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Abstract

This paper quantifies Switzerland's gains from trade using a multi-country multi-sector general equilibrium Ricardian trade model. The model calibration relies on a novel data source on sectoral linkages to provide a Switzerland-centric analysis. I find that using this novel dataset generates 13.4% higher estimates of the gains from trade for Switzerland, as other data sources tend to underestimate Swiss sectors' exposure to foreign markets. Using this quantitative framework, I then perform a policy-oriented counterfactual analysis to assess the gains from Switzerland's trade integration. I find that Switzerland's wide free trade agreement (FTA) network is associated with small real GDP gains but significantly shapes trade flows. Without Switzerland's FTA network, Swiss real exports decline by −6.9%, while imports decline by −7.6%. An FTA with the US raises real GDP in Switzerland and in the US, albeit only slightly, while CH-US real bilateral trade increases by approximately +7%.

JEL classification: F10, F11, F14.
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1 Introduction

As a small open economy, Switzerland is tightly integrated in global markets. In 2018, Switzerland's goods imports amounted to almost 30% of its GDP, and goods exports exceeded one third of its GDP.[1] Given the importance of international trade, Switzerland has been a firm proponent of free trade and has actively pursued deeper bilateral trade integration with its trading partners. In 2018, almost 90% of Swiss imports came from countries with which Switzerland has a preferential or free trade agreement (FTA), while 75% of Swiss exports were destined for favored trading partners.[2] Given the weight of international trade in Switzerland's economic activity, as well as its long tradition of concluding FTAs, this paper aims to quantify the gains from Switzerland's trade integration.

This paper conducts counterfactual analysis to assess Switzerland's gains from trade using a quantitative general equilibrium Ricardian trade model. This paper's contributions are twofold. First, this paper provides a sectoral breakdown of the sources and the magnitude of Switzerland's gains from trade. To do so, this paper relies on a novel dataset that gives precise estimates of the linkages between Swiss and foreign sectors. Second, this paper assesses the welfare and trade effects of Switzerland's trade integration. To do so, it exploits disaggregated tariff data to assess the impact of past FTAs concluded by Switzerland, as well as potential future agreements.

The theoretical framework follows Caliendo and Parro (2015), who build an extension of Eaton and Kortum (2002) to study the effects of NAFTA. The model allows for a rich international trade and production setup. On the trade side, the model matches sectoral trade flows between countries. Trade is shaped by Ricardian forces (technology, costs) and by gravity (trade costs, tariffs). On the production side, the model matches value-added and input-output structure at the sector and country level. Production has constant returns to scale, and markets are perfectly competitive. Departing from Caliendo and Parro (2015), the theoretical framework further allows for endogenous trade balances following Caliendo, Parro, Rossi-Hansberg, and Sarte (2018).

This paper evaluates the welfare and trade effects associated with a shock to fundamentals, for example, an increase in trade costs or tariffs. Welfare effects, commonly referred to as gains from trade, are often the main unit of analysis in quantitative trade papers (Arkolakis, Costinot, and Rodríguez-Clare, 2012; Costinot and Rodríguez-Clare, 2014). They are captured by the change in real wage, or equivalently, the change in real GDP, associated with moving from some observed steady state to another steady state resulting

[1] These figures are based on FCA and SECO data using the business-cycle view of trade (excluding non-monetary gold, other precious metals, coins, precious stones and gems, works of art and antiques).

[2] Figure 2 gives more details on this point in Section 5.

from a shock to fundamentals. The main contribution of Caliendo and Parro (2015) is to allow for a rich input-output structure while generating tractable welfare predictions.

Bringing the model to the data, the calibration is based on 34 countries, including Switzerland, plus a constructed rest of the world, and for 20 sectors: agriculture, manufacturing sectors, and a composite services sector. The model is solved in relative changes following the exact-hat algebra method. Dekle, Eaton, and Kortum (2008) first introduced this method in the context of quantitative trade models. This method reduces the data requirements for the calibration of the model's trade and production structure. A central requirement for the calibration, in particular regarding sectoral linkages, is input-output tables, which in Switzerland bear an "experimental character".[3]

This paper relies on a novel dataset to calibrate Switzerland's sectoral linkages. This new dataset, which resulted from a joint project between the SNB and the ETH, uses firm-level import data from the Federal Customs Administration (FCA) to identify Swiss sectors' imports. Based on this dataset, precise estimates of international input-output linkages between Swiss and foreign sectors are constructed. For the rest of the paper, I refer to this new dataset as the Swiss International Input-Output Table (SIIOT).

This paper proposes a three-part counterfactual analysis. It begins with the evaluation of Switzerland's gains from trade, i.e., the welfare change associated with moving from a world in autarky to the observed equilibrium. Based on this first counterfactual exercise, I detail how the model assumptions and data sources affect the magnitude of Switzerland's gains from trade.

Using the SIIOT, as opposed to other data sources, matters for the level of Switzerland's gains from trade. The baseline calibration, which relies on the SIIOT, suggests that Switzerland's welfare gains from trade are 17.2%. Conducting the same calibration, but relying on Switzerland's WIOT estimates for the sectoral linkages, suggests that Switzerland's gains from trade are 14.9%. By not using the SIIOT, gains from trade are thus underestimated by 13.4%. The discrepancy in Switzerland's gains from trade is driven by the underestimation of Swiss sectors' exposure to foreign markets by the WIOT. On average, Swiss sectors source 2.6% more inputs from foreign sources based on the SIIOT, and thus, the larger exposure to foreign markets in the SIIOT leads to a larger sectoral linkages effect and larger welfare effects.

The rest of the counterfactual analysis studies two policy-oriented trade shocks. It assesses the welfare and trade effects of Switzerland's wide FTA network by evaluating the counterfactual equilibrium in which those agree-

[3]The SFSO acknowledges this feature on its website. Section 3 examines this topic in more detail.

ments are dissolved. Then, it assesses the effects of concluding a new FTA with the United States. Overall, both policy-oriented counterfactual exercises assess the gains of Switzerland's past and ongoing trade integration, but they focus on one specific aspect of trade integration through FTAs by studying a tariff shock. WTO rules dictate that, following the dissolution of Switzerland's FTA network, Switzerland should apply most-favored nation (MFN) tariff rates. The first exercise thus evaluates the effects of applying MFN tariff rates, rather than preferential FTA tariff rates. The second exercise studies the reverse scenario. It evaluates the effects of applying preferential FTA tariff rates rather than MFN tariff rates if Switzerland were to conclude an agreement with the US.

If Switzerland's FTA network dissolves, welfare in Switzerland declines by -0.58%. The aggregate welfare effect is thus relatively small but may be much more pronounced for some sectors, e.g., up to a 6.9% labor productivity loss in the textile sector. Aggregate real exports decline by -6.9%, while real imports decrease by -7.6%. Both declines are driven by trade with Switzerland's neighboring countries. Real trade with non-FTA trading partners increases only slightly and cannot compensate for the loss of Switzerland's favored trading partners. The model thus challenges the notion that Switzerland could ride out a trade shock by reallocating imports and exports across trading partners. Furthermore, sectors perform unequally in weathering the trade shock. There are clear winners (e.g., agriculture) that experience increases in real exports, but there are also clear losers (e.g., textiles) whose exports see significant declines.

If Switzerland concludes an FTA with the US, both countries see welfare gains, albeit small gains. Real GDP increases by $+0.04\%$ in Switzerland and by $+0.01\%$ in the US. The small welfare effects reflect the already low level of CH-US bilateral tariffs, which limit the scope for welfare gains. Nevertheless, bilateral trade increases to a certain extent: Swiss real exports to the US increase by $+7.2\%$, while US real exports to Switzerland increase by $+7.6\%$. The increase in Swiss real exports to the US, however, mostly takes place at the expense of other export destinations: Swiss real exports decline across all other trading partners, bringing only a modest increase in aggregate Swiss real exports ($+0.4\%$). Across all sectors, real exports increase. The magnitude, however, varies significantly. Sector-level real exports to the US increase by up to $+73\%$ in the textile industry but by less than 1% in the paper and other transport industries.

