	2.0
MetalProd	−1.2	−4.4	−1.7	1.0	6.9	3.6
Minerals	−1.2	2.8	0.4	0.7	−0.4	−0.3
NonFer	−1.2	2.3	1.1	1.1	−2.7	−5.3
OthManuf	−1.2	−3.4	−0.6	0.6	5.6	1.1
Trans. eq.	−1.2	2.7	1.6	0.9	−7.3	−4.7
Petroleum	−0.6	−0.4	−0.1	0.4	−0.7	−0.2
Textile	−1.2	7.6	2.3	0.8	−3.3	−2.1
Vehicles	−1.2	−2.2	−0.6	1.2	−4.8	−2.7
Serv	−1.6	−18.4	−0.2	0.5	−13.3	−0.1
Transport	−1.4	2.7	0.2	0.5	−2.4	−0.4

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

to reduce their production prices (Machinery −1.2%, Chemistry −1.1%, Electronics −0.8%). This indeed contributes to the observed deterioration of the Chinese terms of trade. In contrast, as expected, we observe in Appendix table D.8 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. Sectors hit by retaliation suffer, as expected. We record a −11.0% drop in the value added in the Oilseeds sector, and similarly a −7.6% drop in the value added of the Fiber crops sector. At the other extreme, Iron and steel protected by article 232 exhibit a +9.2% increase in their value added. The Electronics sector also records a +8.3% in its value added. For Metal products and Machinery, the increase is more modest (resp. +3.6% and +2.0%). 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 (-11.1%). Metal products and Machinery are affected to a lesser extent (-1.7% and -1.3% respectively). Sectors benefiting from the retaliation enjoy an increase in their value added (Oilseed +10.0%, Fiber crops + 8.4%).

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 11.1% decrease, while the US gain 8.3%. In dollar terms, and in the long run, Chinese losses are even more impressive, with a USD 47.7 bn drop, while US gains reach only USD 4.8 bn. Accordingly, this industry will record a massive destruction of value. In the Iron and steel sector US gains are also sizeable (9.2% of value added, or a USD 7.3 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, in relative terms, Machinery and Metal products post modest gains for the US and modest losses for China.[28]

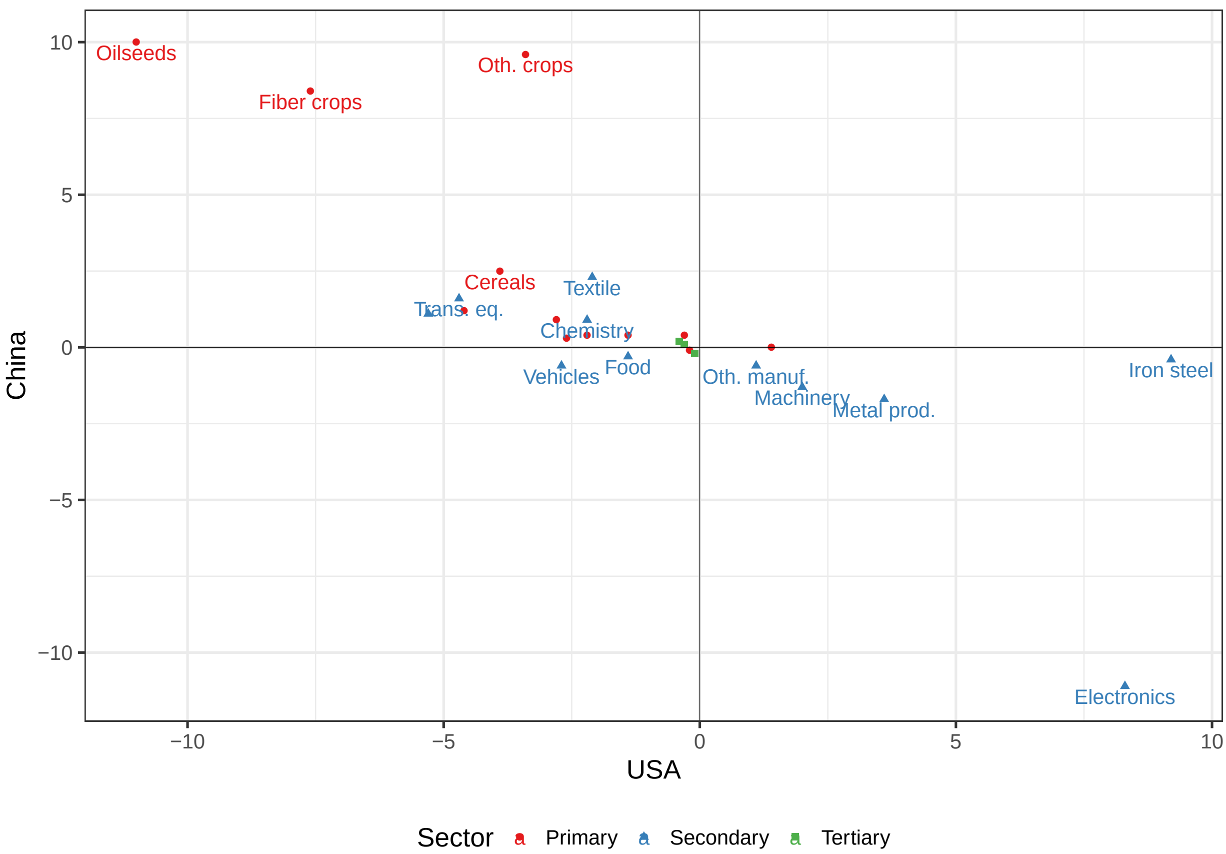
In the quadrant where the two countries loose, the Food sector shows up, but for small changes, in particular in China, together with the Vehicle sector. The latter looses more in the US (-2.7%, corresponding to USD -4.8 bn) than in China (-0.6%, i.e. USD -2.2 bn). Indeed, the US automotive industry, beyond Chinese retaliation, suffers from a loss of competitiveness on all markets because of the increase in its production costs, caused by higher prices for steel and (Chinese) car components.

Lastly, the quadrant where the US loose and China gains is very populated: it gathers 16 out the 26 sectors we consider in the US economy. These are the sectors mainly hit by Chinese retaliation. First, the US are hit heavily in Oilseeds by Chinese retaliations: US value added records a -11.0% drop (or USD -6.8 bn),[29] 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 -2.2% drop in value added, representing more than USD -12.3 bn given the size of this sector. The same remark pertains to the US industry of Transport equipment other than automobiles, posting a -4.7% and USD -7.3 bn drop in value added. The latter sector suffers, like the one of Vehicles, from reduced competitiveness in the US as well as in third markets, because of the increased prices of intermediate consumptions.

[28]Changes in absolute terms in the Machinery sectors are large due to the initial size of this sector, USD +13.3bn in the US and USD -16.5 bn in China.

[29]We do not take into account any exceptional compensating subsidy granted to the agricultural sector.

Figure 2 – Scenario 1 – Relative changes in value added, by sector, in 2030 (%)



2.4. Impacts of pending sanctions and retaliations on trade and value added

We now examine briefly how the pending sanctions and retaliations would modify the results of our central scenario.[30]

The prospects of another battle in the automobile industry combined with the previous series of sanctions and retaliation (as in scenario 2) are indeed firstly a massive decrease in Japanese car (−72.0%) and car components (−69.9%) exports to the US. European exports of cars and components to the US are also affected; especially Germany would be hit by a massive drop in exports (resp. −49.0% and −58.9%). But beyond these expected results, we are interested in the additional impact of these measures on trade in final versus intermediate goods, and ultimately on value added. To proceed, results are no longer presented with respect to the baseline, but with respect to scenario 1.

