The impact of trade tensions on Switzerland: A quantitative assessment

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This paper quantifies the impact of trade tensions between the United States and China. Using a general equilibrium Ricardian trade model, it provides a Swiss-centric analysis of two tariff escalation shocks. Counterfactual analysis shows that welfare and trade effects are broadly negative for the United States and China. In contrast, both tariff escalation shocks could lead to a small increase in real GDP in Switzerland. The labor productivity of Swiss manufacturing sectors increases slightly, especially in sectors that are well-connected to China. While trade collapses between the United States and China, Swiss real exports to the United States in selected sectors increase significantly.

JEL codes: gains from trade, tariffs, trade wars
Key words: F10, F11, F14

1 Introduction

After years of deepening trade integration between countries, and relative stability within the multilateral trading system, protectionism has made a noted comeback. The United States has recently introduced trade barriers against selected industries and trading partners (USTR, 2017; 2018a; 2019). In particular, it has actively implemented import tariffs against its largest trading partner, China, prompting waves of retaliation.[2] Growing trade tensions between the two countries have generated significant uncertainty. Academics, policymakers, and international organizations have underlined the potential consequences of these trade tensions. For example, the IMF has warned that tariff increases would hurt trade and, ultimately, macroeconomic outcomes (IMF, 2019). Echoing this assessment, the OECD explained that trade tensions not only hurt the short-term outlook but also the medium-term prospects of the global economy, and has called for rapid government action to reinvigorate growth (OECD, 2019).

This paper proposes a quantitative assessment of the implications of growing trade tensions between the United States and China. Using a general equilibrium

1 Email for correspondence: laurence.wicht@snb.ch. The author thanks Claudia Bernasconi, Pınar Yeşin, and the participants at the 2019 *Aussenwirtschaft* workshop for valuable comments, as well as Jeremias Kläui and Viktória Vidaházy for excellent research assistance. The views expressed in this paper are those of the author and do not necessarily reflect those of the Swiss National Bank. All remaining errors are my own.

2 See, for example, four waves of tariff escalation between the United States and China as published by the US Trade Representative (USTR) and the Chinese Ministry of Commerce (MOFCOM) (MOFCOM, 2018a; 2018b; USTR, 2018b; 2018c).

Ricardian trade model, it provides a Swiss-centric analysis of their welfare and trade effects. To do so, the paper builds on the theoretical framework and calibration approach of Wicht (2019), which calibrates a multi-country multi-sector trade model to study Switzerland's gains from trade.

The theoretical framework follows Caliendo and Parro (2015), who propose an extension of Eaton and Kortum (2002) to study the effects of the North American Free Trade Agreement (NAFTA). The model allows for a rich international production and trade setup. On the production side, the model matches value added and input–output structure at the sector and country level. Production is at constant returns to scale and markets are perfectly competitive. On the trade side, the model matches sectoral trade flows between countries. Trade is shaped by Ricardian forces (technology and costs) and by gravity (trade costs). Departing from Caliendo and Parro (2015), the theoretical framework further allows for endogenous trade balances following Caliendo et al. (2018). Bringing the model to the data, the calibration accounts for 34 countries (including Switzerland) plus a constructed rest of the world, and for 20 sectors (agriculture, manufacturing sectors, and a composite service sector).

The counterfactual analysis studies two tariff shocks. In the first shock, the model evaluates the effects of the tariff escalation between the United States and China as of May 2019. This shock encompasses several tariff waves since 2018, which affect half of the current trade value between the two countries. In the second shock, the model evaluates the effects of an eventual worsening of trade tensions, in which all bilateral tariffs between the United States and China are set to a 25% ad-valorem rate. This second shock thus encompasses an additional bilateral tariff increase, moving from the state of tariffs as of May 2019 to 25% bilateral tariff rates.

The counterfactual analysis studies the welfare and trade effects associated with moving from an initial equilibrium to a counterfactual equilibrium resulting from each tariff shock.[3] Welfare effects, which are broadly designated as gains from trade in the literature, are often the main unit of analysis in quantitative trade papers (Arkolakis et al., 2012; Costinot and Rodríguez-Clare, 2014). Country-level welfare effects are captured by the change in real GDP, while sectoral welfare effects are captured by the change in sectoral labor productivity. Trade effects are useful to illustrate the impact of the tariff shock on key economic indicators, which are often the focus of policy discussions. In particular, this paper focuses on changes in aggregate trade balances and real exports. Although the

3 Note that welfare and trade effects associated with the second shock represent an effect additional to those of the first shock. The counterfactual equilibrium resulting from the second shock is compared to the baseline equilibrium resulting from the first.

main focus of this paper is Switzerland, welfare and trade effects for the United States and China are presented to contrast with those of Switzerland.

Considering welfare effects, the United States and China bear losses following each tariff shock of –0.13% and –0.07%, respectively, for the United States and –0.15% and –0.10%, respectively, for China. The model predicts that aggregate losses are larger for China than for the United States. Sector-level results, however, indicate that Chinese manufacturing sectors tend to have smaller declines in labor productivity compared to US manufacturing sectors. Although the US administration hopes to protect domestic production (USTR, 2018d), the model suggests that US exporting sectors are the hardest hit by the bilateral tariff escalation. Furthermore, the magnitudes of the welfare losses are relatively small. This is not an unusual outcome in this type of model, so it is useful to put the results into perspective. CALIENDO and PARRO (2015) estimate, for example, that the tariff cuts associated with NAFTA led to a +0.11% increase in US real GDP. The model predicts that the first tariff shock more than offsets US gains realized through trade integration with its neighbors. In particular, the model shows that the first shock has the largest effects. An additional tariff escalation would not have as much impact on welfare as the tariffs first implemented.

In contrast to the United States and China, the counterfactual analysis predicts small welfare gains for Switzerland, with real GDP increasing by +0.01% following each shock. Furthermore, each tariff shock leads to modest labor productivity increases in Swiss manufacturing sectors. Labor productivity gains depend, however, on a sector's exposure to the United States and to China. Sectors with a high exposure to China have larger productivity gains, while sectors with a high exposure to the United States tend to have lower productivity gains. The larger productivity losses of US manufacturing sectors thus weigh on Swiss manufacturing sectors. In contrast, Chinese goods remain comparatively competitive and benefit the Swiss sectors with good access to Chinese inputs.

Turning to trade effects, both tariff shocks have a limited impact on aggregate trade balances, but they may significantly alter bilateral trade balances and sectoral trade flows. In particular, trade between the United States and China collapses. China's contribution to the US aggregate trade deficit is halved following each tariff shock. Both countries' real exports also decline, driven by their bilateral trade collapse. While US real exports decline across all trading partners, China's real exports increase across all its non-US trading partners. Chinese exports thus remain competitive towards non-US trading partners, which supply the United States in China's stead. The model thus predicts that while US reliance on Chinese imports decreases, its reliance on other trading partners increases and the US aggregate trade deficit remains intact.

Swiss real exports shift across trading partners and sectors, although they stay stable at the aggregate level. In particular, Swiss real exports to the United States increase. In given sectors, such increases may reach up to 24%. The counterfactual analysis thus suggests that trade tensions between the United States and China affect bystander countries such as Switzerland. The significant trade reallocation between the United States, China, and their trading partners provides challenges and opportunities.

Although the model suggests that Switzerland could slightly benefit from the trade tensions between the United States and China, the results should be interpreted carefully within the scope of the theoretical framework. Model characteristics ground the counterfactual results. The model cannot account for the transition from one steady state to another, which may entail significant frictions and costs. The model also focuses on a single transmission channel of trade shocks on real activity, though other channels – such as uncertainty, business confidence, and investment – may play an important role. In particular, the model cannot account for safe haven pressures, which could result from uncertainty and could negatively impact Switzerland. These aspects could possibly lead to larger effects and offset the small gains of bystander countries such as Switzerland.

This paper is organized as follows. Section 2 situates this paper within the literature. Section 3 gives an overview of the theoretical framework and of the calibration approach. Section 4 details the construction of the two tariff shocks. Section 5 presents the results of the counterfactual analysis. Section 6 concludes.

2 Related literature

This paper builds upon the extensive quantitative literature exploring the impact of trade costs on welfare and the determinants of gains from trade. In particular, the paper first relates to the quantitative general equilibrium Ricardian trade literature (Eaton and Kortum, 2002; Dekle et al., 2008; Caliendo and Parro, 2015) and, within that literature, to the papers focusing on Switzerland (Hepenstrick, 2016; Wicht, 2019). The paper is also broadly related to the extensive literature studying the effects of trade policy. Ossa (2016) and Goldberg and Pavcnik (2016) provide surveys of this literature.