This paper quantifies the gains from Switzerland's trade integration. However, the results should be carefully interpreted within the scope of the theoretical framework. Model characteristics ground the counterfactual results. For example, the model is static. Thus it cannot account for dynamic effects, such as investment decisions and technological spillovers. The model also focuses on a single transmission channel for the benefits of an FTA on real activity: tariffs. Other aspects of an FTA may affect real activity through additional channels. For example, services trade and investment could also contribute to welfare gains, especially if embedded in a dynamic setting.

This paper builds on a broad literature that uses quantitative trade models to evaluate the sources and magnitudes of welfare gains from trade. The handbook chapter by Costinot and Rodríguez-Clare (2014) gives a broad overview of the literature looking at quantifying the gains from trade. Arkolakis et al. (2012) show how a large class of trade models, following the contributions of Armington (1969), Krugman (1980), Eaton and Kortum (2002) and Melitz (2003), make similar predictions for the level of gains from trade. Broadly, this paper also builds on an extensive literature studying the impact of trade policy. Ossa (2016) and Goldberg and Pavcnik (2016) provide surveys of the recent literature.

With its focus on Switzerland, this paper is closely related to Hepenstrick (2016), who uses an Eaton and Kortum (2002) model to quantify Switzerland's gains from trade. He performs a counterfactual analysis of shutting down trade with selected trading partners and decreasing multilateral trade cost. Echoing this paper's findings, he concludes that Switzerland depends little on any single trading partner because of the significant trade-reallocation effects. However, welfare effects may be large if the trade shocks impact many trading partners, such as the European Union. This paper is also closely related to Wicht (2019), which assesses the impact of the trade war between the US and China on Switzerland. Using the same theory and calibration framework, the analysis shows that Switzerland could experience small welfare gains following the tariff escalation between the US and China. Swiss sectors' labor productivity increases, especially in sectors that are well connected to China.

This paper is organized as follows. Section 2 develops the theoretical framework. Section 3 details the calibration strategy and presents the data source for Switzerland's sectoral linkages. Section 4 examines the sources of welfare gains from trade under autarky. Section 5 assesses the welfare and trade effects of Switzerland's trade integration. Section 6 concludes.

2 The theoretical framework

The theoretical model follows the static general equilibrium Ricardian trade model of Caliendo and Parro (2015), a multi-sector extension of Eaton and Kortum (2002). The model setup allows for multiple countries and sectors. There are N countries, which may trade between each other. Exporting, or origin, countries are indexed by i. Importing, or destination, countries are indexed by n. There are S sectors. By assumption, sectors are either tradable or nontradable. Tradable sectors may export and can be thought of as the agriculture or manufacturing sectors. Nontradable sectors cannot export and can be thought of as services. The model is thus tailored for goods trade.

2.1 Consumers

Country n is populated with L_n homogeneous consumers. They supply one unit of labor in exchange for wage w_n. Labor is perfectly mobile across sectors but immobile across countries. Consumers spend a fixed share of income on goods from any given sector. Formally, they have Cobb-Douglas preferences over S sectors

$$Q_n = \prod_{s=1}^{S} (Q_n^s)^{\beta_n^s}, \tag{1}$$

where $0 < \beta_n^s < 1$ is country n's consumer expenditure share on sector s with $\sum_{s=1}^{S} \beta_n^s = 1$, and Q_n^s is the composite good of sector s aggregated over a continuum of goods $\omega \in [0, 1]$ given by

$$Q_n^s = \Big[\int_0^1 q_n^s(\omega)^{\frac{\sigma^s - 1}{\sigma^s}} d\omega \Big]^{\frac{\sigma^s}{\sigma^s - 1}}, \tag{2}$$

where $\sigma^s > 1$ is the elasticity of substitution in sector s.

Given the Cobb-Douglas consumer preferences, the aggregate consumer price index P_n in country n is given by

$$P_n = \prod_{s=1}^{S} \Big(\frac{P_n^s}{\beta_n^s} \Big)^{\beta_n^s}, \tag{3}$$

where P_n^s is the price of the composite good of sector s.

Consumers have two-tiered preferences, as shown by equations (1) and (2). Given the Cobb-Douglas outer tier, country n's consumers demand a share β_n^s of sector s's composite good. Given the CES inner tier, consumer demand for good ω of sector s is

$$q_n^s(\omega) = \Big(\frac{p_n^s(\omega)}{P_n^s} \Big)^{-\sigma^s} Q_n^s, \tag{4}$$

where $p_n^s(\omega)$ is the price of good ω, and the price of the composite good P_n^s is given by

$$P_n^s = \Big(\int_0^1 p_n^s(\omega)^{1-\sigma^s} d\omega \Big)^{\frac{1}{1-\sigma^s}}.$$

2.2 Production

Markets are perfectly competitive: prices equal costs. In any sector s of any country n, a representative producer produces the composite good Q_n^s at minimum costs. To produce the composite good, the producer demands a continuum of goods $\omega \in [0, 1]$.

A representative producer combines labor and intermediate inputs to produce good ω of sector s in country n. Formally, good ω follows a Cobb-Douglas production function with constant returns to scale given by

$$x_n^s(\omega) = z_n^s(\omega) l_n^s(\omega)^{\alpha_n^s} \prod_{k=1}^{S} [Q_n^k(\omega)]^{(1-\alpha_n^s)\rho_n^{ks}}, \tag{5}$$

where $z_n^s(\omega)$ is the productivity of good ω, $0 < \alpha_n^s < 1$ is the labor (or value-added) share, and $0 < \rho_n^{ks} < 1$ is the input share of producing sector s from supplying sector k, with $\sum_{k=1}^{S} \rho_n^{ks} = 1$.

Productivity $z_n^s(\omega)$ is drawn from a Fréchet distribution with cumulative distribution function

$$F_n^s(z) = \exp(-T_n^s z^{-\theta^s}), \tag{6}$$

where $T_n^s > 0$ is the average productivity of goods produced by sector s in country n and $\theta^s > 0$ captures the productivity dispersion, with a low θ^s associated with high dispersion in productivity.

Like consumer preferences, the production function of equation (5) is two-tiered. The outer tier is Cobb-Douglas: to produce good ω, sector s's representative producer demands a share $(1-\alpha_n^s)\rho_n^{ks}$ of sector k's composite good in country n. The inner tier is CES: demand for any input good ω of sector k is given by equation (4).

Producers minimize costs given the production function of equation (5). Because of the perfectly competitive markets, the price of good ω produced by sector s of country n equals its cost $c_n^s / z_n^s(\omega)$, where the input bundle cost c_n^s is given by

$$c_n^s = \lambda_n^s w_n^{\alpha_n^s} \prod_{k=1}^{S} \left(P_n^k\right)^{(1-\alpha_n^s)\rho_n^{ks}}, \tag{7}$$

where $\lambda_n^s = (\alpha_n^s)^{-\alpha_n^s} \prod_{k=1}^{S} \left[(1-\alpha_n^s)\rho_n^{ks}\right]^{-(1-\alpha_n^s)\rho_n^{ks}}$ is a constant.

The model has a rich production setup, which accounts for the value-added and input-output structure at the sector and country level. The setup's strength is its ability to study trade shocks across sectors. As seen in equation (7), costs, and thus prices, in one sector depend on prices in all other sectors. The intensity with which an increase in input prices impacts output prices across sectors depends on the value-added (α_n^s) and input-output (ρ_n^{ks}) shares.

2.3 International trade

Goods are perfectly substitutable. For any good ω, consumers and producers compare prices across source countries and buy the good from the cheapest supplying country. Formally, country n's buyers purchase good ω of sector s at price

$$p_n^s(\omega) = \min_i \Big[\frac{c_i^s \kappa_{in}^s}{z_i^s(\omega)}\Big], \tag{8}$$

where κ_{in}^s is the iceberg trade cost between source country i and destination country n for goods of sector s, with $\kappa_{in}^s \geq 1$ if $i \neq n$ and $\kappa_{in}^s = 1$ if $i = n$. By assumption, if sector s is nontradable, then $\kappa_{in}^s = \infty$ for all $i \neq n$.