Under scenario 2, and compared to scenario 1, the first striking result illustrated in Figure 3 is the reorientation of US imports of assembled cars to the benefit of NAFTA, especially Canada (+23%), at the expense of the EU (−6%) and, mainly, Japan (−45%, i.e. USD −61 bn). Due to the presence of integrated value chains within the NAFTA, this induces an expansion of US exports of parts and components of vehicles to the two assembly platforms – Canada and Mexico. In other words, one side effect of protecting the US market from European and Japanese competition for assembled cars is to increase US exports of parts and components to the Canadian and Mexican assembly plants of the regional car industry.

Let's now consider how scenario 3 (a phasing out of bilateral EU-US tariffs for manufactured products, excluding cars) would modify the impact of the trade war represented under scenario 1. The potential impact on bilateral trade flows with the US is shown in Figure 4. Cooling the trade tensions would have no visible impact on countries other than the EU. US exports of intermediate goods to the EU would record a significant 10% increase compared to a steady trade war (as in scenario 1), meaning an increase by 5% with respect to the baseline, instead of a decrease by 4% in scenario 1, as shown in figure 1. At the same time, EU exports of intermediate products to the US would increase by the same order of magnitude. Interestingly, trade in intermediate goods, in both directions, would increase by more than trade in final goods, mirroring the fact that the two sides of the Atlantic are deeply connected through GVCs.

Turning to the impact on value added, we finally ask what would be the impact of the extension of the tariff war to the automobile industry given the high fragmentation of GVCs in this sector. We focus here on scenario 2, since there is not much additional action in scenario 3. We summarize the complex effects in figure 5. In this figure, we plot the relative changes in value added by sector in the long run, in percentage, for Germany and France. We compare the outcome for these two countries to illustrate how a common set of sanctions

[30] In the following, we focus on the impacts on trade and value added, mainly at the sector level. In the Appendix, tables D.9 and D.10 provide the main aggregate results for selected countries obtained in scenarios 2 and 3, respectively.

Figure 3 – Scenario 2 – Impacts on US trade flows (variations with respect to scenario 1, in 2030)

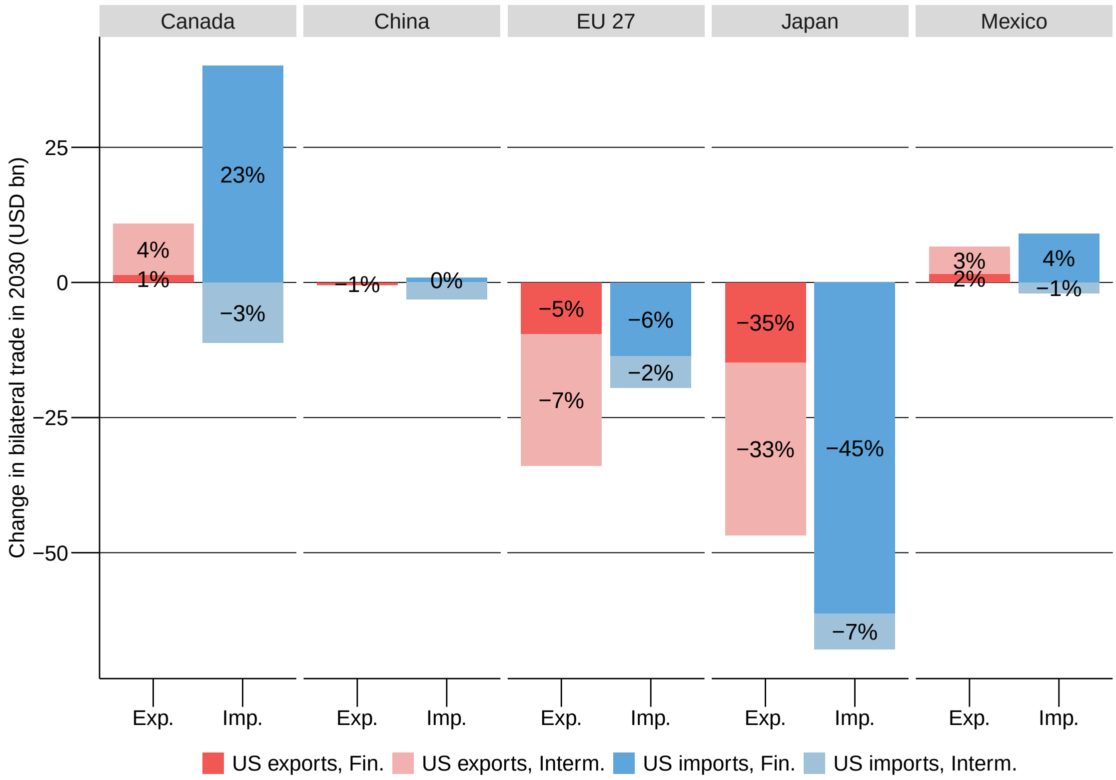
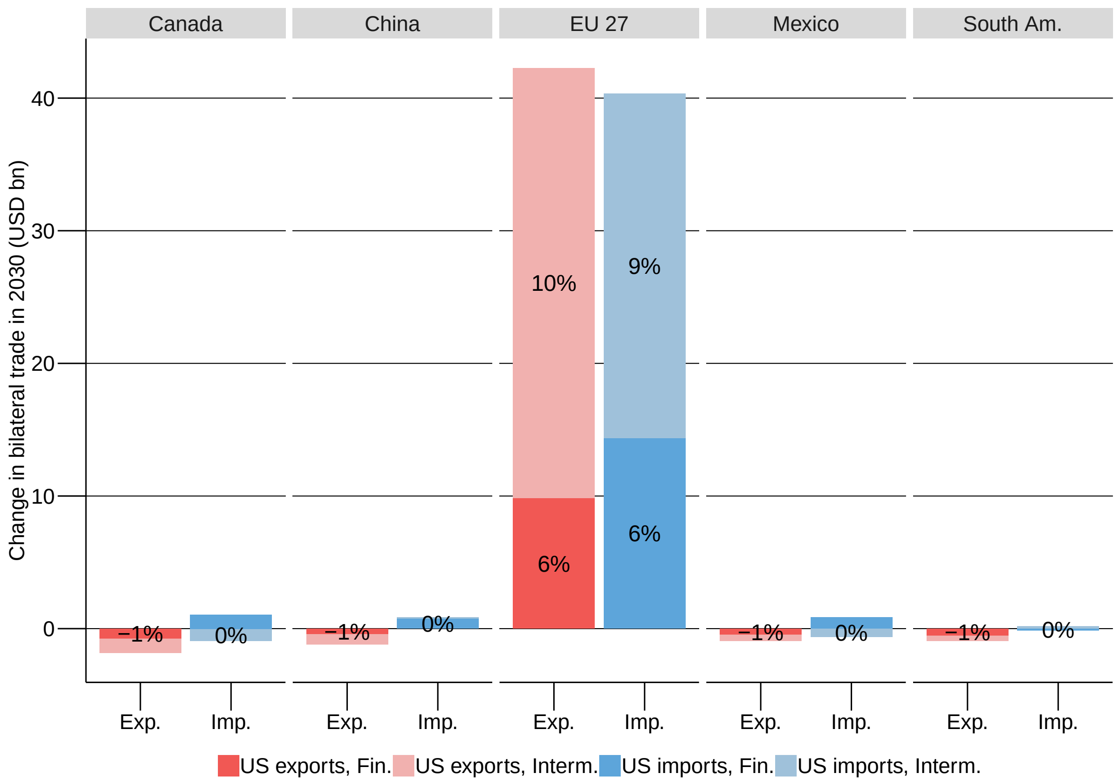
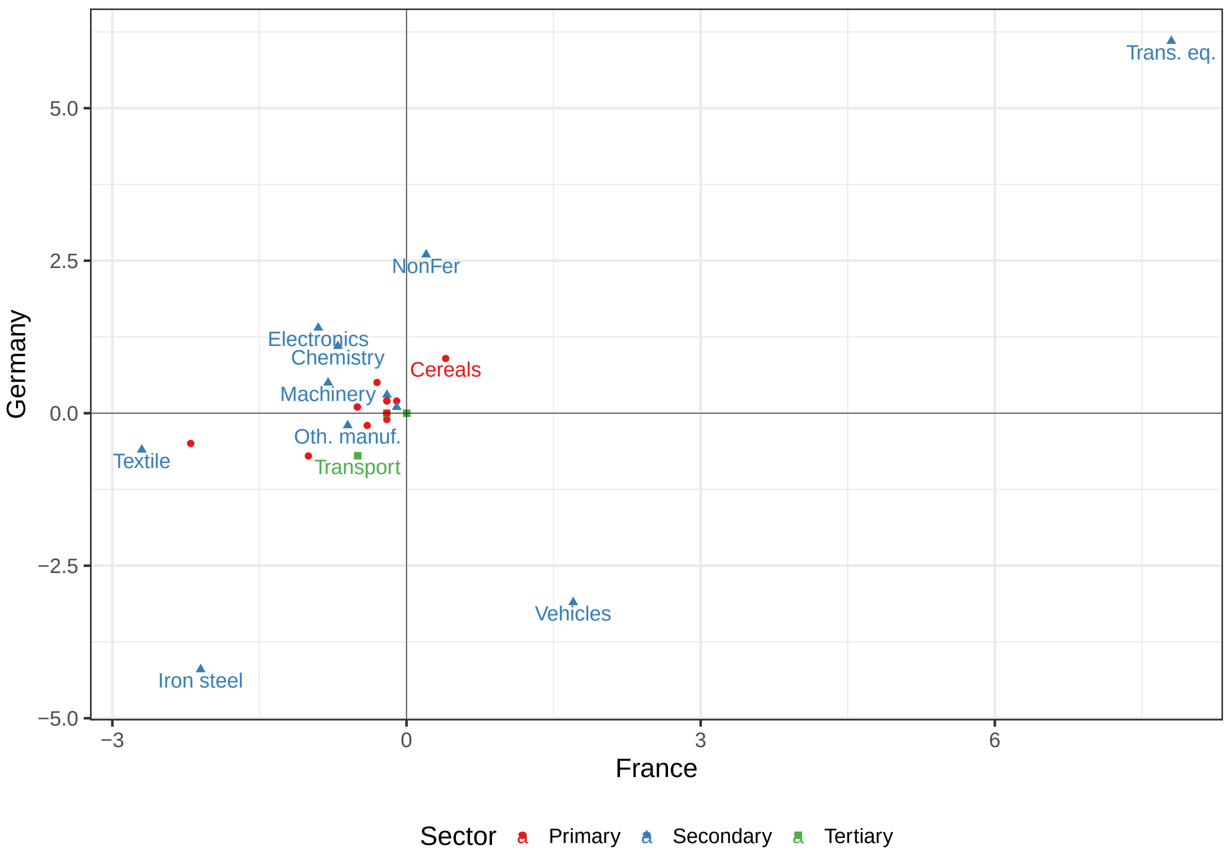