The recent tariff escalation has prompted several studies attempting to quantify its consequences for the global economy. Most contributions seek to quantify the effects of tariff increases using general equilibrium models. For example, the IMF estimates the impact of an illustrative scenario in which tariffs between the United States and China increase by 25%. Such a scenario leads to estimated

GDP losses ranging from 0.3% to 0.6% in the United States and from 0.5% to 1.5% in China (IMF, 2019). Further accounting for uncertainty effects linked to trade, the ECB estimates that, over the medium term, an overall 10% increase in trade barriers (tariff and non-tariff) lowers US GDP by 1.5%, and global trade and global activity by more than 2.5% and 1%, respectively (ECB, 2018; 2019).

Other contributions explicitly study the newly implemented tariffs. Balistreri et al. (2018) use computational models of global trade under assumptions of perfect and monopolistic competition to evaluate the impact of tariffs. They estimate that the welfare cost of the trade tensions for the United States amounts to $124 billion, or around 1% of private consumption. Bellora and Fontagné (2019) rely on a computable general equilibrium (CGE) model accounting for global value chains and imperfect competition. They find GDP losses of 0.4% for China and 0.3% for the United States due to the measures in place as of early January 2019. Caceres et al. (2019) study the potential long-term effects of three illustrative scenarios using a CGE trade model calibrated to 165 countries. They find small negative welfare effects, but large sectoral effects.

The current paper adopts a similar approach to those papers by using a general equilibrium trade model, but relies on a Ricardian framework. The paper is most closely related to Charbonneau and Landry (2018), who use Caliendo and Parro's (2015) model to evaluate the impact of the recent tariff escalation on countries' welfare. Their paper finds moderate effects on long-run aggregate prices and output levels, but significant changes in trade flows and sectoral output reallocations. Felbermayr and Steininger (2019) also propose an analysis of the growing trade tensions, using Caliendo and Parro's (2015) model augmented with an explicit specification of non-tariff trade barriers. They focus on the welfare and trade effects for the European Union and obtain results broadly in line with the findings of Charbonneau and Landry (2018). The current paper differs from these in two aspects. First, it allows for endogenous trade balances, which is particularly relevant given the context of the growing trade tensions between the United States and China. Second, it proposes a Swiss-centric analysis.

Other approaches rely on US import data and import prices to estimate the impact of the newly implemented tariffs on the US economy. Amiti et al. (2019) use disaggregated US import data to estimate the impact of tariffs on prices. They find that the new 2018 import tariffs cost US consumers and US importing firms $3 billion per month in added tax costs and another $1.4 billion per month in deadweight welfare losses. Fajgelbaum et al. (2019) estimate a supply-side model of the US economy to measure the aggregate and regional effects of US and retaliatory tariffs in general equilibrium. They find consumer and producer losses from higher costs of imports of $68.8 billion and an aggregate welfare loss of $7.8 billion.

3 Theory and calibration background

The theoretical framework follows WICHT (2019), which calibrates a multi-country, multi-sector general equilibrium Ricardian trade model to study Switzerland's gains from trade. This section first summarizes the model's main characteristics and mechanisms, then gives an overview of the calibration strategy.[4]

3.1 Theoretical background

The theoretical framework follows CALIENDO and PARRO (2015) and has the following main characteristics. The model is static and in general equilibrium. In this context, counterfactual analysis studies a shock to underlying fundamentals, which induces a new steady state. This new steady state, in which wages and prices have fully adjusted, is compared to an observed initial steady state. Because of its static nature, the model cannot account for the transition to the new steady state, adjustment costs, dynamic or short-term effects.

The model has multiple countries and sectors. There is a finite number of countries N, which may trade between each other. There is a finite number of sectors S. By assumption, sectors are either tradable or nontradable. Tradable sectors, which may export, can be thought of as agriculture or manufacturing sectors. Nontradable sectors, which cannot export, can be thought of as services. The model and its calibration are thus tailored to trade in goods.

The model has a rich production setup, which is able to match value added and input-output structure at the sector and country level. A representative firm combines labor and intermediate inputs following a Cobb-Douglas production function with constant returns to scale. Labor is perfectly mobile across sectors, but perfectly immobile across countries. Consumers receive wages and have Cobb-Douglas preferences, spending a fixed income share on each sector's composite good.

The model is Ricardian. Markets are perfectly competitive, with prices equaling costs. Producers and consumers buy perfectly substitutable goods from the

4 Model derivations and details on the calibration are given in WICHT (2019).

cheapest source. The model thus does not account for idiosyncratic firms, profits, or love of variety, as in a MELITZ (2003) framework. Instead, international trade is driven by technology, production costs, and trade costs. Formally, the trade share of sector *s* from exporting country *i* to importing country *n* follows a gravity equation given by:

$$\pi_{in}^{s} = \frac{T_i^s \left[c_i^s \kappa_{in}^s\right]^{-\theta^s}}{\sum_{k=1}^{N} T_k^s \left[c_k^s \kappa_{kn}^s\right]^{-\theta^s}}, \tag{1}$$

where T_i^s is the technology level, c_i^s are production costs, κ_{in}^s is the iceberg trade cost with $\kappa_{in}^s \geq 1$ if $i \neq n$ and $\kappa_{in}^s = 1$ if $n = i$, and θ^s is the trade elasticity.

As shown in EATON and KORTUM (2002), the technology parameter, T_i^s, and the trade elasticity, θ^s, are parameters of an underlying Fréchet distribution, which governs country-specific and sector-specific productivity draws for the production of goods. The probabilistic representation of productivity draws allows for a closed-form solution of trade shares and aggregate prices. Both parameters may be interpreted through the lens of Ricardian absolute and comparative advantages. A high T_i^s makes productivity draws within a sector on average higher, and a country more likely to export. Thus, the technology parameter can be thought of as the absolute advantage. A low θ^s implies a high productivity dispersion. All else being equal, a high productivity dispersion implies a stronger trade resistance to increases in trade costs. In other words, a high productivity dispersion implies a low trade elasticity. Thus, the dispersion parameter can be thought of as the comparative advantage.

International trade is costly. Bilateral iceberg trade costs of equation (1) are decomposed as:

$$\kappa_{in}^s = d_{in}^s (1 + \tau_{in}^s), \tag{2}$$

where d_{in}^s are non-tariff trade barriers and τ_{in}^s is the ad-valorem tariff rate applied by country *n* on goods of sector *s* from country *i*. Non-tariff barriers include distance and transport costs. Distant countries tend to have higher trade costs, which lower the probability of these countries trading with each other. Trade is thus shaped by gravity.

Within the context of escalating trade tensions between the United States and China, this paper focuses on the tariff component of equation (2). All else being equal, the direct effect of a bilateral tariff increase is to lower the corresponding bilateral trade share. A higher tariff rate makes foreign goods more expensive and thus lowers the likelihood that the foreign country is the cheapest supplier. Tariff increases, however, affect trade shares beyond this direct price effect: they raise input prices. Higher prices in one sector further feed into prices in other sectors through the input-output structure and result in higher output prices, which in turn tend to make exports less competitive. Direct and indirect effects of trade shocks may be studied based on the model's general equilibrium nature and the complex sectoral production structure.

The theoretical framework makes one departure from Caliendo and Parro (2015) in that trade balances, whether surpluses or deficits, are endogenous. Caliendo and Parro (2015) provide a counterfactual analysis of the welfare and trade effects of NAFTA assuming either balanced trade or exogenous trade balances. These assumptions have several disadvantages. First, imposing balanced trade is a strong assumption to put on the data. Indeed, countries may run trade surpluses or deficits. For instance, the US trade deficit amounted to $875 billion in 2018; the Swiss trade surplus amounted to CHF30 billion in 2018, or just above 4% of GDP. Furthermore, reducing the US trade deficit, which largely drives the US current account deficit, has been an objective of the US administration (USTR, 2017; 2018a; 2018d; 2019). The assumption of exogenous trade balances, however, precludes assessing whether tariffs on selected trading partners may significantly affect the US aggregate trade deficit.[5]

Trade balances are modeled following Caliendo et al. (2018). Labor income is not fully used up for consumption but is partly allocated to an international portfolio, which is then redistributed equally across countries. The trade balance – whether a surplus or a deficit – emerges from the difference between receipts from the international portfolio and expenses to it. Because these receipts and expenses depend on wages, trade balances adjust in any counterfactual equilibrium.

The model is solved in relative changes following the "exact hat algebra" method. Dekle et al. (2008) first introduced this method in the context of Ricardian trade models. The counterfactual analysis thus studies the equilibrium change in welfare and trade following tariff shocks, which I describe in the following section.