Following Eaton and Kortum (2002), the assumption that productivity draws follow a Fréchet distribution generates a closed-form solution for prices and trade shares. The price of the composite good from sector s in country n is

$$P_n^s = \zeta^s \Big(\sum_{i=1}^{N} T_i^s (c_i^s \kappa_{in}^s)^{-\theta^s} \Big)^{-\frac{1}{\theta^s}} = \zeta^s \Big(\Phi_n^s \Big)^{-\frac{1}{\theta^s}}, \tag{9}$$

where $\zeta^s = \Gamma(\frac{\theta^s + 1 - \sigma^s}{\theta^s})^{\frac{1}{1-\sigma^s}}$ is a constant, requiring the following parameter restriction: $\theta^s + 1 > \sigma^s$.

The trade share of sector s between exporting country i and importing country n is country i's share in country n's total expenditure on sector s's goods. It is given by

$$\pi_{in}^s = \frac{T_i^s [c_i^s \kappa_{in}^s]^{-\theta^s}}{\sum_{k=1}^{N} T_k^s (c_k^s \kappa_{kn}^s)^{-\theta^s}}. \tag{10}$$

The trade share π_{in}^s is simply the probability that country i is the cheapest supplier compared to all other countries supplying country n. All else equal, the cheaper country i's goods are compared to all other countries' goods, then the higher the trade share.

International trade is driven by Ricardian forces (technology, productivity and costs) and by gravity (trade costs). The productivity distribution parameters T_i^s and θ^s shape equation (10). 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 higher on average and a country more likely to export. It captures the technology level of sector s in country n. Thus, the parameter T_i^s can be thought of as the absolute advantage. A low θ^s implies a high productivity dispersion. All else equal, a high productivity dispersion implies stronger trade resistance to an increase in trade cost. In other words, a high productivity dispersion implies a low trade elasticity. Thus, the dispersion parameter can be thought of as the comparative advantage.

Trade is also shaped by gravity. The trade cost κ_{in}^s captures characteristics of the bilateral trade relationship between exporting country i and importing country n. Bilateral iceberg trade costs can be decomposed as

$$\kappa_{in}^{s} = d_{in}^{s}(1 + \tau_{in}^{s}), \tag{11}$$

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

The model's general equilibrium nature, as well as the complex sectoral production and trade structure, allow to study the direct and indirect effects of trade shocks. All else being equal, the direct effect of an increase in trade costs is to lower the corresponding bilateral trade share. A higher trade cost makes foreign goods more expensive and thus lowers the probability that the foreign country is the cheapest supplier. Increases in trade costs affect trade shares beyond this direct price effect: they raise input prices. Higher prices in one sector feed into other sectors' prices through the input-output structure and result in higher output prices, which in turn tend to make exports less competitive.

2.4 Trade balances

Static models of international trade often assume balanced trade or exogenous trade balances. For example, Caliendo and Parro (2015) provide a counterfactual analysis of the welfare and trade effects of NAFTA under both assumptions. However, these assumptions have several disadvantages. Imposing balanced trade is a strong assumption to place on the data. Indeed, countries may have high, often persistent, trade surpluses or deficits.

Assuming exogenous trade balances is sufficient to avoid this data violation. Economic theory supports this assumption, as trade balances are largely driven by savings and investment decisions, which are outside the scope of a static model. Nevertheless, Ossa (2014) argues that introducing exogenous trade balances as nominal transfers in the consumer's budget constraint has two limitations. First, exogenous transfers may lead to extreme general equilibrium adjustments in response to a change in trade costs. If trade costs are infinitely high, such adjustments cannot be rationalized. Second, the assumption of constant nominal transfers implies that the choice of numéraire matters since real transfers change with nominal prices.[4]

[4] To circumvent these limitations, Ossa (2014) first purges the data of trade balances. He solves for counterfactual trade flows that satisfy balanced trade, thereby replicating the exercise of Dekle et al. (2008). Then, he performs the counterfactual analysis on the purged dataset. Others have proposed dynamic models of trade to account for the effect of trade shocks on trade balances (Eaton, Kortum, Neiman, and Romalis, 2016; Reyes-Heroles, 2016).

Instead of assuming balanced trade or exogenous trade balances, this paper allows for endogenous trade balances. Following Caliendo et al. (2018), consumers allocate part of their labor income to an international portfolio, which is then redistributed equally across countries. Formally, let $0 \leq \iota_n \leq 1$ be the labor income share allocated to the international portfolio by country n. The trade balance D_n is reflected in the difference between receipts from and expenses to the international portfolio. Formally, it holds

$$D_n = \chi L_n - \iota_n w_n L_n, \tag{12}$$

where $\chi = \frac{\sum_i \iota_i w_i L_i}{\sum_i L_i}$ is the equal share of the international portfolio that is redistributed to consumers across countries. Trade balances D_n thus depend on wages, allowing for adjustments following any shock to fundamentals. Note that a trade deficit is captured by $D_n > 0$ while a trade surplus implies that $D_n < 0$.

2.5 Equilibrium

The equilibrium requires the following conditions. The goods market clearing requires that the total production of sector s in country i equals total supply worldwide. Let Y_i^s be the total production of sector s in country i. Then it must hold that

$$Y_i^s = \sum_{n=1}^{N} \frac{\pi_{in}^s}{1 + \tau_{in}^s} \Big(\beta_n^s I_n + \sum_{b=1}^{S} (1 - \alpha_n^b) \rho_n^{sb} Y_n^b \Big), \tag{13}$$

where I_n is country n's total income.

Income I_n is given by the labor income share allocated to domestic consumption, receipts from the international portfolio, and duties from imports R_n. Formally, it holds that

$$I_n = (1 - \iota_n) w_n L_n + \chi L_n + R_n. \tag{14}$$

Given equation (12), country n's income must satisfy

$$I_n = w_n L_n + D_n + R_n. \tag{15}$$

Each component of country n's income must satisfy the following conditions. The labor market clearing requires that labor income equals total value-added. Formally, it must hold

$$w_n L_n = \sum_{s=1}^{S} \alpha_n^s Y_n^s. \tag{16}$$

Revenues from imports satisfy

$$R_n = \sum_{i=1}^{N}\sum_{s=1}^{N} \tau_{in}^s M_{in}^s, \tag{17}$$

where country n's imports from country i's sector s, M_{in}^s, may be written as

$$M_{in}^s = \frac{\pi_{in}^s}{1+\tau_{in}}\Big(\beta_n^s I_n + \sum_{b=1}^{S}(1-\alpha_n^b)\rho_n^{sb} Y_n^b\Big), \tag{18}$$

and the trade deficit D_n satisfies equation (12).

Given employment L_n, the domestic value-added share allocated to the international portfolio ι_n, sectoral technology levels T_n^s, and bilateral trade costs d_{in}^s, the equilibrium is characterized by a wage vector $\mathbf{w} = [w_1, \ldots, w_N]$ and prices P_n^s that solve equations (13) through (18) for all $i, n = 1, \ldots, N$ and $s = 1, \ldots, S$.

2.6 Solving the equilibrium in relative changes

As in other general equilibrium Ricardian frameworks, the model is difficult to calibrate in levels: the underlying parameters are hard to identify in aggregate data. To simplify the calibration, Dekle, Eaton, and Kortum (2008) first proposed solving the model in relative changes, rather than in levels. Based on that method, the counterfactual equilibrium resulting from any change in fundamentals may be calculated with few data requirements.