Figure 4 – Scenario 3 – Impacts on US trade flows (variations with respect to scenario 1, in 2030)



(the US tariffs on the car industry coming on the top of scenario 1) combined with a common set of retaliatory tariffs decided at the European level, can lead to very different impacts. This is indeed due to the initial trade patterns of the two countries, but also to the complex organization of value chains, through which the price effects of tariffs spread. The main result is that the German value added would be severely hit in the car industry, while this industry would not suffer in France (Vehicles is the only sector in the bottom right quadrant of figure 5). The reason is manifold. First, there would be direct losses of market shares in the US market, due to US tariffs on assembled cars. Second, German producers' cars assembled in the US and imported in the EU would be hit by the European retaliations leading to a sizeable loss of German sales on the European market. A third channel is through the imports of American parts and components in Germany, again as a consequence of European retaliations. Another sector showing up in this comparison is Other transport equipment: the two countries would gain in relative terms, although the initial value added of the sector is three times higher in France. We already warned against this result driven by the assumption of European retaliatory measures in this sector.

Figure 5 – Scenario 2 – Relative changes in value added, by sector, in 2030 (%)



Finally, the impact of scenario 3 on value added is, as expected, limited. None of the industrial sectors in Germany or France records a change in value added above USD 0.5 bn, with the exception of Machinery in Germany (+2 bn).

3. The political economy of a trade war in presence of GVCs

We have shown how the integration of economies throughout GVCs was shaping the impacts of a trade war. When trade in intermediate goods is affected – directly or indirectly – by sanctions or retaliations, the economic impact is transmitted throughout the value chain. In turn, the imposing country can be hurt by its own policy, because domestic components are present in imported final products, or because foreign components enter as an input in the production of exported products. The main message of our exercise is that GVCs are nowadays so prevalent that a trade war will be costly for all belligerents. This said, the next question is why do the US engage in costly policies putting their own competitiveness at risk? Motivations going beyond the contribution of this paper could indeed be at stake, e.g. imposing losses to China as a retaliation for presumed intellectual property theft. However, it might be a more subtle move, consistent with political economy motives. Section 232 can indeed support the brick-and-mortar factories; but what about Section 301? The related sanctions and retaliations are profoundly reshaping the sectoral value added of belligerents, as illustrated above; such large shifts of value added will necessarily be transmitted to the compensation of production factors within sectors. Recall for instance that we expect a USD 13.3 bn increase in the value added of Machinery in the US, or a 4.8 bn increase in the value added of Electronics. This contrasts with a -7.3 bn decrease in value added in Other transport equipment, or -12.3 bn decrease in Chemistry.[31]