The counterfactual analysis focuses on welfare and trade effects. Welfare effects are given by the change in real wage, or equivalently the change in real GDP. As shown by Caliendo and Parro (2015), the welfare effect may be decomposed into a final goods effect, an intermediate goods effect, and a sectoral linkages effect. Goods effects capture the change in goods' productivity, while the sectoral

5 Imposing exogenous trade balances is consistent with economic theory within the model's static framework. But this assumption presents other theoretical drawbacks, which are examined in more detail in Wicht (2019).

linkages effect captures relative input price changes across sectors. The aggregate, country-level welfare effects may be decomposed into sectoral effects – they are simply an average of the change in sectoral labor productivity, weighted by consumer expenditure shares. Appendix B details the welfare equation and its decomposition. Trade effects are useful to illustrate the impact of the tariff shock on key economic indicators, which are often the focus of policy discussions. In particular, this paper focuses on changes in aggregate trade balances and real exports.

3.1 Calibration overview

Solving the model in relative changes greatly simplifies the calibration in terms of identification and data requirements. Following a change in fundamentals (for example, tariffs), the equilibrium change in wages and prices can be solved with initial data on trade shares, aggregate trade balances, tariffs, consumer preferences and production function parameters as well as estimates of trade elasticities.

The initial equilibrium is based on 2014 data. The model is calibrated for 34 countries, including Switzerland, and a constructed rest of the world (ROW). There are 20 sectors: 19 are tradable (covering agriculture and manufacturing sectors) and one is a composite nontradable service sector.[6] Initial trade shares are constructed using UN Comtrade bilateral trade data, World Integrated Trade Solution (WITS) tariff data from the World Bank, and OECD Structural Analysis (STAN) production data. Initial trade balances are taken from Comtrade data. The World Input-Output Tables (WIOT) are the main data source for the construction of consumer expenditure shares, sectoral value-added shares, and input-output linkages. Finally, sectoral trade elasticities are taken from Caliendo and Parro (2015).

Input-output tables are central to the model calibration and the counterfactual analysis. The quality of Swiss input-output tables, however, is notably uncertain. The Swiss Federal Statistical Office (SFSO) publishes national input-output tables, but prospective users are warned about their “experimental character”.[7] Instead of using the SFSO tables, the calibration relies on a new dataset that identifies sectoral linkages between Swiss importers and foreign suppliers based on firm-level data from the Swiss Federal Customs Administration (FCA). Based on this new dataset, precise estimates of sectoral linkages between Switzerland and its trading partners are constructed.[8]

6 Appendix A lists the sample countries and the sector classification.
7 See www.bfs.admin.ch/bfs/en/home/statistics/national-economy/input-output.html.
8 This new data source and its characteristics are presented in more detail in Wicht (2019). Note that the WIOT include Switzerland. However, the WIOT are not necessarily a viable alternative data source, as they build on the SFSO tables.

The calibration relies on estimates of trade shares and of sectoral linkages. Such estimates are essential to provide a Swiss-centric analysis of the growing trade tensions between the United States and China, since the tariff shocks may impact Switzerland only indirectly (for instance, through imports or input-output linkages). To illustrate the potential strength of each channel, Figure 1 highlights the exposure of Swiss sectors to US and Chinese trade. These figures are consistent with the model calibration.

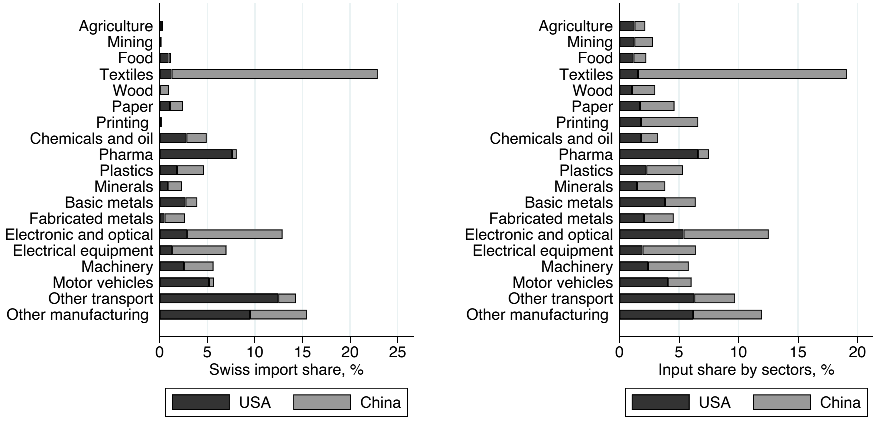
Although the United States and China are not Switzerland's main trading partners, they still account for a significant share of Swiss imports. Figure 1a reports Swiss import shares from US and Chinese sectors, consistent with equation (1). The US manufacturing transport industries (motor vehicles and other transport) have relatively high trade shares with Switzerland (5.2% and 12.5%, respectively). The US other manufacturing and pharmaceutical industries similarly have high trade shares with Switzerland (9.5% and 7.6%, respectively). Chinese exports to Switzerland are concentrated in two sectors: textiles, and electronic and optical instruments (with trade shares of 21.6% and 10%, respectively).[9] Overall, Figure 1a suggests that Switzerland imports most US and Chinese goods from a limited number of sectors, and at different intensities.

Through input-output linkages, imports from the United States and China are distributed to all Swiss sectors. It is possible to go one step beyond Swiss import shares, and construct the input shares from the United States and China for Swiss sectors based on sectoral linkages. These input shares are calculated as the spending share allocated by Swiss sectors on manufacturing goods produced in the United States or China.[10] It is immediately apparent that there is a positive correlation between Swiss aggregate import shares (Figure 1a) and Swiss sectors' input shares (Figure 1b). This follows from the large diagonal entries of input-output tables, with Swiss sectors buying most inputs from their own sector. Nevertheless, all Swiss sectors have at least some exposure to US and Chinese goods. The cumulated input shares range from 2.1% in the agricultural sector to 19.1% in the textile industry. The counterfactual analysis examines how these aspects of Swiss exposure to US and Chinese trade translate into sectoral welfare effects.

9 A large import share is not necessarily equivalent to a large trade value. For example, the US electronic and optical sector has a relatively small trade share with Switzerland (2.9%) but accounts for 12.1% of total Swiss imports from the United States.

10 Formally, the input share of Swiss sector k corresponds to $\Sigma_{s=1}^{S} \pi_{in}^{s}\ \rho_{n}^{sk}$, where the importing country n is Switzerland, the exporting country i is either the United States or China, and ρ_{n}^{sk} is the share of inputs bought by sector k of country n from sector s.

Figure 1: Swiss exposure to US and Chinese trade



(a) Swiss import share (b) Sectoral input share

Notes: Figure (a) reports the Swiss import share (in percent) from US and Chinese sectors. This import share corresponds to the trade share π_{in}^{s} as defined in equation (1), where the importing country n is Switzerland and the exporting country i is either the United States or China. Figure (b) reports the input share, in percent, of Swiss sectors allocated on goods produced in the United States and China. The input share of Swiss sector k corresponds to $\Sigma_{s=1}^{S}\pi_{in}^{s}\,\rho_{n}^{sk}$, where the importing country n is Switzerland, the exporting country i is from sector s.

Sources: SNB, UN Comtrade, OECD STAN, own calculations.

4 Constructing the tariff shocks

The previous section outlined the theoretical framework and calibration approach, which are the basis for the evaluation of the counterfactual equilibrium resulting from any tariff change between sample countries. The counterfactual analysis focuses on the tariff escalation between the United States and China. Specifically, I solve for the counterfactual equilibrium resulting from two tariff shocks: (1) the tariff escalation between the United States and China as of May 2019, and (2) a hypothetical additional tariff escalation between the United States and China of all bilateral tariffs to 25%. This section describes the construction and magnitude of each tariff shock.

I solve for the change in trade costs using equation (2). Formally, I construct an $N \times N$ matrix of the change in trade costs $\hat{\kappa}_{in}^{s}$ for each sector $s = 1, \ldots, S$, given by:

$$\hat{\kappa}_{in}^{s} = \frac{1+\tau_{in}^{s\,\prime}}{1+\tau_{in}^{s}}, \tag{3}$$

where τ_{in}^{s} is the initial 2014 (trade-weighted) tariff rate applied by country n on goods of sector s from country i and $\tau_{in}^{s'}$ is the counterfactual tariff resulting from the tariff shock. If countries are not directly involved in the tariff escalation or if $i = n, \hat{\kappa}_{in}^{s} = 1$ since the counterfactual tariff is equal to the initial one. In contrast, if countries are involved in the tariff escalation, then the counterfactual tariff is higher than the initial tariff, i.e., $\tau_{in}^{s'} > \tau_{in}^{s}$, which in turn implies that the trade cost increases, i.e., $\hat{\kappa}_{in}^{s} > 1$.