Let $\hat{x} = \frac{x'}{x}$ be the ratio of the counterfactual value x' to the initial value of variable x. Following any change in the exogenous variables (e.g., technology parameters, tariffs, trade costs), the price change of sector s's composite good in country n can be expressed as a function of the relative change in trade costs and input bundle costs as well as the initial levels of trade shares. Formally, it holds

$$\hat{P}_n^s = \Big(\sum_{i=1}^{N} \pi_{in}^s (\hat{c}_i^s \hat{\kappa}_{in}^s)^{-\theta^s}\Big)^{-\frac{1}{\theta^s}}, \tag{19}$$

where the change in sector s's input bundle cost in country i, $\hat{c}_i^s$, is

$$\hat{c}_i^s = \hat{w}_i^{\alpha_i^s} \prod_{k=1}^{S} \Big(\hat{P}_i^k\Big)^{(1-\alpha_i^s)\rho_i^{ks}}. \tag{20}$$

The counterfactual trade share can be expressed as a function of the change in wages, input bundle costs, and bilateral trade costs as well as the initial trade shares. Formally, the counterfactual trade share of sector s between country i and country n is given by

$$\pi_{in}^{s\,\prime} = \frac{\pi_{in}^{s}(\hat{c}_i^s\hat{\kappa}_{in}^s)^{-\theta^s}}{\sum_{k=1}^{N}\pi_{kn}^{s}(\hat{c}_k^s\hat{\kappa}_{kn}^s)^{-\theta^s}}. \tag{21}$$

The counterfactual equilibrium conditions can be solved building on equations (19) to (21). The counterfactual supply of goods in each sector $Y_i^{s\,\prime}$ and counterfactual labor income satisfy

$$Y_i^{s\,\prime} = \sum_{n=1}^{N}\frac{\pi_{in}^{s\,\prime}}{1+\tau_{in}^{s\,\prime}}\Big(\beta_n^s I_n^{\,\prime} + \sum_{b=1}^{S}(1-\alpha_n^b)\rho_n^{sb}Y_n^{b\,\prime}\Big) \tag{22}$$

and

$$w_n^{\prime}L_n = \sum_{s=1}^{S}\alpha_n^s Y_n^{s\,\prime}. \tag{23}$$

Finally, counterfactual income in country n satisfies

$$I_n^{\prime} = w_n^{\prime}L_n + D_n^{\prime} + R_n^{\prime}, \tag{24}$$

where counterfactual import revenues satisfy

$$R_n^{\prime} = \sum_{i=1}^{N}\sum_{s=1}^{N}\frac{\tau_{in}^{s\prime}}{1+\tau_{in}^{s\prime}}\pi_{in}^{s\,\prime}\Big(\beta_n^s I_n^{\,\prime} + \sum_{b=1}^{S}(1-\alpha_n^b)\rho_n^{sb}Y_n^{b\,\prime}\Big) \tag{25}$$

and the counterfactual trade deficit satisfies

$$D_n^{\prime} = \chi^{\prime}L_n - \iota_n w_n^{\prime}L_n, \tag{26}$$

with $\chi^{\prime} = \frac{\sum_i \iota_i w_i^{\prime} L_i}{\sum_i L_i}$.

The counterfactual equilibrium resulting from a change in fundamentals is thus characterized by a vector of wage changes $\hat{\mathbf{w}} = [\hat{w}_1, \ldots, \hat{w}_N]$ that solves equations (19) to (26). The numerical algorithm used to solve the model follows Alvarez and Lucas (2007) and is reported in Appendix A.

2.7 Welfare

The counterfactual analysis studies the welfare and trade effects of a tariff or trade shock. In particular, welfare effects are often the main unit in analysis in quantitative trade models. As in a general class of trade models, the welfare change is given by the change in real wage, or equivalently, the change in real GDP (Arkolakis et al., 2012). Formally, following a shock to fundamentals, the welfare change is given by

$$\frac{\hat{w}_n}{\hat{P}_n} = \underbrace{\prod_{s=1}^{S} (\hat{\pi}^s_{nn})^{-\frac{\beta^s_n}{\theta^s}}}_{\text{Final goods}} \underbrace{\prod_{s=1}^{S} (\hat{\pi}^s_{nn})^{-\frac{\beta^s_n(1-\alpha^s_n)}{\theta^s\alpha^s_n}}}_{\text{Intermediate goods}} \underbrace{\prod_{s=1}^{S}\prod_{k=1}^{S} \left[\hat{P}^k_n/\hat{P}^s_n\right]^{-\frac{\beta^s_n\rho^{ks}_n(1-\alpha^s_n)}{\alpha^s_n}}}_{\text{Sectoral Linkages}}. \tag{27}$$

The change in welfare may be decomposed into a final goods effect, an intermediate goods effect, and a sectoral linkages effect. The final and intermediate goods effects capture the change in the productivity of goods supplied to country n. An increase in the home trade share π^s_{nn} reflects the loss of more productive foreign goods. How it contributes to the aggregate welfare change depends on the consumer expenditure share β^s_n, value-added share α^s_n, and trade elasticity θ^s. A lower trade elasticity (i.e., greater productivity dispersion) is associated with a larger welfare effect for a given change in the home trade share.

The sectoral linkages effect captures relative price changes. If following a negative trade shock, input prices increase more than a sector's own price, then welfare declines. Productivity losses in other sectors offset the sector's own productivity gains. In contrast, if input prices increase less than a sector's own output price, then welfare increases. The relatively smaller increases in input prices offset the sector's own productivity losses. If sectoral linkages are perfectly symmetric, these effects cancel each other out. In practice, which effect dominates depends on the input-output structure, the trade shock, and consumer expenditure shares.

In the counterfactual analysis, I further decompose the welfare change into sectoral labor productivity changes. Formally, the change in labor productivity in sector s of country n is given by

$$\frac{\hat{w}_n}{\hat{P}^s_n} = (\hat{\pi}^s_{nn})^{-\frac{1}{\theta^s}} (\hat{\pi}^s_{nn})^{-\frac{1-\alpha^s_n}{\theta^s\alpha^s_n}} \prod_{k=1}^{S} \left[\hat{P}^k_n/\hat{P}^s_n\right]^{-\frac{\rho^{ks}_n(1-\alpha^s_n)}{\alpha^s_n}}. \tag{28}$$

Weighting $\frac{\hat{w}_n}{\hat{P}^s_n}$ by the corresponding consumer expenditure share β^s_n across all sectors yields equation 27.

3 Calibrating the model to cross-country data

This section describes the model's calibration to cross-country data. It first details the calibration strategy, then introduces the novel data source for Switzerland's sectoral linkages: the Swiss International Input-Output Table (SIIOT).

3.1 Calibration strategy

The calibration is based on 34 countries and a constructed rest of the world (ROW), and 20 sectors: 19 tradable sectors (agriculture, mining, and manufacturing) and one nontradable composite services sector.[5] The calibration is based on 2014 data.

Solving the model in relative changes greatly simplifies the calibration in terms of identification and data requirements. The equilibrium resulting from a change in fundamentals, e.g., tariffs or trade costs, can be solved with data on initial trade shares, tariffs, and calibrated production and consumption function parameters, as well as estimates of the domestic share of labor income allocated to the international portfolio and of trade elasticities. Table 1 summarizes the model parameters and moments to be calibrated and their corresponding data source. When possible or necessary, Swiss data sources were used to construct Switzerland-specific parameters. Table 1 singles out model parameters or moments that use Swiss data sources. If no other data source is listed, the main data source is used for Switzerland.

Table 1: Data sources for the calibration

Parameter/Moment		Data source	
Production		Main	Swiss
Consumer spending shares	β_n^s	WIOT	
Value-added shares	α_n^s	WIOT	SFSO
Input-output linkages	ρ_n^{sb}	WIOT	SIIOT
		Data source	
Trade		Main	Swiss
Trade flows	M_{in}^s	UN Comtrade	
Initial tariffs	τ_{in}^s	World Bank WITS	
Trade elasticities	θ^s	Caliendo and Parro (2015)	
Gross output	Y_n^j	OECD STAN, WIOT	SFSO
GDP	$w_n L_n$	IMF WEO	
Employment	L_n	World Bank	

Notes: This table summarizes the data sources used for the calibration of each relevant model parameter or moment. All data is for 2014. Swiss data sources are listed for parameters or moments that use Swiss data sources. If no other data source is listed, then the main data source is used for Switzerland.