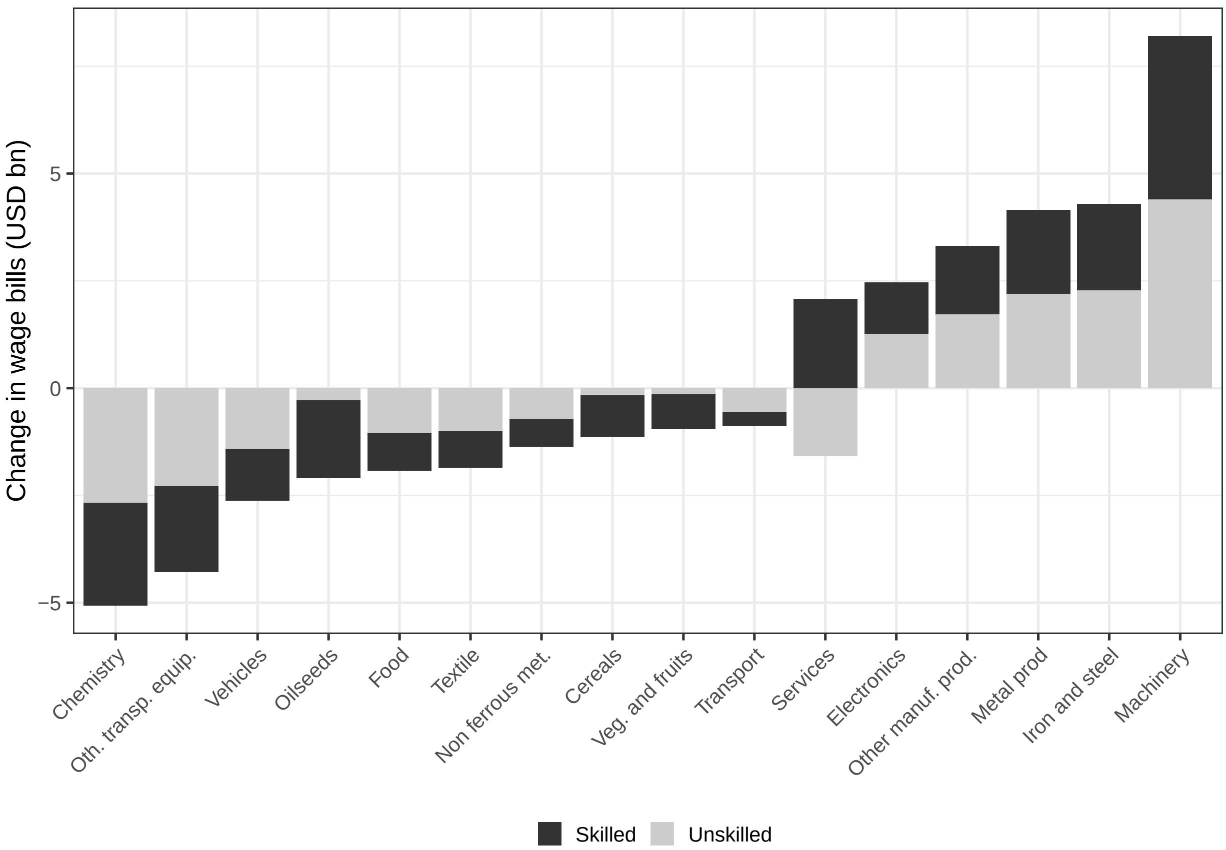
The next step is to analyse the impacts on production factors employed in the different sectors of sanctions, retaliations and their propagation throughout GVCs. Let's start with labor, recalling that we have two categories of workers, skilled and unskilled. We show in figure 6 the variations in the wage bill of each category of workers and in each sector in 2030. These are variations in constant dollars between the counterfactual and the reference. For sake of clarity we omit sectors in which the variation is small, and sectors are ranked by increasing impact on their wage bill. In our central scenario here presented, the largest increase in the wage bill is for Machinery (+ USD 8.2 bn). This leads to a similar 2.1% increase in the wage bill of skilled and unskilled workers. Since wages (for a given skill level and in a given country) are common across sectors in our model, we can interpret the percentage changes in wage bills as job creation versus job losses (at constant wages and skill composition).[32] In Iron and steel, the absolute change in the wage bill is smaller (4.3 bn), but corresponds again to a similar percentage increase for the two categories of workers (resp. 9.3 and 9.5% for skilled and unskilled). This increase of around 9% in the number of jobs in this industry is the largest impact in relative terms (just followed by Electronics with an additional 8% jobs). Metal products and Other manufactured products also create jobs, while most of the other sectors – and firstly Chemistry and Transport equipment – destroy jobs.

[31] As for farmers, the discussion is more complex due to subsidies received as compensation from the Federal level; we can thus hardly assume that the e.g. USD 6.8 bn loss of value added in Oilseeds will translate into an equivalent loss for the production factors engaged in this sector.

[32] Actually, the variation in US skilled real wages is -0.42% in scenario 1 and -0.56% if we add US sanctions on cars and induced EU retaliation. Figures are respectively -0.24% and -0.37% for unskilled wages. Hence, for instance, a 5% drop in the wage bill in Chemistry represents a less than 5% decrease in the number of jobs.

The broad picture is accordingly that the ultimate impact of the trade war in the US is to displace workers from downstream (e.g. Vehicles) to upstream industries (e.g. Iron and steel). Interestingly, for Services, we observe a negative impact on unskilled workers contrasting with the positive impact on skilled workers. One possible explanation is that skilled workers are concentrated upstream, however our sectoral detail does not authorize us to decompose this effect. Lastly, considering agricultural products, Oilseeds and Fiber crops are the two more vulnerable sectors in terms of job losses. Vegetable and fruits, and Cereals follow.

Figure 6 – Scenario 1 – Changes in US wage bills, by sector, in 2030 (USD bn)