Equation (3) has two characteristics that should be underlined. First, it is defined for some sector s. Tariff shocks are thus constructed at the sector level.[11] Tariffs, however, are defined at a much finer level of aggregation. Within a sector, goods may be subjected to a wide range of tariffs. To account for this higher level of aggregation, initial sectoral tariffs are constructed as the trade-weighted average of tariff headings within a sector. Trade weights are based on 2014 trade data. Counterfactual tariffs are constructed keeping trade weights fixed. Second, equation (3) shows that, by assumption, trade tensions only have an effect through tariffs. Non-tariff trade barriers – that is, d_{in}^{s} in equation (2) – are unchanged.

4.1 Shock 1: The tariff escalation between the United States and China as of May 2019

Bown and Kolb (2018) keep a detailed, up-to-date record of the newly introduced US trade barriers. They identify several “battles” of the growing trade tensions in which the US administration focuses on specific industries or trading partners. In some of these “battles”, measures have already been implemented. For example, the US administration has imposed safeguard tariffs on solar panel and washing machine imports, arguing that such imports have harmed US domestic production (USTR, 2019). The US administration further invoked national security concerns to impose tariffs on steel and aluminum imports. In retaliation, several countries – including China, the European Union, and Canada – have imposed tariffs on US goods. In other “battles”, concrete measures have not yet materialized. For example, the US administration has made repeated threats to impose tariffs on automobile products.

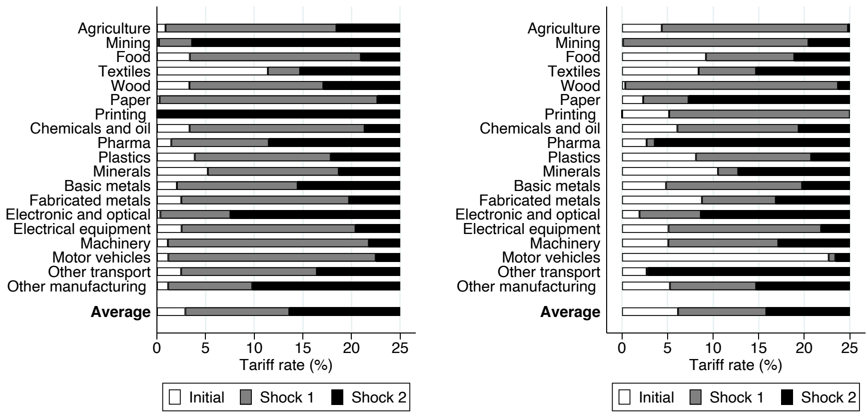
The US administration’s measures cover a wide range of products and trading partners. However, this paper focuses on a single “battle” which is perhaps the most striking in terms of magnitude and intensity, namely, the measures against China. Starting in August 2017, the USTR initiated an investigation into Chinese trade practices, in particular regarding technology and intellectual property

11 Details on the tariff shock construction are given in Appendix A.

practices. The investigation's conclusions gave grounds for the United States to impose tariffs on Chinese exports, and by August 2018, tariffs on $50 billion of Chinese exports, mainly intermediate and capital goods, were implemented. In retaliation, China imposed tariffs on a similar amount of US exports. However, the measures were not deemed sufficient, and tariffs on an additional $200 billion of Chinese exports – first subjected to a 10% ad-valorem rate and then to a 25% rate – were implemented. Again, China retaliated, imposing tariffs on an additional $60 billion of US exports. As of May 2019, this tariff escalation affected around half of the 2018 bilateral trade value between the two countries.

The first shock aims to evaluate the welfare and trade effects of the tariff escalation between the United States and China as of May 2019. To do so, the shock is built using the targeted product lists published by the USTR and by the Chinese Ministry of Commerce (MOFCOM).[12] Figure 2 summarizes the extent of this first tariff shock.

Figure 2: Tariff shocks



(a) US tariffs on Chinese exports (b) Chinese tariffs on US exports

Notes: This figure shows the (trade-weighted) average tariff applied by (a) the United States on Chinese exports; and (b) China on US exports, in the initial year, after the first tariff shock (reflecting the tariff hike between the United States and China as of May 2019), and after the second tariff shock (all bilateral tariffs to 25%). Trade weights are fixed to 2014.

Sources: USTR, MOFCOM, UN Comtrade, OECD STAN, World Bank WITS, own calcualations.

12 The links for each tariff wave are reported in the references (USTR, 2018b; 2018c; MOFCOM, 2018a; 2018b). Table A.1 gives more details on each tariff wave.

On the US side, the magnitude of the first tariff shock is significant. Figure 2a shows the initial and new tariffs applied by the United States on Chinese exports. Overall, initial US tariffs on Chinese exports are relatively low: the aggregate (trade-weighted) average tariff is 2.9%. With the exception of textiles and minerals, average tariffs are below 4% in all sectors. Following the first tariff shock, the aggregate average tariff increases by 10.7 percentage points, from 2.9% to 13.6%. Tariff increases at the sector level, however, are heterogeneous. For example, tariffs increase by more than 20 percentage points in three sectors (machinery, motor vehicles, and paper), while they increase by less than 5 percentage points in three other sectors (printing, mining, and textiles). Furthermore, Chinese sectors that account for most exports to the United States do not necessarily bear the largest tariff increases. For instance, the electronic and optical industry, the largest Chinese exporting sector to the United States (accounting for 18% of 2014 exports), is subjected to a 7.2 percentage point tariff increase. Textiles, the second largest Chinese exporting sector to the United States (15% of 2014 exports), are subjected to a 3.3 percentage point tariff increase.

On the Chinese side, the magnitude of retaliatory measures is similar to that of the United States. Figure 2b shows the initial and new import tariffs applied by China on US exports. Initial Chinese tariffs on US exports are higher than initial US tariff rates: the aggregate average tariff is 6.1%. At the sector level, US exports are initially taxed with tariff rates ranging from 1% in the mining and wood industries to 22.7% in the motor vehicles industry. Following the first tariff shock, the aggregate average tariff rate increases by 9.7 percentage points, from 6.1% to 15.8%. Again, sectoral exposure varies. The smallest tariff increases are applied to the motor vehicles and other transport industries (less than 1 percentage point), while the largest tariff increases are applied to the wood industry and to the agricultural sector (23.3 and 20.4 percentage points, respectively). In contrast to the United States, China has placed an emphasis on one of the main US exporting sectors: the agricultural sector, the second-largest exporting sector to China (accounting for 15.3% of 2014 exports), is subjected to one of the largest tariff hikes.

In conclusion, both US and Chinese import tariffs increase on average by a similar magnitude of around 10 percentage points. However, at the sector level, tariff increases are heterogeneous. The US and Chinese administrations have focused on different types of exports. The United States has applied tariffs on a large product range across manufacturing sectors, targeting mostly intermediate and capital goods. China, on the other hand, has notably targeted US agricultural exports. The main export category between the United States and China, electronic and optical equipment, is relatively spared by the first tariff shock.

4.2 Shock 2: A hypothetical additional tariff escalation between the United States and China (all bilateral tariffs to 25%)

In parallel with the tariff escalation, the United States and China have conducted talks to reach a bilateral trade agreement. So far, the talks have been unfruitful, with truce periods disrupted by announcements of additional tariffs and calls for stronger measures. Since May 2019, the situation has evolved. For instance, the United States has announced plans to implement tariffs on an additional $300 billion of Chinese exports. In response to this announcement, China has promised to retaliate. Part of this tariff wave was implemented by early September 2019. Furthermore, trade tensions have spilled over into other aspects of their bilateral economic relationship. For instance, the US administration has introduced sanctions against the Chinese multinational ICT company, Huawei, restricting its access to the US market.

Given these developments, the second tariff shock aims to capture worsening trade tensions. It considers a scenario in which the US and Chinese administrations enforce their threats and implement 25% tariffs on all bilateral trade between the two countries. Figure 2 reports the additional tariff increase such that all bilateral trade between the two countries is subject to a 25% tariff rate. Note that the second tariff shock takes the levels of bilateral tariffs after the first tariff shock as the baseline.

On the US side, the magnitude of the second shock is slightly larger than the first: the aggregate average tariff on Chinese exports increases by 11.4 percentage points (from 13.6% to 25%), compared to 10.7 percentage points following the first tariff shock. Sectors that were relatively spared by the first tariff shock see the largest tariff increases. For instance, the tariff on the electronic and optical industry increases by 17.4 percentage points. Sectors that were targeted in the first tariff shock, on the other hand, bear smaller tariff increases (around a 3 percentage point increase for the machinery, motor vehicles, and paper industries).