Consumer preferences and production function parameters are constructed based on the World Input-Output Tables (WIOT). Consumer expenditure

[5] These countries cover 85% of 2014 world GDP and 80% of 2014 world trade. The full list of countries and sectors is provided in Appendix A.

shares β_n^s are based on their directly observable counterpart, i.e., the country-specific share of final consumption spent on each sector. On average, manufacturing sectors account for approximately 30% of total consumer spending. However, there is significant variation across countries: from less than 15% in Ireland to almost half of final consumer spending in Slovakia. In particular, Switzerland has the sample's second lowest consumer spending share on manufacturing sectors (16% of final consumption).[6]

Sectoral value-added shares α_n^s are matched to the ratio of total value-added to gross production. Swiss sectors' value-added shares are constructed using gross production and value-added data from the Swiss Federal Statistical Office (SFSO). The average value-added share of tradable sectors is 0.33 in the WIOT and 0.37 in Switzerland. The nontradable sector exhibits a larger value-added share: 0.55 in the WIOT and 0.54 in Switzerland. Input-output linkages ρ_n^{sb} are constructed as the share of inputs used by sector b that are bought from sector s. For Switzerland, I construct sectoral linkages using the SIIOT, which I describe in Section 3.2.

Trade shares, consistent with equation (10), are determined in the data with the following steps. Let M_{in}^s denote country n's imports from country i's sector s, then $X_{in}^s = (1 + \tau_{in}^s)M_{in}^s$ is country n's total expenditure on those imports given the tariff rate τ_{in}^s. The expenditure share of country n on country i's sector s is given by

$$\pi_{in}^s = \frac{X_{in}^s}{\sum_{k=1}^N X_{kn}^s},$$

where the domestic expenditure share is $X_{nn}^s = Y_n^s - \sum_{i,i\neq n} X_{ni}^s$ and Y_n^s is sector s's gross output in country n. To construct trade shares, data on imports, tariffs, and gross output are thus required. Import data are taken from UN Comtrade. Tariff data come from the World Bank's World Integrated Trade Services (WITS). Sector-level tariffs are constructed as the trade-weighted average of HS 6-digit level tariff lines within each sector s. Trade weights are based on 2014 UN Comtrade data. Gross output is taken from the OECD Structural Analysis (STAN) database, or from the WIOT if missing if missing from the STAN database.

The labor income share allocated to the international portfolio ι_n is calibrated to satisfy equation (12). To do so, initial data on aggregate trade deficits, labor income and total employment across countries are required. Trade deficits are constructed using UN Comtrade data. Formally, they are given by $D_n = \sum_{i,i\neq n} M_{in}^s - \sum_{n,i\neq n} M_{ni}^s$. I use GDP from the IMF

[6] This approach to calibrating the consumption shares differs from Caliendo and Parro (2015) to avoid some inconsistencies in the aggregate data, which would violate the restrictions on the parameters implied by the theoretical framework (e.g., negative consumption shares). It requires solving for an initial equilibrium, i.e., wages, which rationalize the parameters.

World Economic Outlook (WEO) as a proxy for labor income $w_n L_n$, and employment data L_n is taken from the World Bank. Table 2 reports the calibrated parameters ι_n. They range from 0 (US, UK) to 1 (India). The calibrated parameter ι_n for Switzerland is 0.07, meaning that Swiss labor sets aside 7% of its labor income for the international portfolio. Table 2 further reports the initial trade deficits D_n, expressed as a percent of GDP. Countries with trade deficits tend to have a lower ι_n compared to surplus countries: they receive more from the international portfolio than they pay in to finance their trade deficit.

Table 2: Calibrated domestic labor income share allocated to the international portfolio–ι_n

Country	ι_n	D_n	Country	ι_n	D_n
Australia	0.03	-0.3	Korea	0.12	-3.9
Austria	0.02	0.4	Lithuania	0.00	6.7
Belgium	0.06	-3.6	Mexico	0.17	0.8
Brazil	0.15	0.3	Netherlands	0.11	-7.6
Canada	0.04	-0.2	Norway	0.12	-10.8
China	0.41	-4.9	Poland	0.12	0.6
Czech Republic	0.17	-10.1	Portugal	0.00	6.8
Denmark	0.05	-3.4	Rest of the World	0.42	-2.1
Finland	0.01	1.2	Romania	0.13	4.7
France	0.01	3.5	Russia	0.23	-9.1
Germany	0.13	-8.0	Slovakia	0.09	-4.7
Greece	0.00	10.8	Spain	0.03	2.5
Hungary	0.15	-6.5	Sweden	0.03	-0.3
India	1.00	6.0	Switzerland	0.07	-4.9
Indonesia	0.53	0.5	Turkey	0.02	9.2
Ireland	0.19	-18.1	UK	0.00	7.5
Italy	0.07	-2.8	US	0.00	4.9
Japan	0.02	2.0			

Notes: This table reports the share of domestic labor income allocated to the international portfolio ι_n as calibrated using initial deficit, GDP, and employment data, as well as the trade deficit D_n based on data from 2014, expressed as a percentage of GDP. Consistent with the model, the trade balances D_n are reported as trade deficits. A trade deficit (surplus) is associated with a positive (negative) number.
Sources: UN Comtrade, WEO GDP, own calculations.

Sectoral trade elasticities θ^s are taken from Caliendo and Parro (2015). Most of the sectors can be matched to a single elasticity in the Caliendo and Parro (2015) framework. The sectoral elasticities range from 0.4 in the other transport manufacturing sector to 16.5 in the paper and printing industries.[7]

3.2 The Swiss International Input-Output Table

This paper proposes a novel data source to construct Swiss input-output linkages: the Swiss International Input-Output Table (SIIOT). Calibrations of multi-sector quantitative trade models rely heavily on input-output tables. As shown in Section 3.1, they are the basis for the construction of production function parameters. This section details the advantages of using the SIIOT, gives a brief overview of how this dataset was constructed, and examines its features. More detail on the construction of the SIIOT is given in Appendix A.

The Swiss Federal Statistical Office (SFSO) publishes national input-output tables (IOT). However, it gives the following warning to prospective users: "given the particular state of data sources in Switzerland, the available IOT–as well as its previous years' versions–bears an experimental character. This stems from the fact that, in Switzerland, some of the compulsory data sources for an IOT's production are missing and therefore have to be estimated."[8] Missing data include commodity-level production and industry breakdowns of intermediary input use.

In addition to their "experimental character", the SFSO IOT do not describe international sectoral linkages. These linkages, however, are important for studying the cross-sectoral transmission of trade shocks. For example, the WIOT were built to account for such international linkages and support such analyses. In its latest 2016 release, the WIOT include estimates for Switzerland. Instead of using the SFSO IOT, one could thus rely on the WIOT. However, the WIOT are in fact built based on the Swiss IOT. Nathani, Hellmüller, and Schwehr (2016) adapted the SFSO data for the WIOT. Although they tried to refine the SFSO estimates, they acknowledge that the SFSO tables' "experimental character" carries over into the WIOT. For a small, open economy, however, information on international linkages may be as important as the data on purely domestic linkages.

The SIIOT provides an alternative data source on international linkages for Switzerland. It is the result of a collaboration between the SNB and the ETH. The project's objective was to identify sector-level goods imports based on disaggregated firm-level trade data from the Swiss Federal Customs Administration (FCA). A difficulty in doing so is that transaction-level trade data only give partial information on Swiss importers' identities. Typically, the importer's name and address are available, but not its sector of activity. The challenge was to match firm-level trade data to other datasets to recover

[7] Table A.1 in Appendix A reports the sector description, correspondence to the ISIC classification and corresponding trade elasticity θ^s.