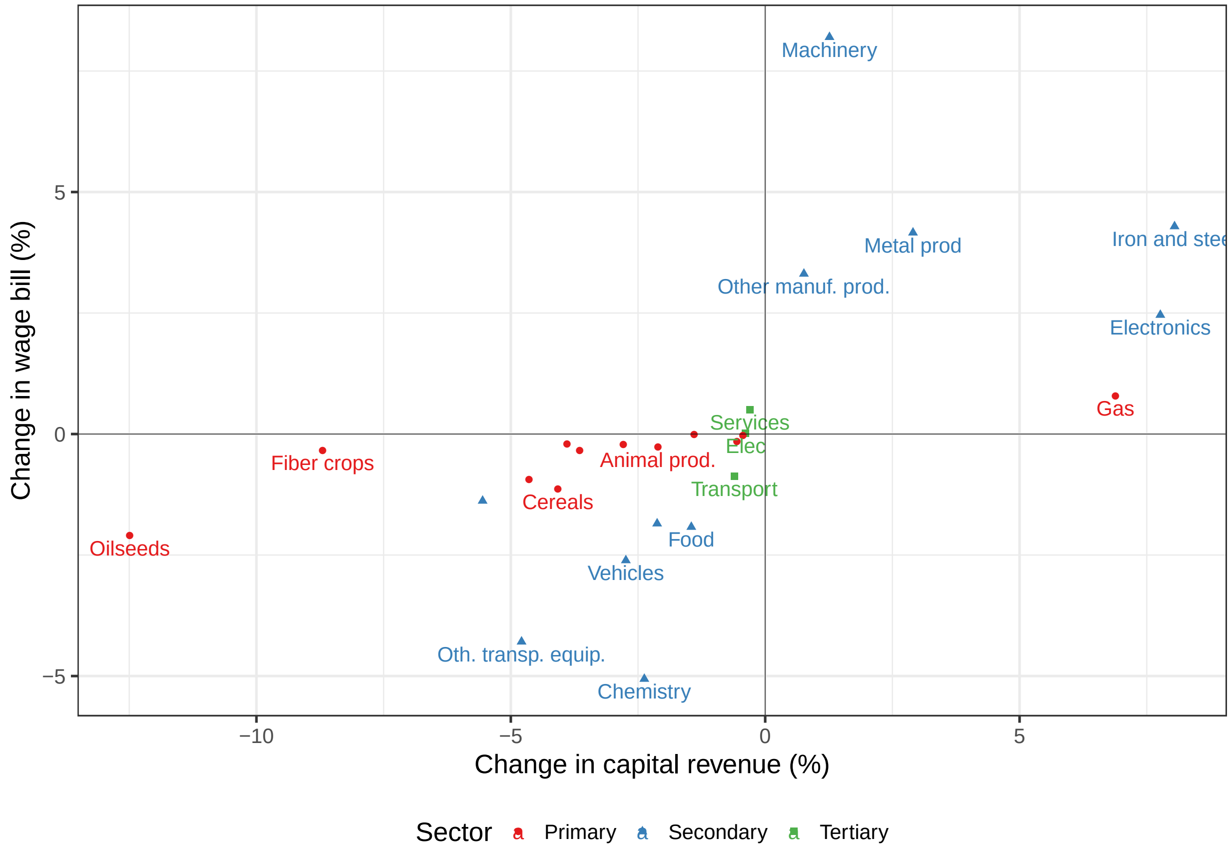


Besides labor, production relies on other factors, and importantly on capital.[33] We show in figure 7 the total change in US wage bills (i.e. grouping the two categories of workers) and in capital. Differently from the adjustment mechanism pertaining to labor, and provided that the adjustment of the sectoral capital stock is driving the recursive dynamics of the model,[34] the observed change in capital revenue is the result of net investment in protected sectors and progressive adjustment of the return to capital to its baseline equilibrium value. In the top right quadrant of figure 7 we observe sectors where both components of the value added win: workers and capital owners. These are the protected sectors which did show up in the right quadrants of figure 3). In the bottom left sectors, both factors lose; this is due either to the transmission of prices along the GVCs

[33]We do not comment the variation in the return to land for sake of simplicity. It indeed decreases in the relevant sectors.
[34]Sectoral gross investment is driven by the differences in return to capital across sectors, while there is a common depletion rate of installed capital.

(Other transport equipment, Vehicles) or to Chinese retaliations (e.g. Oilseeds).

Figure 7 – Scenario 1 – Changes in US wage bills and capital revenue, by sector, in 2030 (%)



4. Conclusion

We embedded the most detailed information related to the trade war in a recursive dynamic GE model of the world economy featuring global value chains and imperfect competition. The channels of transmission of price changes along the value chains were accordingly fully described. Beyond the direct effect of retaliation, tariffs increase the cost of imported intermediate consumption, hence reducing the competitiveness of the imposing country's exports. Tariffs on parts and components also increase the final consumer price of final goods in which they are embodied. Similarly, tariffs on final goods deter export of value added of the domestically produced components contained in these imports.

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

Ultimately the effects of the trade war on sectoral value added in the US are highly uneven: among industrial sectors, Iron and steel, Electronics, Machinery or Metal products record sizeable gains, while Chemistry, Other transport equipment, Vehicles, Textile or Food record losses. Consistent with political economy determinants, these twists of value added are transmitted to production factors, leading to sizeable creation and destruction of jobs, and reallocation of capital to the benefit of protected sectors, mostly at the expense of their clients.

By entering into a trade war, the US administration reached its goal to weaken the Chinese economy and protect certain industries, but this comes at a cost for the US economy itself, because GVCs are ubiquitous in most of its sectors. The order of magnitude that we obtain, taking stock of competition on third countries markets, is not negligible: -0.4% of GDP. These results confirm the theoretical intuition that trade wars are costly for all trading partners jointly involved in GVCs.

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Appendix

A. The long term dynamic baseline

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 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 productivity, 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[35]

Capital accumulates according to a permanent-inventory process with a constant deprecation 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

[35] 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.

can fully describe the world economy in projection.

B. Sources for the tariff scenario

B.1. Section 232

We detail below the sources for the US.[36] 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 2018 by two Presidential proclamations (one for aluminum and one for steel), published in the Federal Register of March 15, 2018. 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 March 22, 2018 (published on March 28). At the end of April, two new proclamations updated and detailed these exemptions (proclamations made public on April 30, 2018 and published on the Federal Register on May 5, 2018). In particular, tariffs on imports from Canada, Mexico and the EU finally increased, starting from June 1; Argentina, Brazil and South Korea negotiated voluntary 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.[37]

Following the end of the renegociation of the North American Free Trade Agreement, tariffs imposed by the US to Canada and Mexico (and the resulting retaliatory duties imposed by Canada and Mexico to the US) were removed on May 20, 2019. On the following day, one additional adjustment was made: the additional duties imposed on Turkey were brought back to the level applied to other countries, after they had been increased on August 13, 2018.[38]

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

- March 8, 2018 : https://www.govinfo.gov/content/pkg/FR-2018-03-15/pdf/2018-05477.pdf;
- March 22, 2018 : https://www.govinfo.gov/content/pkg/FR-2018-03-28/pdf/2018-06420.pdf concerning the exemptions;
- April 30, 2018: https://www.govinfo.gov/content/pkg/FR-2018-05-07/pdf/2018-09840.pdf concerning quotas and detailed schedule, when needed;
- May 19, 2019: https://www.govinfo.gov/content/pkg/FR-2019-05-23/pdf/2019-10999.pdf.

For steel:

[36] Official documents of countries other than the US will be provided in the Supplementary materials.
[37] An up-to-date timeline is available at https://piie.com/blogs/trade-investment-policy-watch/trump-trade-war-china-date-guide
[38] https://www.govinfo.gov/content/pkg/FR-2019-05-21/pdf/2019-10759.pdf

- March 8, 2018: https://www.govinfo.gov/content/pkg/FR-2018-03-15/pdf/2018-05478.pdf
- March 22, 2018: https://www.govinfo.gov/content/pkg/FR-2018-03-28/pdf/2018-06425.pdf concerning one missing HS6 product category and exemptions;
- April 30, 2018: https://www.govinfo.gov/content/pkg/FR-2018-05-07/pdf/2018-09841.pdf concerning quotas and detailed schedule, when needed;
- May 19, 2019: https://www.govinfo.gov/content/pkg/FR-2019-05-23/pdf/2019-11002.pdf.

B.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, 2018 the others on August 23, 2018.[39].

As China retaliated against these measures with equivalent additional tariffs on similar values of imports 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, 2018.[40] These duties were initially set to increase to 25 p.p. on March 1, 2019. However, in the first months of 2019, tensions seemed to be contained and the increase was postponed;[41] the two opponents tried to negotiate a truce, but without success, at least in the first instance. As a result, the increase from 10 to 25 p.p. in US tariffs on the USD 200 bn inmports from China took place in May 2019. Again, China retaliated against each move by the US. On September 24, 2018 it increased duties, by 5 to 10 p.p., on around USD 60 bn imports from the US to retaliate against the imposition of additional duties on List 3. On June 1, 2019 China further increased tariffs on a subset, worth USD 35.5 bn, of the USD 60 bn list of September 2018. The resulting additional tariffs were then between 10 to 25 p.p.