On the Chinese side, the magnitude of the second shock is slightly smaller than the first: the aggregate average tariff on US exports increases by 9.2 percentage points (from 15.8% to 25%), compared to 9.7 percentage points following the first tariff shock. Compared to the United States, China has less room to maneuver. Because of China's initially higher tariff rates, the second tariff shock is smaller at the aggregate level compared to the United States.

Overall, both tariff shocks are associated with significant tariff increases for both countries. However, there is significant heterogeneity at the sector level. In the next section, I evaluate the welfare and trade effects of both tariff shocks.

5 Quantifying the impact of trade escalations

This section presents the counterfactual analysis, in which I solve for the equilibria resulting from the tariff shocks presented in Section 4. I first evaluate the counterfactual equilibrium associated with the observed tariff escalation between the United States and China as of May 2019 (the first shock). I compare this counterfactual equilibrium to the initial equilibrium calibrated to 2014 data. Then I evaluate the counterfactual equilibrium associated with a hypothetical additional tariff escalation between the United States and China (the second shock, which sees all tariffs set to 25%). I compare this counterfactual equilibrium to the equilibrium resulting from the first shock. Welfare and trade effects thus represent additional effects associated with the second tariff shock, rather than the combined effect of both shocks.

In this section, I first present the aggregate welfare effects and their decomposition, as well as sectoral results. I then examine aggregate and bilateral trade effects, as well as changes in real exports across countries and selected sectors.

5.1 Welfare effects

The United States and China bear welfare losses following the first tariff shock; Switzerland sees a small welfare gain. As shown in column (1) of Table 1, the model predicts the largest decline in real GDP for China (–0.15%) and a slightly smaller decline in real GDP for the United States (–0.13%). Comparatively, other countries are relatively unaffected by the tariff escalation, although small welfare gains are possible. For instance, real GDP increases by +0.01% in Switzerland. NAFTA countries (i.e., Canada and Mexico) profit from the tariff escalation, with real GDP increasing by +0.03%.[13] NAFTA countries thus benefit from their proximity to the United States and their preferential trade agreement. Overall, however, the tariff escalation has negative implications, with world real GDP declining by –0.05%.

13 For groups of countries, I report GDP-weighted averages of changes.

Table 1: Welfare effects

	Shock 1				Shock 2			
Country	**Total**	**Final Goods**	**Intermediate Goods**	**Sectoral Linkages**	**Total**	**Final Goods**	**Intermediate Goods**	**Sectoral Linkages**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States	-0.13	-0.05	-0.07	-0.01	-0.07	-0.05	-0.06	0.03
China	-0.15	-0.03	-0.09	-0.03	-0.10	-0.03	-0.08	0.01
Switzerland	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
EU	0.01	0.00	0.00	-0.00	0.01	0.00	0.00	-0.00
NAFTA	0.03	0.01	0.03	-0.00	0.02	0.01	0.02	-0.00
Asia	0.01	0.00	0.01	-0.00	0.01	0.00	0.01	-0.00
Emerging	-0.00	-0.00	-0.01	0.00	0.01	-0.00	0.00	0.00
Other AEs	-0.01	-0.00	-0.01	-0.00	-0.01	-0.00	-0.01	-0.00
World	-0.05	-0.01	-0.03	-0.01	-0.02	-0.01	-0.02	0.01

Notes: This table reports the welfare change, in percent, measured by the change in real wage (real GDP), associated with each tariff shock. It further reports the decomposition of the welfare effects into the final goods, intermediate goods, and sectoral linkages effects. Appendix B details the welfare equation and its decomposition. The counterfactual equilibrium resulting from the first shock is compared to the initial calibrated equilibrium based on 2014 data. The counterfactual equilibrium resulting from the second shock is compared to the counterfactual equilibrium resulting from the first shock. I report GDP-weighted averages of the changes for groups of countries. EU comprises all EU countries of the sample; NAFTA (MEX, CAN); Asia (JPN, KOR, IND, IDN); Emerging (BRA, RUS, TUR, ROW); Other AEs (NOR, AUS).

Goods and sectoral linkages effects all contribute to welfare changes. Columns (2) to (4) report the welfare decomposition into the final goods effect, intermediate goods effect, and sectoral linkages effect. Following the first tariff shock, the decline in US and Chinese real GDP is mostly driven by the intermediate goods effect (–0.07% and –0.09%, respectively) and to a lesser extent by the final goods effect (–0.05% and –0.03%, respectively). Although the model predicts a larger aggregate welfare loss for China, the first tariff shock impacts US consumers more than Chinese consumers. Sectoral linkages contribute slightly to the welfare decline in the United States and China (–0.01% and –0.03%, respectively). Productivity losses in some sectors thus spill over to other sectors through input-output linkages, driving aggregate welfare losses. In line with the United States and China, the intermediate goods effect drives the slight welfare gains of Switzerland and NAFTA countries.

The United States and China bear additional losses following the second tariff shock, while Switzerland still benefits marginally. Column (5) shows the welfare change associated with an additional increase in bilateral tariffs. As with the first tariff shock, China has the largest decline in real GDP (–0.10%) and the United States has the second largest decline (–0.07%). The welfare gains for other countries tend to be smaller. Switzerland and NAFTA countries benefit marginally, with increases in real GDP of +0.01% and +0.02%, respectively. The overall welfare effect remains negative, with world real GDP declining by –0.02%.

In contrast to the first tariff shock, goods and sectoral linkages effects may offset each other following the second tariff shock. Columns (6) to (8) further report the welfare decomposition in the final, intermediate, and sectoral linkages effects. As with the results associated with the first shock, changes in real GDP due to the second tariff shock are mostly driven by the intermediate goods effect. For instance, intermediate goods effects in the United States and China are almost as large as their aggregate respective welfare losses, at –0.06% and –0.08%, respectively. Sectoral linkages, however, attenuate the welfare losses (+0.03% and +0.01% for the United States and China, respectively). This result suggests that smaller changes in input prices in some sectors mute the productivity losses in other sectors.

Overall, the first tariff shock generates the largest welfare effects. Even if the tariff escalation were to worsen between the United States and China, it would not have as much impact on welfare as the tariffs that were implemented first. Nevertheless, the welfare effects are small overall. In light of these results, it is important to make three remarks. First, it is known that welfare effects associated with changes in trade barriers are typically small in this type of model.

For instance, Caliendo and Parro (2015) find that tariff cuts associated with NAFTA lead to a +0.11% increase in US real GDP. Within the scope of the model, the first tariff shock would entirely offset the welfare gains realized by the United States through trade integration with its neighbors, Canada and Mexico. Second, the welfare effects of the tariff escalation are grounded by the theoretical model. Its static nature and its focus on goods trade, without consideration of investment or uncertainty, limit the transmission channels of the trade shock. Third, although the welfare effects are relatively small, I show that the trade effects, especially at the sector and bilateral country levels, may be significant.

5.2 Sectoral labor productivity effects

Compared to China, US manufacturing sectors bear larger productivity losses; Swiss manufacturing sectors exhibit small productivity gains. Table 2 reports the change in sectoral labor productivity for these three countries. Following the first tariff shock, labor productivity decreases in all US sectors. The electrical equipment, machinery, and electronic and optical sectors bear the largest losses (−1.96%, −1.50%, and −1.46%, respectively). Similarly, labor productivity decreases in all Chinese sectors. Compared to the United States, however, losses tend to be smaller. The other manufacturing sector loses the most (–0.89%). Labor productivity in the electronic and optical sector sees the second largest decrease (–0.47%). In contrast, Swiss labor productivity increases in all sectors with the exception of the other transport industry. Productivity increases by up to +0.2% in the textile industry.

Consistent with the aggregate results, sectoral labor productivity changes resulting from the second tariff shock are smaller than those associated with the first shock. They also show broadly similar patterns. On average, labor productivity in US sectors declines more than in Chinese sectors. The US textiles, other manufacturing, and electronic and optical sectors have the largest losses (−1.80%, −1.38%, and −1.05%, respectively). On the Chinese side, the other transport industry is the only sector with a productivity loss greater than 1%. Labor productivity declines in all Chinese sectors, while two US sectors see productivity gains: the chemical and oil (+0.02%) and mining industries (+0.04%). On the Swiss side, labor productivity increases in all sectors, with the exception of the other transport industry. The textiles industry sees the largest increase in productivity (+0.15%).