[8] See https://www.bfs.admin.ch/bfs/en/home/statistics/national-economy/input-output.html.

the importing firm's sector of activity. Several datasets were collected for that purpose: the KOF Enterprise Panel survey, a subset of the ORBIS dataset, and finally a subset of the BISNODE dataset. In the easiest cases, transaction-level trade data could be matched to these datasets using the Swiss firm identifier (UID). Unfortunately, registering the importing firm's UID was not always mandatory in the trade data, and in many cases, it was missing or incorrect. In those cases, the match was achieved based on the importing firm's name and address. The ETH developed a machine learning algorithm to generate clean firm identifiers, assign transactions to a single entity (or cluster), and ultimately recover the importer's sector of activity.

The resulting database is a transaction-level database of Swiss importers, in which the importing firm's sector of activity is identified. This database allows for the construction of precise estimates of sectoral imports and thus international input-output linkages. In the calibration and subsequent counterfactual analysis, Swiss input-output linkages ρ_n^{sb} are based on the SIIOT.

Table 3: Descriptive statistics - SIIOT and WIOT sectoral linkages

All linkages

	N	Mean	St. Dev.	Median	Min	Max
SIIOT	361	2.0	4.9	0.3	0.0	43.1
WIOT	361	2.0	5.3	0.2	0.0	49.9

Diagonal linkages

	N	Mean	St. Dev.	Median	Min	Max
SIIOT	19	18.2	9.6	18.8	0.5	43.1
WIOT	19	18.9	12.1	17.4	3.4	49.9

Non-diagonal linkages

	N	Mean	St. Dev.	Median	Min	Max
SIIOT	342	1.1	2.1	0.3	0.0	19.3
WIOT	342	1.1	2.4	0.2	0.0	19.4

Notes: This table reports summary statistics of Switzerland's linkages between tradable sectors based on the SIIOT and WIOT. It further reports summary statistics for diagonal linkages, i.e., ρ_n^{sb} where $s = b$, and non-diagonal linkages, i.e., ρ_n^{sb} where $s \neq b$. Note that linkages from and to the services sector are excluded since they are the same in the SIIOT and WIOT by assumption.

The SIIOT shows typical features of input-output tables: a strong diagonal and many entries close to zero.[9] In other words, most industries

[9]Table B.1, reported in Appendix B due to space concerns, shows the sectoral linkages

have a high input share from their own sector. In addition, input shares are concentrated in a few sectors. To further illustrate the characteristics of the SIIOT sectoral linkages, I compare them to those of the WIOT and report summary statistics in Table 3.

Overall, SIIOT sectoral linkages are broadly in line with those of the WIOT. Table 3 reports similar descriptive statistics across both data sources. This is to be expected since the WIOT and SIIOT differ only in the allocation of inputs across sectors. However, sectoral linkages based on the WIOT tend to have a slightly higher standard deviation than those based on the SIIOT, while diagonal linkages based on the SIIOT tend to be lower than those of the WIOT. Nevertheless, the correlation between the SIIOT and the WIOT is high, 0.86.

At the sector level, the SIIOT data may deviate significantly from the WIOT. I calculate the deviations between the SIIOT and the WIOT sectoral linkages and calculate the sum of positive deviations between data sources for each Swiss buying sector, which gives an estimate of how much the allocation of input uses differs across data sources.[10] As shown in Column (1) of Table 4, the deviations may be significant. More than a fifth of inputs in the other manufacturing and the electronic and optical industries are allocated to different suppliers in the WIOT compared to the SIIOT: 20.5% and 22.2%, respectively. On average, 10% of input shares are allocated to different sectors across data sources.

These deviations across data sources matter for the study of trade shocks. Let ξ_n^s denote the exposure of country n's sector b to foreign markets, which is measured by the share of inputs that is sourced from abroad. Formally, it is given by

$$\xi_n^b = \sum_{s=1}^{S} (1 - \pi_{nn}^s) \rho_n^{sb}. \tag{29}$$

Intuitively, ξ_n^s captures how exposed importing sectors are to a foreign trade shock. Without sectoral linkages ($\rho_n^{sb} = 0$ for all $s \neq b$, and $\rho_n^{ss} = 1$), a trade shock affects sector s only if sector s is impacted directly. With sectoral linkages, shocks can be transmitted across sectors. Sectors that have large linkages with open sectors (sectors with small home trade shares π_{nn}^s) are particularly vulnerable to foreign shocks.

The WIOT tend to underestimate Swiss sectors' exposure to foreign markets. To show this, I calculate the sectoral exposure to foreign markets using the SIIOT linkages and then using the WIOT linkages. Column (2)

between Swiss and foreign tradable sectors based on the SIIOT. I describe the relevant assumptions for the construction of the Swiss input-output linkages for 2014 in detail in Appendix A. The services sector is not reported, as the SIIOT does not provide any information on how many inputs are sourced from foreign services sectors or how much the services sector buys from foreign sectors.

[10] Table B.2 in Appendix A reports the full matrix of deviations between the sectoral linkages based on the SIIOT and those reported in the WIOT.

of Table 4 reports the difference between the two measures. The largest underestimations are in the electronic and optical, other manufacturing, and wood industries: based on the SIIOT, these industries buy 11.6%, 5.6%, and 5% more inputs from abroad, respectively, than is suggested by the WIOT. The WIOT underestimate the exposure to foreign markets for all but two sectors: the pharmaceutical industry and the mining sector. In these two cases, however, the resulting overestimations are small: 0.2% and 0.6%, respectively. On average, Swiss sectors buy 2.6% more inputs from foreign markets based on the SIIOT. In Section 4, I show how this data feature translates into the quantitative results.

Using the SIIOT to calibrate sectoral linkages ρ_n^{sb} requires one significant assumption: international linkages are representative of domestic input-output linkages. To give support for this assumption, Column (3) of Table 4 reports for each Swiss tradable sector the share in total inputs of inputs sourced from abroad. In other words, it reports the openness of the Swiss tradable sectors. At the aggregate level, the SIIOT identifies linkages for 45.5% of inputs used in the production of the Swiss tradable sectors. International linkages are thus almost as important as domestic linkages for a small open economy such as Switzerland. One caveat, however, should be emphasized: the representativeness of the SIIOT is unequal across sectors. For example, the agriculture, mining, and food industries source less than a fourth of their inputs from abroad. However, the motor vehicles, basic metals and textile industries source more than three fourths of their inputs from abroad. Note that while the WIOT tend to underestimate Swiss sectors' exposure to foreign markets, this feature does not follow from the representativeness of international linkages at the sector level. In fact, there is almost no correlation between sectoral openness and the deviation in sectoral exposure to foreign markets (-0.04). This suggests that the SIIOT identifies some new feature of Swiss sectors' exposure to foreign trade shocks.

Table 4: Sector-level characteristics of the SIIOT

	Deviation from WIOT		Openness
	Total	Exposure	
	(1)	(2)	(3)
Agriculture	13.5	1.2	10.1
Mining	6.5	-0.6	14.3
Food	11.8	2.2	23.1
Textiles	2.8	0.6	80.1
Wood	14.4	5.0	37.7
Paper	7.3	2.2	68.7
Printing	5.9	2.4	40.8
Chemicals and oil	6.4	3.2	50.5
Pharma	6.0	-0.2	57.0
Plastics	6.6	1.3	73.3
Minerals	3.0	0.4	44.6
Basic metals	12.1	2.1	92.1
Fabricated metals	10.9	3.2	52.9
Electronic and optical	22.2	11.6	36.8
Electrical equipment	11.5	3.6	29.6
Machinery	5.7	1.5	51.8
Motor vehicles	16.8	3.9	92.3
Other transport	7.6	0.5	58.9
Other manufacturing	20.5	5.6	59.1
Average	10.1	2.6	-
Aggregate	-	-	45.5

Notes: This table details selected characteristics of the SIIOT. Column (1) reports the total deviation in sectoral linkages, i.e., the sum of positive deviations between SIIOT and WIOT sectoral linkages, in percent, for each buying sector. Column (2) reports the difference between the sectoral exposure to foreign markets based on the SIIOT and based on the WIOT data. The sectoral exposure to foreign markets is defined in equation (29). Column (3) reports the share, in total inputs, of inputs sourced from foreign markets. Foreign inputs are constructed based on the SIIOT.
Sources: SFSO, SIIOT, WIOT, own calculations.