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, 2018 (List 1): 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, 2018 (List 2): 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, 2018 (List 3): https://www.govinfo.gov/content/pkg/FR-2018-09-21/pdf/2018-20610.pdf

[39]These two waves correspond to the "List 1" and "List 2", as they are called by the US Trade Representative, see https://ustr.gov/issue-areas/enforcement/section-301-investigations/tariff-actions

[40]The products of this wave of tariffs constitute the "List 3" in the USTR classification.

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

- Increase in the tariffs applied to List 3 on May 9, 2019: https://www.govinfo.gov/content/pkg/FR-2019-05-09/pdf/2019-09681.pdf

For China:

- List of products covered by additional duties entered into force on July 6, 2018: http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201806/P020180616034361843828.pdf
- List of products covered by additional duties entered into force on August 23, 2018: http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201806/P020180616034362364988.pdf
- Lists of products covered by additional duties entered into force on September 24, 2018: http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803_2980950.html
- Lists of products covered by increased additional duties entered into force on June 1, 2019 : http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201905/t20190513_3256788.html

C. Aggregations

Table C.1 – 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
OthTranseq	OthTranseq	otn
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

Table C.2 – 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

Table D.3 – Scenario 1 – Trade value and protection: most impacted bilateral flows of goods for intermediate consumption

Sector	Exporter	Importer	Tariffs (in %)		Trade	Change in prot. rev.
			Reference	Scenario	(USD bn.)	(USD bn.)
Machinery	China	USA	1.6	20.9	44	8.5
Electronics	China	USA	0.3	18.7	25	4.6
Chemistry	China	USA	2.7	21.0	24	4.3
Vehicles	China	USA	1.0	23.5	14	3.1
Metal prod.	China	USA	1.8	23.6	12	2.6
Vehicles	USA	China	14.2	27.1	15	1.9
Chemistry	USA	China	5.1	13.9	19	1.6
Non ferrous met.	USA	China	0.7	16.9	10	1.6
Oilseeds	USA	China	1.5	13.7	13	1.5
Iron and steel	EU27	USA	0.2	19.8	6	1.3
Machinery	USA	China	3.8	14.0	10	1.1
Other manuf. prod.	China	USA	1.4	11.9	10	1.1
Electronics	USA	China	0.4	7.6	14	1.0
Minerals	China	USA	3.0	20.4	6	1.0
Other manuf. prod.	USA	China	2.0	13.2	9	1.0

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index. Sectors are ranked by decreasing impact on tariff revenue.
Source: BACI (2017), MAcMap-HS6, authors' calculation.

D. Additional results

Table D.4 – Scenario 1 – Trade value and protection: most impacted bilateral flows of goods for final consumption

Sector	Exporter	Importer	Tariffs (in %)		Trade	Change in prot. rev.
			Reference	Scenario	(USD bn.)	(USD bn.)
Electronics	China	USA	0.3	11.1	142	15.5
Machinery	China	USA	1.4	16.6	59	9.0
Other manuf. prod.	China	USA	1.6	9.8	59	4.8
Textile	China	USA	11.8	14.7	61	1.8
Machinery	USA	China	4.4	13.1	18	1.6
Chemistry	China	USA	2.9	12.2	13	1.2
Food	China	USA	5.0	24.5	5	1.1
Food	USA	China	10.4	26.3	5	0.8
Metal prod.	China	USA	2.7	13.1	7	0.7
Electronics	USA	China	2.3	11.5	6	0.6
Oth. transp. equip.	China	USA	1.5	24.5	2	0.5
Oth. transp. equip.	USA	EU27	1.7	4.1	17	0.4
Veg. and fruits	USA	China	6.6	27.2	2	0.4
Chemistry	USA	China	3.8	8.3	4	0.2
Other manuf. prod.	USA	China	4.8	10.8	4	0.2
Oth. transp. equip.	USA	China	2.9	4.1	14	0.2

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index. Sectors are ranked by decreasing impact on tariff revenue.
Source: BACI (2017), MAcMap-HS6, authors' calculation.

Table D.5 – Scenario 1 – Changes in bilateral trade, in the US (variations with respect to the baseline, in 2030)

Partner	Exports			Imports		
	Ref. (USD bn)	Diff. (USD bn)	Var. (%)	Ref. (USD bn)	Diff. (USD bn)	Var. (%)
Argentina	14	−0.5	−3.5	8	−0.0	−0.0
Australia	57	−3.2	−5.6	20	1.4	6.8
Brazil	59	−2.4	−4.1	40	1.9	4.9
Canada	335	−5.4	−1.6	491	23.9	4.9
China and Hong-Kong	355	−130.4	−36.7	896	−432.3	−48.3
CIS countries	56	−3.3	−5.9	94	−0.3	−0.3
EFTA	44	−2.5	−5.7	48	3.9	8.1
France	86	−5.0	−5.8	69	6.1	8.8
Germany	132	−6.9	−5.2	121	11.8	9.7
India	50	−3.5	−7.0	137	8.4	6.1
Japan	145	−5.6	−3.9	202	21.6	10.7
Korea	115	−4.6	−4.0	109	13.1	12.0
Latin America	182	−5.2	−2.8	201	8.0	4.0
Mexico	258	0.6	0.2	354	28.9	8.2
Other Oceania	12	−0.6	−5.2	7	0.2	3.3
Rest of ASEAN	154	−4.6	−3.0	242	40.2	16.6
Rest of Asia	83	−3.1	−3.7	126	21.9	17.4
Rest of European Union	320	−15.0	−4.7	281	18.5	6.6
RoW	332	−12.6	−3.8	414	10.0	2.4
UK	150	−8.0	−5.3	113	6.9	6.1

Notes: Variations in the policy scenario, in volume, with respect to the reference scenario, based on a Fisher index.
Sources: MIRAGE-e simulations, author's calculation.

Figure D.1 – Scenario 1 – Impacts on US trade flows (variations with respect to the baseline, in 2030