Table 2: Sectoral labor productivity effects

Sector	Shock 1			Shock 2		
	US	China	Switzerland	US	China	Switzerland
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture	-0.09	-0.22	0.04	-0.00	-0.06	0.03
Mining	-0.02	-0.21	0.09	0.04	-0.15	0.05
Food	-0.19	-0.19	0.04	-0.02	-0.08	0.03
Textiles	-0.68	-0.16	0.20	-1.80	-0.09	0.15
Wood	-0.46	-0.20	0.04	-0.08	-0.08	0.03
Paper	-0.26	-0.26	0.05	-0.05	-0.16	0.04
Printing	-0.15	-0.16	0.02	-0.12	-0.10	0.01
Chemicals and oil	-0.16	-0.31	0.06	0.02	-0.18	0.04
Pharma	-0.11	-0.17	0.01	-0.03	-0.23	0.00
Plastics	-1.03	-0.28	0.06	-0.37	-0.15	0.05
Minerals	-0.73	-0.15	0.04	-0.23	-0.12	0.03
Basic metals	-0.33	-0.21	0.06	-0.11	-0.14	0.05
Fabricated metals	-0.61	-0.20	0.04	-0.09	-0.13	0.04
Electronic and optical	-1.46	-0.47	0.07	-1.05	-0.34	0.06
Electrical equipment	-1.96	-0.27	0.07	-0.07	-0.16	0.06
Machinery	-1.50	-0.36	0.05	-0.12	-0.24	0.05
Motor vehicles	-0.52	-0.23	0.04	-0.04	-0.18	0.05
Other transport	-0.43	-0.27	-0.02	-0.18	-1.39	-0.01
Other manufacturing	-1.26	-0.89	0.07	-1.38	-0.63	0.05
Services	-0.06	-0.09	0.01	-0.02	-0.07	0.01

Notes: This table reports the percentage change in sectoral labor productivity associated with the tariff shocks for the United States, China, and Switzerland. See Appendix B for a formal derivation of the sectoral labor productivity change. The counterfactual equilibrium resulting from the first shock is compared to the initial calibrated equilibrium based on 2014 data. The counterfactual equilibrium resulting from the second shock is compared to the counterfactual equilibrium resulting from the first shock.

Sector-level productivity losses can be significantly larger than aggregate welfare losses. This result is implied by the data and the calibration: consumers have small expenditure shares on those sectors with the highest losses. For instance, consumers spend most of their income on services (i.e., on nontradable goods). However, productivity changes in the nontradable sector are relatively small; trade shocks mainly impact the service sector's productivity through input-output linkages, which are not the main driver of welfare changes. In other words, the largest effects of trade shocks are found in tradable sectors, but they are muted at the aggregate level because of the low consumer expenditure shares on those sectors.

Country-specific consumer expenditure shares thus contribute to the lower aggregate US welfare losses compared to China, and the lower gains for Switzerland. Indeed, large consumer expenditure shares on nontradable sectors are especially prevalent in advanced economies: the calibration suggests that Swiss and US consumers spend only 16% of their income on tradable goods. In emerging market economies, this feature is still significant but less prominent: Chinese consumers spend 44% of their income on tradable goods. Thus, compared to China, the relatively larger share of consumer spending on services drives the lower US aggregate welfare losses, despite higher productivity losses in manufacturing sectors. Sector-level results are thus useful for shedding light on these underlying mechanisms. Considering the Swiss case, the large spending share on nontradable goods, and the service sector's low productivity gains, explain the small aggregate welfare gains.

5.3 Heterogeneous sectoral outcomes in Switzerland

The exposure of Swiss sectors to the United States or China is associated with heterogeneous sectoral outcomes. Table 3 shows how sectoral productivity gains vary depending on this exposure. In other words, it evaluates the impact of the import prices and input-output linkages channels as detailed in Figure 1.

Swiss sectoral outcomes are shaped by import shares from the United States and China. Panel (a) first relates the productivity gains of Swiss sectors and the aggregate Swiss import shares from US and Chinese sectors as seen in Figure 1a. It reports the productivity gains of Swiss sectors in the bottom 20%, median, and top 20% in terms of import shares from the United States and China. The results suggest that if a sector has a large import share from the United States, it exhibits lower productivity gains. This feature holds after both tariff shocks. In contrast, where Switzerland has a large sectoral import share from China, then this sector exhibits higher productivity gains. Again, this feature holds after both tariff shocks. Overall, the results suggest that the productivity losses of US sectors weigh on Switzerland, while Chinese goods remain competitive.

Similarly, Swiss sectoral outcomes depend on their reliance on US and Chinese inputs. Panel (b) reports the productivity gains of sectors in the bottom 20%, median, and top 20% in terms of input shares from the United States and from China, as seen in Figure 1b. There is some evidence that the sectors relying most on US inputs have lower productivity gains following the first shock, while the effect largely disappears following the second shock. Nevertheless, Panel (b) shows that the opposite effect for China still holds: sectors with the largest input shares from China exhibit larger productivity gains. Following each tariff shock, Chinese goods remain relatively productive and Swiss sectors with access to such goods thus tend to have greater productivity gains. These results illustrate the differential effects of the tariff shocks on a third-party country: Swiss sectors exposed to the United States tend to gain less than those exposed to Chinese sectors.

Table 3: Productivity gains for Swiss sectors and exposure to the United States and China

Panel (a): sectoral productivity changes across import shares

	Shock 1			**Shock 2**		
	Bottom 20%	**Median**	**Top 20%**	**Bottom 20%**	**Median**	**Top 20%**
	(1)	(2)	(3)	(4)	(5)	(6)
US	0.04	0.04	0.03	0.03	0.04	0.02
China	0.04	0.06	0.11	0.02	0.04	0.08

Panel (b): Sectoral productivity changes across input shares

	Shock 1			**Shock 2**		
	Bottom 20%	**Median**	**Top 20%**	**Bottom 20%**	**Median**	**Top 20%**
	(1)	(2)	(3)	(4)	(5)	(6)
US	0.05	0.05	0.02	0.04	0.04	0.01
China	0.03	0.05	0.09	0.02	0.04	0.07

Notes: Panel (a) reports the labor productivity changes of Swiss sectors in the bottom 20%, median, and top 20% in terms of import shares from the United States and from China. Panel (b) reports the labor productivity changes of Swiss sectors in the bottom 20%, median, and top 20% in terms of input shares from the United States and from China. Sectoral import shares and input shares are as reported in Figure 1. Sectoral real labor productivity changes are as reported in Table 2. See Appendix B for a formal derivation of the sectoral labor productivity change. The counterfactual equilibrium resulting from the first shock is compared to the initial calibrated equilibrium based on 2014 data. The counterfactual equilibrium resulting from the second shock is compared to the counterfactual equilibrium resulting from the first shock.

5.4 Aggregate trade effects

Each tariff shock implies little rebalancing at the country level. In particular, the US trade deficit is stable. Table 4 reports trade deficits in the initial equilibrium and following the first two tariff shocks. Following the first and second shocks, the US trade deficit declines by –0.01 and –0.02 percentage points, respectively. The model thus suggests that trade policy applied to a single trading partner cannot effectively reduce an aggregate trade deficit.

If anything, the model suggests that the tariff escalation has a greater impact on the Chinese trade surplus: following the first and second tariff shocks, it declines by –0.13 and –0.1 percentage points of GDP, respectively. Similarly, the trade deficit of NAFTA countries declines by –0.07 and –0.05 percentage points of GDP following the first and second shock, respectively, while the trade deficit of Asian countries declines by –0.04 percentage points of GDP following each tariff shock. In comparison, the Swiss trade surplus increases only marginally, by +0.01 percentage points of GDP. Total balances remain stable: the sum of deficits across all countries as a percent of world GDP declines by –0.01 percentage points following each tariff shock.