4 Switzerland's gains from trade

To assess Switzerland's total gains from trade, I compare a world in autarky to the initial equilibrium calibrated to the 2014 data. Gains from trade are thus given by the welfare change associated with moving from a world without international trade, i.e., trade costs are infinite ($\kappa_{in}^s = \infty$ for $i \neq n$), to the observed equilibrium. Baseline results refer to the model and calibration described in Sections 2 and 3.[11]

Switzerland's gains from trade are 17.2%. Under the baseline model and calibration, real GDP is thus 17.2% higher in the observed equilibrium compared to that of a world in autarky. This effect is driven only by shutting down international trade. All other factors, in particular productivity and technology levels, are held constant.

Table 5: Source of Switzerland's gains from trade

(1) Baseline	17.2
(2) No I-O linkages ($\rho_n^{ks} = 0$ if $k \neq s$, $\rho_n^{ss} = 1$)	20.5
(3) No intermediate inputs ($\alpha_n^s = 1$)	8.1
(4) One sector model	5.2
(5) No SIIOT	14.9

Notes: This table reports the change in real wage (real GDP) associated with moving from autarky, i.e., a world in which all trade is prohibited, to the observed equilibrium. Row (1) reports the welfare change in the baseline model and calibration as detailed in Sections 2 and 3. Row (2) shuts down the sectoral linkages effect, i.e., $\rho_n^{ks} = 0$ if $k \neq s$ and $\rho_n^{ss} = 1$ for all n, s, meaning that only the final goods and intermediate goods effects are active. Row (3) shuts down the intermediate inputs effect, i.e., $\alpha_n^s = 1$ for all n, s, meaning that only the final goods effect is active. Row (4) reports the welfare change in an Eaton and Kortum (2002)-like one-sector model as in Hepenstrick (2016). Row (5) reports the welfare change if the calibration does not use the SIIOT data for sectoral linkages but instead uses the WIOT estimates for Switzerland's sectoral linkages.

Gains from trade are higher when not accounting for sectoral linkages. Swiss real GDP is 20.6% higher in the observed equilibrium than in the autarky world based on a model without sectoral linkages ($\rho_n^{ks} = 0$ if $k \neq s$ and $\rho_n^{ss} = 1$). The baseline results therefore predict lower gains from trade

[11] I solve the model under the assumption of balanced trade, setting $\iota_n = 0$ for all countries. Without this assumption, the large trade cost decreases implied by moving from autarky to the observed equilibrium lead to extreme general equilibrium wage adjustments, which cannot be rationalized. Ossa (2014) pointed out this feature of GE trade models.

for Switzerland by 3.4 percentage points. This implies that the sectoral linkages effect is negative in the baseline model. To explain this result, let us go back to the aggregate and sectoral welfare equations. As explained, based on equation (28), the sectoral linkages effect can be either positive or negative. Following trade liberalization (a decrease in trade costs), the sectoral linkages effect is positive in a given sector if its inputs have relatively higher productivity gains (higher price decreases), which benefit the buying sector. The sectoral linkages effect is negative in a given sector if its inputs have relatively lower productivity gains, which weigh on the buying sector. Figure 1a shows this feature across sectors. It reports the sectoral contributions to Switzerland's gains from trade in the baseline model and in the model without sectoral linkages. The difference in sectoral contributions thus captures the sectoral linkages effect. In the baseline results, relatively closed sectors (e.g., services or agriculture) experience larger contributions to welfare gains, meaning that they benefit from their exposure to open, productive sectors through input-output linkages. In contrast, open sectors (e.g., textiles or pharmaceuticals) experience smaller contributions to welfare gains in the baseline results as their own productivity gains are hindered by their sectoral linkages. In the baseline results, the aggregate negative sectoral linkages effect implies that the second effect is quantitatively more important overall. In other words, relatively open sectors lose more than relatively closed sectors gain through input-output linkages.

Intermediate inputs drive most of the gains from trade. If the model does not account for intermediate inputs ($\alpha_n^s = 1$), then real GDP is 8.1% higher in the observed equilibrium than in the autarky world. Welfare gains from trade are thus largely underestimated if the intermediate input channel is not taken into account. The use of foreign inputs contributes to the competitiveness of countries and the overall comparative advantage of countries, which in turn generates larger welfare effects.

Accounting for multiple sectors generates higher gains from trade. I compare the baseline results to a one-sector model, following Eaton and Kortum (2002). To do so, I aggregate all tradable sectors into one sector using the same data and calibration approach.[12] This is equivalent to the analysis of Hepenstrick (2016), which assesses the sources and magnitudes of Switzerland's gains from trade. Based on the one-sector model, real GDP is 5.2% higher in the observed equilibrium than in the autarky world. Welfare gains from trade are thus largely underestimated. When accounting for multiple sectors, variation in sectoral import shares and in sector-specific trade elasticities is quantitatively important for welfare gains from trade.

Switzerland's gains from trade are lower if sectoral linkages are based on the WIOT rather than on the SIIOT. I show this discrepancy by solving

[12]The one-sector model includes intermediate inputs but no sectoral linkages. Following Simonovska and Waugh (2014), I use an aggregate trade elasticity of 4.14.

for Switzerland's gains from trade using the baseline model and the baseline calibration with one exception: instead of relying on the SIIOT, I use the WIOT to construct Switzerland's sectoral linkages. I find that real GDP is 14.9% higher in the observed equilibrium than in the autarky world. Thus, by relying on the WIOT sectoral linkages for Switzerland, welfare gains from trade are underestimated by 13.4%.[13]

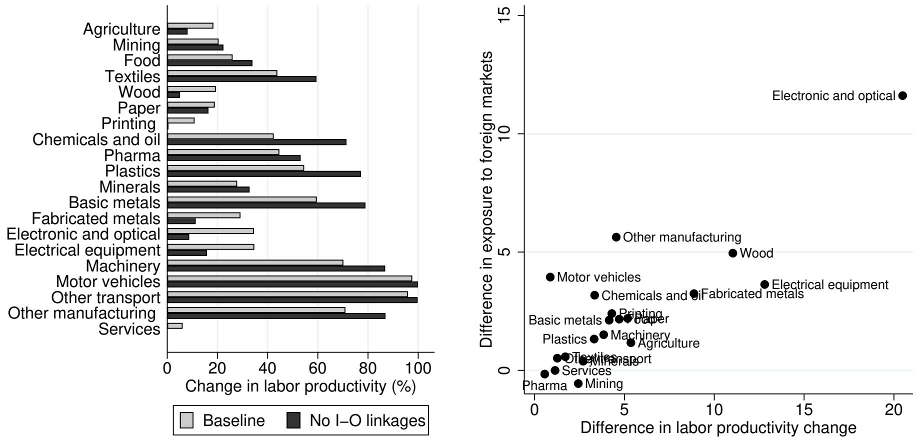
Compared to the baseline results, sectoral contributions to welfare gains are underestimated in all sectors. Sectoral labor productivity increases based on the SIIOT are therefore higher than those predicted using the WIOT. However, the magnitude of the discrepancy in sector-level changes in labor productivity depends on the sector-level underestimation of foreign exposure by the WIOT.[14] As shown in Figure 1b, there is a strong positive correlation between the two measures. For example, the WIOT underestimate the foreign exposure of the electronic and optical industry the most, by 11.6%. The counterfactual analysis finds the largest discrepancy in the labor productivity change between each data source for this sector. Namely, based on the SIIOT, the labor productivity change in the electronic and optical industry is 20.6% higher than that based on the WIOT data. Conversely, the SIIOT suggests that the pharmaceutical industry and the mining industry are slightly less exposed to foreign sectors than the WIOT suggest. For these two sectors, the discrepancy in the labor productivity change is relatively small: 1.3% and 2.6%, respectively.