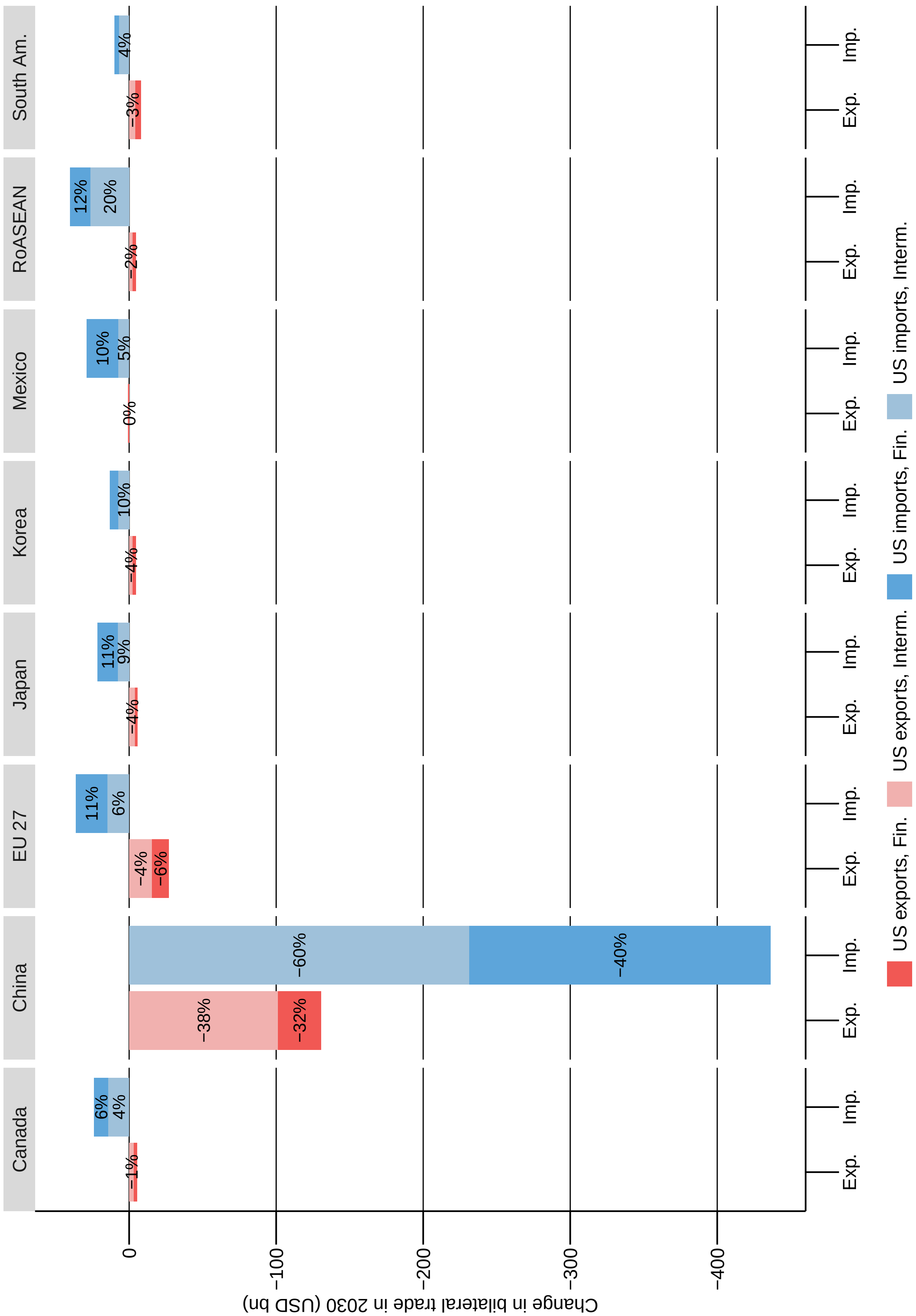

Table D.6 – Scenario 1 – Changes in bilateral trade, in China (variations with respect to the baseline, in 2030)

Partner	Exports			Imports		
	Ref. (USD bn)	Diff. (USD bn)	Var. (%)	Ref. (USD bn)	Diff. (USD bn)	Var. (%)
Argentina	20	1.4	6.9	25	1.9	7.6
Australia	109	4.6	4.2	211	−3.7	−1.8
Brazil	81	5.1	6.3	128	2.0	1.6
Canada	69	8.7	12.6	75	−3.3	−4.4
CIS countries	400	13.9	3.5	297	−3.7	−1.2
EFTA	38	2.6	6.8	42	−2.0	−4.7
France	115	5.4	4.8	62	−2.8	−4.4
Germany	203	9.2	4.5	123	−5.6	−4.5
India	134	7.9	5.9	118	−4.7	−4.0
Japan	319	16.8	5.3	316	−15.3	−4.9
Korea	240	10.8	4.5	327	−16.1	−4.9
Latin America	134	9.0	6.7	141	−3.6	−2.6
Mexico	70	8.2	11.6	23	−2.0	−8.8
Other Oceania	28	1.6	5.8	38	−0.5	−1.4
Rest of ASEAN	507	26.2	5.2	487	−12.1	−2.5
Rest of Asia	197	9.8	5.0	386	−20.9	−5.4
Rest of European Union	522	21.4	4.1	193	−8.3	−4.3
RoW	592	28.3	4.8	835	−7.5	−0.9
UK	139	8.5	6.1	51	−2.8	−5.5
USA	848	−409.5	−48.3	391	−142.3	−36.4

Notes: Variations in the policy scenario, in volume, with respect to the reference scenario, based on a Fisher index.
Sources: MIRAGE-e simulations, author's calculation.

Table D.7 – Scenario 1 – Changes in US bilateral trade, by destination use (final vs, intermediate, variations with respect to the baseline, in 2030)

Partner	Goods for final consumption			Intermediate goods		
	Ref. (USD bn)	Diff. (USD bn)	Var. (%)	Ref. (USD bn)	Diff. (USD bn)	Var. (%)
US Exports						
Argentina	4	−0.2	−4.2	10	−0.3	−3.2
Australia	30	−1.6	−5.5	27	−1.5	−5.6
Brazil	21	−0.9	−4.1	37	−1.5	−4.0
Canada	115	−2.2	−1.9	220	−3.2	−1.4
China and Hong-Kong	90	−29.2	−32.5	266	−101.2	−38.1
CIS countries	33	−2.2	−6.8	24	−1.1	−4.6
EFTA	13	−0.7	−5.3	31	−1.8	−5.9
Rest of European Union	107	−6.0	−5.6	213	−9.1	−4.2
France	29	−2.0	−6.9	57	−3.0	−5.2
Germany	54	−3.5	−6.4	77	−3.4	−4.4
India	18	−1.0	−5.9	33	−2.5	−7.7
Japan	44	−1.8	−4.2	101	−3.8	−3.8
Korea	49	−2.2	−4.4	66	−2.4	−3.6
Latin America	73	−2.7	−3.7	109	−2.5	−2.3
Mexico	87	0.5	0.6	171	0.0	0.0
Other Oceania	7	−0.4	−6.1	5	−0.2	−3.9
Rest of ASEAN	56	−2.3	−4.1	99	−2.3	−2.3
Rest of Asia	28	−1.4	−5.0	55	−1.7	−3.1
RoW	170	−6.8	−4.0	162	−5.8	−3.6
UK	62	−2.8	−4.5	88	−5.2	−6.0
US Imports						
Argentina	2	0.0	2.8	6	−0.0	−0.8
Australia	6	0.5	8.2	13	0.8	6.2
Brazil	11	1.2	10.6	29	0.8	2.7
Canada	166	9.6	5.8	326	14.3	4.4
China and Hong-Kong	511	−204.9	−40.1	384	−231.4	−60.2
CIS countries	11	0.4	3.7	83	−0.7	−0.9
EFTA	22	2.5	11.3	26	1.4	5.4
Rest of European Union	109	10.4	9.6	173	8.1	4.7
France	34	4.0	11.6	35	2.1	6.0
Germany	58	7.0	12.0	63	4.7	7.5
India	50	5.3	10.6	88	3.2	3.6
Japan	121	13.8	11.4	81	7.7	9.4
Korea	37	5.7	15.4	72	7.4	10.2
Latin America	48	1.9	4.0	152	6.0	4.0
Mexico	213	21.4	10.1	141	7.5	5.3
Other Oceania	3	0.1	4.7	4	0.1	2.4
Rest of ASEAN	112	13.9	12.3	130	26.3	20.3
Rest of Asia	56	8.7	15.6	71	13.2	18.8
RoW	52	3.7	7.1	362	6.3	1.7
UK	44	3.9	8.9	69	3.0	4.4

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

Sources: MIRAGE-e simulations, author's calculation.