Table 4: Aggregate trade effects

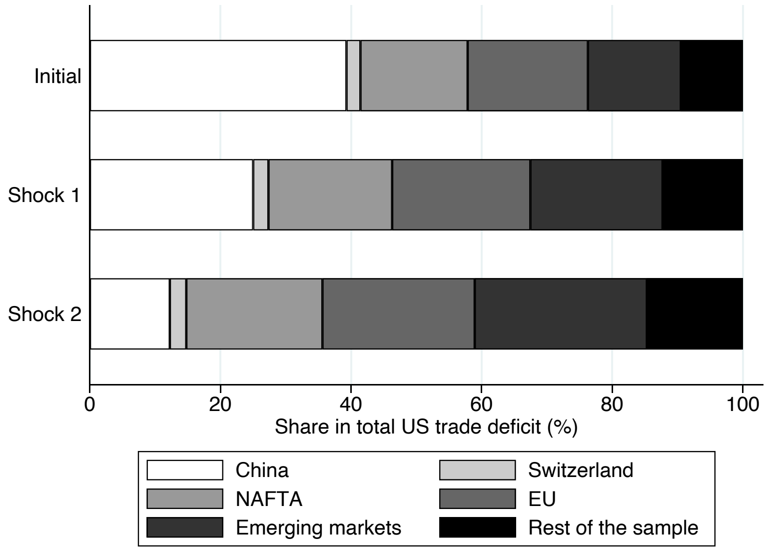
	Trade deficit, % of GDP		
	Initial	**Shock 1**	**Shock 2**
Country	(1)	(2)	(3)
United States	3.84	3.83	3.81
China	-7.10	-6.97	-6.87
Switzerland	-3.51	-3.52	-3.53
EU	-0.19	-0.20	-0.21
NAFTA	1.35	1.28	1.23
Asia	1.96	1.92	1.88
Emerging	-0.69	-0.73	-0.76
Other AEs	-0.94	-0.94	-0.94
World	1.99	1.98	1.97

Notes: This table reports the trade deficit in percent of GDP under the initial equilibrium, and under the counterfactual equilibria resulting from the first and second shocks. A trade deficit (surplus) is associated with a positive (negative) number. The world aggregate deficit is the sum of all deficits in percent of world GDP. EU comprises all EU countries of the sample; NAFTA (MEX, CAN); Asia (JPN, KOR, IND, IDN); Emerging (BRA, RUS, TUR, ROW); Other AEs (NOR, AUS).

5.5 Bilateral trade effects

There is little rebalancing at the country level. However, the tariff escalation between the United States and China may impact bilateral trade balances significantly. In particular, while the US measures do not succeed in reducing the aggregate US trade deficit according to the model, this does not mean that the tariffs against China have no impact on US trade. Figure 3 shows the composition of the US trade deficit across major trading partners in the initial equilibrium and under the counterfactual equilibria. Under the initial equilibrium, China accounts for 40% of the US bilateral trade deficit. The model predicts that the first tariff shock reduces China's share in the US trade deficit by almost half, from 40% to 22%. The second tariff shock leads to a further significant reduction of China's share in the US trade deficit (to 12%). Increases in the shares of emerging markets, the EU, and NAFTA countries compensate for the loss of China as the first US trading partner. Switzerland's weight among US trading partners remains stable: it contributes to around 2% of the US aggregate deficit.

Figure 3: Bilateral trade effects



Notes: This figure shows the US trade deficit's decomposition across trading partners under the initial equilibrium, as well as under the counterfactual equilibria resulting from the first and second tariff shock. Countries are grouped as: NAFTA (CAN, MEX); EU (European Union countries of the sample); Emerging markets (BRA, RUS, TUR, ROW); Rest of the sample (JPN, KOR, IND, IDN, AUS, NOR).

5.6 Real exports

Despite relatively small aggregate welfare and trade effects, tariff shocks may lead to a significant trade reallocation between trading partners. To illustrate this mechanism, I now consider the change in real exports across countries and sectors, which are reported in Table 5.

While US real exports decline across all trading partners, Chinese real exports decline only to the United States; Swiss real exports to the United States increase. As shown in Panel (a), worldwide US real exports decline by −6.8% following the first tariff shock. This decline is largely driven by a significant decrease in real exports to China (–50.4%), but US real exports further decline across all other trading partners (for instance, −1.6% to Switzerland and −2.1% to EU countries). Similarly, worldwide Chinese real exports decline (–4.9%), driven by the decrease in real exports to the United States (–40.8%). Unlike the United States, however, Chinese real exports to their other trading partners increase (for instance, +5.8% to NAFTA countries and +3% to Switzerland). Thus, although welfare effects are larger in China than the United States, looking at real exports suggests that trade effects could be larger in the United States than in China. In particular, while China may divert some of its exports to other trading partners, US exports decline across all trading partners. Beyond the United States and China, total real exports of other countries see smaller changes. They range from a +0.2% increase in Switzerland to a +1.5% increase in NAFTA countries. Across trading partners, however, real exports may see larger changes. In particular, real exports to the United States increase across all exporters to compensate for the decline in Chinese real exports. Swiss real exports to the United States increase by +5.6%.

Sector-level real exports may see larger effects. Panel (b) reports the change in real exports across countries in the electronic and optical sector. This sector is of particular interest as it is one of the main exports between the United States and China: based on the initial 2014 data, it accounts for almost a third of bilateral trade between the two countries. This sector is also a major source of trade for Switzerland. It accounts for 16.3% of bilateral trade value between Switzerland and the United States, and for 34.6% of bilateral trade between Switzerland and China.[14]

14 The model considers all goods within a sector to be perfect substitutes. Although a strong assumption, it is difficult to calibrate this type of model at a finer aggregation level, given data availability. Considering imperfect substitution between goods within a sector goes beyond this paper's scope. For an assessment of the welfare effects of the tariff escalation between the United States and China using finer data (see, for example, Amiti et al., 2019).

Table 5: Change in real exports following the first tariff shock

(a) Total trade

Exporter	Importer							
	US	China	Switzerland	EU	NAFTA	Asia	Others	World
US	-	-50.4	-1.6	-2.1	-0.1	-2.6	-2.8	-6.8
China	-40.8	-	3.0	2.6	5.8	2.3	2.2	-4.9
Switzerland	5.6	-2.5	-	-0.4	1.1	-0.7	-0.9	0.2
EU	4.4	-2.2	0.1	-	1.7	-0.3	-0.4	0.4
NAFTA	3.1	-5.8	-2.2	-2.9	-	-3.2	-2.6	1.5
Asia	6.8	-2.5	0.3	0.0	2.7	-	-0.2	0.4
Others	6.5	-2.8	0.6	0.3	3.2	0.1	-	0.3
World	-4.5	-6.4	0.2	0.3	1.2	0.2	0.1	-

(b) Electronic and optical sector

Exporter	Importer							
	US	China	Switzerland	EU	NAFTA	Asia	Others	World
US	-	-63.0	-6.2	-7.1	-3.2	-7.4	-7.5	-15.8
China	-51.0	-	3.8	2.8	8.0	2.5	2.4	-6.2
Switzerland	23.9	-3.8	-	-1.1	2.4	-1.3	-1.5	1.0
EU	24.6	-3.3	0.5	-	3.8	-0.9	-0.8	2.2
NAFTA	21.5	-5.7	-2.0	-3.0	-	-3.3	-3.4	13.2
Asia	25.1	-2.8	0.8	-0.2	5.9	-	-0.5	0.7
Others	26.0	-2.2	1.6	0.5	6.3	0.3	-	1.7
World	-12.8	-5.6	1.1	0.6	5.1	0.7	0.5	-

Notes: This table reports the change in real exports, in percent, following the first tariff shock. Panel (a) reports the change in total exports across countries. Panel (b) reports the change in real exports of the electronic and optical sector across countries. Rows are exporters. Columns are importers. Results associated with the second tariff shock are reported in Table C.1. EU comprises all EU countries of the sample; NAFTA (MEX, CAN); Asia (JPN, KOR, IND, IDN); Others (BRA, RUS, TUR, ROW, NOR, AUS). For groups of countries, intragroup exports are excluded.

The sectoral results echo the aggregate results but show significantly larger magnitudes. US real exports decline by –15.8%. The largest decrease relates to real exports to China (–63%), but other export destinations also see significant decreases (–6.2% to Switzerland and –7.4% to Asian countries, for example) Chinese real exports towards the United States decline by –51%, but increase towards all other trading partners. For instance, real exports to NAFTA countries increase by +8% and by +3.8% to Switzerland. Finally, real exports to the United States increase for all countries but China; Swiss real exports to the United States increase by +23.9%.

Results relative to the second tariff shock, reported in Table C.1, are broadly in line with those associated with the first tariff shock. US real exports decline across all trading partners, while China's real exports decline only with respect to the United States. Furthermore, other countries' real exports to the United States increase. Sector-level results may be larger than those at the aggregate level.

6 Conclusion

This paper uses a general equilibrium Ricardian trade model to provide a quantitative assessment of the impact of the tariff escalation between the United States and China. In particular, it provides a Swiss-centric analysis of these effects. The counterfactual analysis details several patterns in the welfare and trade effects associated with the evaluated tariff shocks. Regarding welfare, both the United States and China bear losses. China has the largest welfare loss, followed closely by the United States. Chinese manufacturing sectors, however, tend to have lower declines in labor productivity compared to the United States. The model suggests that US manufacturing sectors are the hardest hit by the tariff escalation. Other countries may have small welfare gains; real GDP in Switzerland could increase slightly. The labor productivity of Swiss manufacturing sectors also increases slightly, especially in those sectors well-connected to China. Regarding trade, the tariff escalation implies little aggregate rebalancing, but bilateral trade between the United States and China collapses. To offset this effect, trade reallocation across trading partners and sectors is significant. The model thus suggests that the growing trade tensions between the United States and China offer significant challenges but also opportunities for bystander countries such as Switzerland.