Table D.8 – Scenario 1 – Changes in production price and value added, by sector, in Germany

	Prod. price	Value Added	
Sector	(%)	(USD bn)	(%)
Anim. Agri	0.1	0.0	0.0
Cereals	0.2	0.1	0.6
Fiber Crops	−0.0	−0.0	−0.6
Food	0.1	0.1	0.1
Oilseeds	0.0	−0.0	−0.2
Oth. Crops	0.1	0.0	0.3
Other Agri	−0.1	−0.0	−0.1
Sugar	0.1	0.0	0.1
Veg. Fruits	0.1	0.0	0.0
Chemistry	0.0	0.7	0.6
Coal	0.1	0.0	0.1
Elec	0.0	−0.0	−0.1
Electronics	0.0	0.2	1.0
Gas	−0.3	−0.1	−0.5
Iron and Steel	−0.1	−0.7	−4.8
Machinery	0.0	0.9	0.4
MetalProd	0.0	0.1	0.1
Minerals	0.0	−0.0	−0.1
NonFer	0.1	0.0	0.3
Oil	−0.1	−0.0	−0.1
Oth. Manuf	0.1	−0.3	−0.4
Trans. eq.	0.0	0.2	1.2
Petroleum	−0.0	−0.0	−0.2
Textile	0.1	−0.2	−0.9
Vehicles	0.0	0.1	0.2
Serv	0.1	0.5	0.0
Transport	0.0	−0.9	−0.5

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

Table D.9 – Scenario 2 – Main aggregate results for selected countries

	USA	China	Canada	Germany	Japan	Korea	Mexico
Total tariff revenue	127.47	8.33	6.37	7.60	22.14	1.47	10.93
Exports	−10.09	−4.03	3.49	0.07	−4.86	−0.41	4.99
GDP	−0.50	−0.54	0.72	−0.04	−0.65	−0.35	0.59
Terms of trade	0.05	−1.11	−0.73	0.11	0.92	0.32	0.65
Real return to capital	0.21	−0.15	−0.20	0.01	−0.03	−0.13	0.33
Real return to land	−5.46	1.12	−0.91	0.30	3.58	0.47	−1.71
Skilled real wages	−0.56	−1.07	0.88	−0.04	−0.79	−0.55	0.76
Unskilled real wages	−0.37	−0.72	0.56	−0.02	−0.56	−0.42	0.33

Notes: Percentage deviation from the baseline in 2030, in volume. Volumes are based on a Fisher index.

Source: MIRAGE-VA, authors' calculation.

Table D.10 – Scenario 3 – Main aggregate results for selected countries

	USA	China	Canada	Germany	Japan	Korea	Mexico
Total tariff revenue	92.48	8.10	3.53	−10.78	0.77	−0.02	8.59
Exports	−6.16	−4.12	1.18	0.61	1.04	−0.05	3.42
GDP	−0.38	−0.56	0.29	0.06	0.12	−0.04	0.35
Terms of trade	0.31	−1.12	−0.03	0.06	0.03	0.28	0.91
Real return to capital	0.21	−0.13	−0.23	−0.02	−0.01	−0.00	0.18
Real return to land	−4.94	1.10	−0.79	0.03	0.07	−0.04	−1.30
Skilled real wages	−0.39	−1.09	0.48	0.13	0.12	0.01	0.43
Unskilled real wages	−0.17	−0.74	0.29	0.13	0.12	−0.01	0.35

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

Table D.11 – Variation in wage bills

	Scenario 1			Scenario 2			Scenario 3		
Sector	Skilled (%)	Unskilled (%)	Total (USD bn)	Skilled (%)	Unskilled (%)	Total (USD bn)	Skilled (%)	Unskilled (%)	Total (USD bn)
Animal prod.	−2.08	−2.25	−0.27	−2.21	−2.33	−0.29	−2.28	−2.50	−0.30
Cereals	−4.00	−4.16	−1.14	−4.95	−5.04	−1.40	−3.96	−4.17	−1.13
Chemistry	−2.15	−2.17	−5.06	−3.00	−2.98	−7.00	−0.56	−0.59	−1.35
Coal	−2.77	−2.94	−0.22	−2.69	−2.79	−0.21	−2.80	−2.99	−0.22
Elec	−0.03	0.14	0.02	0.08	0.33	0.09	0.02	0.15	0.04
Electronics	8.42	8.50	2.46	6.82	6.97	2.01	7.64	7.60	2.22
Fiber crops	−8.40	−8.46	−0.34	−9.57	−9.58	−0.39	−8.88	−8.98	−0.36
Food	−1.34	−1.44	−1.92	−1.63	−1.68	−2.28	−1.47	−1.61	−2.13
Gas	7.67	8.17	0.79	7.67	8.23	0.79	7.36	7.83	0.76
Iron and steel	9.34	9.57	4.29	14.25	14.59	6.54	7.75	7.92	3.55
Machinery	2.10	2.19	8.20	0.89	1.00	3.62	2.10	2.15	8.12
Metal prod	3.68	3.72	4.16	4.78	4.89	5.43	3.94	3.95	4.43
Minerals	−0.23	−0.24	−0.15	−0.15	−0.11	−0.08	−0.29	−0.34	−0.19
Non ferrous met.	−5.28	−5.28	−1.38	−1.39	−1.15	−0.33	−4.06	−4.06	−1.06
Oilseeds	−12.21	−12.27	−2.10	−12.67	−12.67	−2.18	−12.45	−12.55	−2.14
Other crops	−3.44	−3.56	−0.34	−5.15	−5.21	−0.51	−3.71	−3.86	−0.37
Other agri. prod.	−3.89	−4.07	−0.21	−4.10	−4.20	−0.22	−3.96	−4.18	−0.22
Other manuf. prod.	1.19	1.16	3.31	1.21	1.23	3.44	0.99	0.93	2.70
Oth. transp. equip.	−4.62	−4.75	−4.29	−17.49	−17.78	−16.14	−2.71	−2.84	−2.54
Petroleum	−0.08	0.03	−0.03	−0.03	0.15	0.07	0.31	0.39	0.39
Services	0.03	−0.06	0.50	0.07	0.00	4.85	0.01	−0.12	−2.47
Sugar	−1.24	−1.39	−0.01	−1.46	−1.56	−0.01	−1.37	−1.56	−0.01
Textile	−2.05	−2.20	−1.85	−1.19	−1.31	−1.09	−2.71	−2.89	−2.44
Transport	−0.29	−0.31	−0.87	−0.14	−0.09	−0.32	−0.35	−0.46	−1.21
Veg. and fruits	−4.87	−5.16	−0.94	−5.08	−5.32	−0.98	−5.08	−5.41	−0.98
Vehicles	−2.57	−2.69	−2.61	6.51	6.56	6.49	−2.85	−3.01	−2.91

Notes: Percentage deviation from the baseline in 2030.
Source: MIRAGE-VA, authors' calculation.