Nevertheless, these results should be interpreted carefully within the scope of the theoretical framework. Model characteristics ground the results. The model produces estimates of the welfare and trade effects following a tariff escalation from one steady state to another, but it cannot account for the transition between steady states, which may entail significant frictions and costs. The model also focuses on a single transmission channel of trade shocks on real activity, but other channels may also play an important role. In particular, uncertainty may affect business confidence and stock markets, which in turn may impact investment. Furthermore, the model cannot account for safe haven pressures, which could result from uncertainty and could negatively impact Switzerland. Such channels could possibly lead to larger effects and offset the small gains of bystander countries such as Switzerland.

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A Data appendix

Countries: Australia, Austria, Belgium, Brazil, Canada, Switzerland, China, the Czech Republic, Germany, Denmark, Spain, Finland, France, the United Kingdom, Greece, Hungary, Indonesia, India, Ireland, Italy, Japan, South Korea, Lithuania, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Sweden, Slovakia, Turkey, and the United States.

Sectors: The sector classification follows the ISIC revision 4 classification. The sectors and their corresponding two-digit headings (reported in parentheses) are the following: Agriculture, forestry and fishing (01–03); Mining and quarrying (5–9); Food products, beverages and tobacco (10–12); Textiles, apparel and leather (13–15); Wood (16); Paper (17); Printing and reproduction of recorded media (18); Chemicals and coke, refined petroleum products and nuclear fuel (19–20); Pharmaceuticals (21); Rubber and plastics products (22); Other non-metallic mineral products (23); Basic metals (24); Fabricated metal products, except machinery and equipment (25); Computer, electronic and optical products (26); Electrical equipment (27); Machinery and equipment n.e.c. (28); Motor vehicles, trailers and semi-trailers (29); Other transport equipment (30); Furniture and other manufacturing (31–32); Services (>32).

Tariff shocks: Table A.1 summarizes the timing, magnitude, and source of the tariff waves taken into account for the construction of the first tariff shock. I make the following assumptions to construct the shocks. The USTR and MOFCOM publish lists of goods subjected to tariffs at an HS 8-digit level. Whenever an HS 6-digit level good contains at least one HS 8-digit level good targeted by the tariff hike based on these lists, I apply the corresponding tariff rate to the entire HS 6-digit level good. This approximation is necessary because UN Comtrade data only make HS 6-digit level bilateral trade data available, which are used to construct trade weights. Whenever an HS 6-digit level good is targeted by several waves, I apply the highest ad-valorem tariff rate. Regarding the Chinese September 2018 tariff wave, the 5%, 10%, 20%, and 25% ad-valorem rates apply to 313, 600, 749, and 2,017 goods, respectively.

Table A.1: Shock 1 – waves of tariff escalation

US tariffs				
Date	**Trade value (USD bn)**	**# of goods**	**Tariff rate**	**Source**
April 2018	50	876	25	USTR (2018b)
September 2018	200	3,038	25	USTR (2018c)
Chinese tariffs				
Date	**Trade value (USD bn)**	**# of tariff headings**	**Tariff rate**	**Source**
June 2018	50	469	25	MOFCOM (2018a)
September 2018	60	3,679	5,10,20,25	MOFCOM (2018b)

B Theory appendix

Although the model derivations are reported in WICHT (2019), it is useful to describe the welfare equation briefly. As in CALIENDO and PARRO (2015), the welfare change is given by:

$$\frac{\hat{w}_n}{\hat{P}_n} = \underbrace{\prod_{s=1}^{S} (\hat{\pi}_{nn}^s)^{-\frac{\beta_n^s}{\theta^s}}}_{\text{Final goods}} \underbrace{\prod_{s=1}^{S} (\hat{\pi}_{nn}^s)^{-\frac{\beta_n^s(1-\alpha_n^s)}{\theta^s \alpha_n^s}}}_{\text{Intermediate goods}} \underbrace{\prod_{s=1}^{S} \prod_{k=1}^{S} \left[\hat{P}_n^k / \hat{P}_n^s\right]^{-\frac{\beta_n^s \rho_n^{ks}(1-\alpha_n^s)}{\alpha_n^s}}}_{\text{Sectoral Linkages}} \tag{4}$$

where $\hat{x} = \frac{x'}{x}$ is the ratio of counterfactual value to initial value of variable x, $\beta_n^s > 0$ is the consumer spending share with $\sum_{s=1}^{S} \beta_n^s = 1$, α_n^s is the value added share with $0 \leq \alpha_n^s \leq 1$, ρ_n^{ks} is the input share of sector k employed in the production of sector s with $\sum_{k=1}^{S} \rho_n^{ks} = 1$, w_n is the wage rate, P_n^s is the price of the goods supplied by sector s in country n, and $P_n = \prod_{s=1}^{S} \left(\frac{P_n^s}{\beta_n^s}\right)^{\beta_n^s}$ is the aggregate price index of country n. The change in welfare may be decomposed into a final goods effect, intermediate goods effect, and sectoral linkages effect. The final and intermediate goods effects capture the change in productivity of goods supplied to country n. The sectoral linkages effect captures the changes in inputs used per worker. If the prices of inputs increase more than sector s's output price, then welfare declines.

The change in labor productivity in sector s of country n is given by:

$$\frac{\hat{w}_n}{\hat{P}_n^s} = \left(\hat{\pi}_{nn}^s\right)^{-\frac{1}{\theta^s}} \left(\hat{\pi}_{nn}^s\right)^{-\frac{1-\alpha_n^s}{\theta^s \alpha_n^s}} \prod_{k=1}^{S} \left[\hat{P}_n^k / \hat{P}_n^s\right]^{-\frac{\rho_n^{ks}(1-\alpha_n^s)}{\alpha_n^s}}.$$

Weighting $\frac{\hat{w}_n}{\hat{P}_n^s}$ by the corresponding consumer expenditure share β_n^s across all sectors yields equation 4.

B Additional tables

Table C.1: Change in real exports following the second tariff shock

(a) Total trade

Exporter	Importer							
	US	China	Switzerland	EU	NAFTA	Asia	Others	World
US	-	-30.0	-1.3	-1.7	-0.5	-2.1	-2.2	-3.1
China	-44.6	-	2.7	2.3	4.6	2.1	2.1	-2.7
Switzerland	4.2	-1.9	-	-0.3	0.6	-0.6	-0.7	0.2
EU	3.1	-1.6	0.1	-	1.0	-0.3	-0.3	0.3
NAFTA	1.9	-4.5	-1.3	-1.8	-	-2.1	-1.6	0.9
Asia	5.4	-1.9	0.2	-0.0	1.7	-	-0.1	0.4
Others	6.5	-2.5	0.4	0.1	2.0	0.0	-	0.4
World	-2.1	-3.2	0.1	0.2	0.7	0.2	0.2	-

(b) Electronic and optical sector

Exporter	Importer							
	US	China	Switzerland	EU	NAFTA	Asia	Others	World
US	-	-87.0	-5.2	-6.0	-3.1	-6.3	-6.4	-11.6
China	-85.0	-	3.4	2.5	6.4	2.3	2.2	-5.2
Switzerland	18.0	-3.2	-	-1.0	1.6	-1.3	-1.3	1.0
EU	18.6	-2.7	0.5	-	2.7	-0.8	-0.7	2.0
NAFTA	16.9	-4.1	-1.2	-2.0	-	-2.2	-2.3	11.4
Asia	19.1	-2.2	0.8	-0.1	4.5	-	-0.3	1.0
Others	19.4	-2.0	1.0	0.2	4.5	-0.0	-	1.5
World	-9.6	-3.9	0.9	0.6	3.9	0.6	0.5	-

Notes: This table reports the change in real exports, in percent, following the second tariff shock. Panel (a) reports the change in total exports across countries. Panel (b) reports the change in real exports of the electronic and optical sector across countries. Rows are exporters. Columns are importers. Results associated with the first tariff shock are reported in Table 5. EU comprises all EU countries of the sample; NAFTA (MEX, CAN); Asia (JPN, KOR, IND, IDN); Others (BRA, RUS, TUR, ROW, NOR, AUS). For groups of countries, intragroup exports are excluded.