Sectors with a larger exposure to foreign markets tend to show larger labor productivity gains based on the SIIOT compared to the WIOT. In other words, the counterfactual analysis based on the SIIOT generates larger welfare gains from trade compared to traditional data sources because the SIIOT suggests that Swiss industries have larger linkages with industries with which Switzerland has large import shares. Moving from autarky to the observed equilibrium, prices decrease more in those sectors with high import shares. These higher price decreases are weighted by higher sectoral linkages. Given the welfare equation, this drives higher welfare gains.

[13]If one were to follow the calibration approach of Caliendo and Parro (2015) for consumption shares, different linkages would imply different consumption shares. As a robustness check, I solve for consumption shares following the original approach of Caliendo and Parro (2015) despite data limitations and solve for Switzerland's gains from trade under different model assumptions. Table B.4 presents the results. In that robustness, the model without the SIIOT linkages predicts 11% lower gains from trade than the model with SIIOT linkages.

[14]Table B.3 reports sectoral labor productivity changes under both calibrations as well as the contribution of each sector to the discrepancy in the aggregate welfare change compared to the baseline. In the aggregate, variation in the labor productivity changes of the services sector plays a major role, as it has by far the largest consumption share in Switzerland and thus determines a major part of the aggregate welfare change.

Figure 1: Sector-level sources of discrepancies in gains from trade



(a) With and without I-O linkages (b) With and without SIIOT

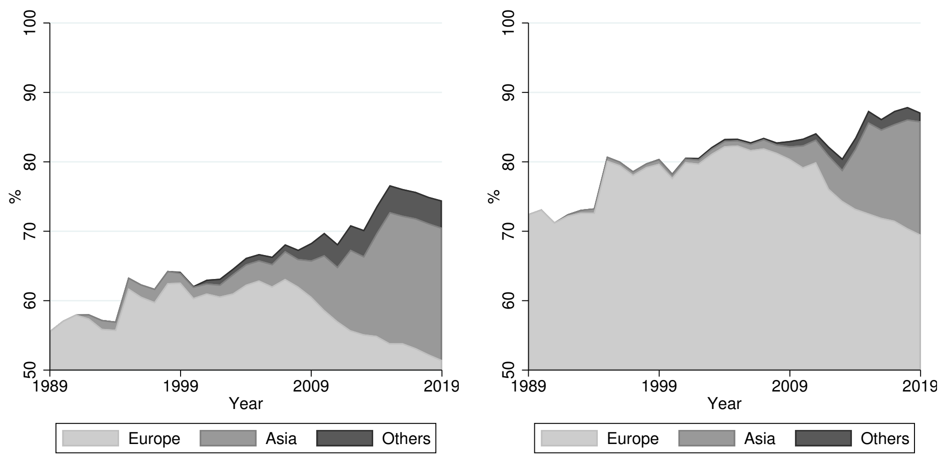
Notes: This figure reports the sector-level sources of discrepancies in gains from trade across models and data assumptions. Figure (a) reports the sectoral labor productivity changes in the baseline model and in the model without sectoral linkages. The change in sectoral labor productivity is given by equation (28). Figure (b) assesses the sources of discrepancies in welfare gains across data sources for Switzerland's sectoral linkages. The x-axis plots the difference between the sectoral contributions to gains from trade based on the SIIOT and based on the WIOT. The y-axis plots the difference between sectoral exposure to foreign markets based on the SIIOT and based on the WIOT data. The difference in sectoral exposure is as reported in Table 4 and based on equation (29).

5 The welfare and trade effects from Switzerland's trade integration

Switzerland has pursued continued integration with its trading partners, which is reflected in its wide free trade agreement (FTA) network. Starting with the European Free Trade Agreement (EFTA) in 1960, Switzerland has since concluded more than 30 FTAs with at least as many trading partners. Notable FTAs were concluded with Canada and Japan in 2009 and China in 2014, while extensive bilateral agreements have been negotiated with the European Union.

FTA partners account for the majority of Swiss trade and their importance has grown over time. Figure 2 reports the share of Swiss exports to and imports from FTA trading partners. On the export side, the share of Swiss trade to FTA partners increased from 57% to 75% between 1989 and 2019. At first, European countries accounted for most of this trade. Over the last decade, however, the share of European countries in Swiss exports has decreased. Compared to a peak of 63% in 2007, European countries accounted for 51% of 2019 Swiss exports. Instead, the trade share of Asian countries with which Switzerland has an FTA (e.g., Japan and China) has increased sharply. In 2019, they accounted for 19% of Swiss exports. On the import side, Switzerland relies even more on its FTA partners than it did in the past. The share of Swiss trade from FTA partners increased from 72% to 87% between 1989 and 2019. As with exports, reliance on European countries for imports has decreased over the past decade. Between 2008 and 2019, their share decreased from 81% to 70%. Most of the increase in imports from FTA partners is driven by Asian countries. In 2019, they accounted for 16% of Swiss imports.

Figure 2: Share of Switzerland's trade with FTA partners



(a) Exports (b) Imports

Notes: This figure reports the share of Swiss trade flows to and from trading partners with which Switzerland has an FTA. Figure (a) reports the share of exports to FTA partners. Figure (b) reports the share of imports from FTA partners. The list of trading partners with which Switzerland has an FTA comes from the SECO. FTA trading partners are classified as European countries, Asian countries (CHN, JPN, etc) and others (CAN, MEX, etc). Exports and imports reflect the business-cycle view of trade (excluding non-monetary gold and other special trade).
Sources: FCA, SECO, own calculations.

Switzerland's wide FTA network is reflected in the calibration's country sample. In 2019, Switzerland had an FTA with all sample countries but four: Australia, India, Russia, and the US. Among those, Switzerland is officially negotiating an agreement with India and Russia. Finally, there have recently been talks to start negotiations with the US.

This section turns towards policy-oriented counterfactual exercises. In particular, these exercises evaluate the welfare and trade effects of Switzerland's trade integration. The counterfactual analysis considers two trade shocks: (1) the dissolution of Switzerland's FTA network, and (2) the conclusion of an FTA with the US. The rest of this section first details the shocks' construction and then presents the results of the quantitative analysis associated with each shock.

5.1 Constructing the trade shocks

To perform the counterfactual analysis, I feed a trade shock into the initial calibrated equilibrium. Given the focus on FTAs, trade shocks are captured by increases or decreases in tariffs between Switzerland and the selected trading partners. For each shock, I solve for the change in trade costs using equation (11). 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

$$\hat{\kappa}_{in}^s = \frac{1 + \tau_{in}^{s\,\prime}}{1 + \tau_{in}^s}, \tag{30}$$

where τ_{in}^s is the initial 2014 (trade-weighted) tariff rate applied by country n to goods of sector s from country i and $\tau_{in}^{s\,\prime}$ is the counterfactual tariff after the relevant tariff shock. For example, following trade liberalization, the counterfactual tariff is lower than the initial tariff, i.e., $\tau_{in}^{s\,\prime} < \tau_{in}^s$, which in turn implies that the trade cost decreases, i.e., $\hat{\kappa}_{in}^s < 1$. Note that $\hat{\kappa}_{in}^s \neq 1$ only if the exporting or importing country is Switzerland. Many elements of the trade shock matrices are thus $\hat{\kappa}_{in}^s = 1$.

Two characteristics of equation (30) should be emphasized. First, initial tariffs are constructed using trade weights from 2014 trade data. Counterfactual tariffs are constructed while keeping the trade weights fixed. Second, an underlying assumption of equation (30) is that the trade shock has an effect only through tariffs. Non-tariff trade barriers, d_{in}^s in equation (11), are unchanged. This counterfactual analysis considers only goods trade liberalization through tariff reduction. Other aspects of an FTA, such as services trade or investment, are outside this paper's scope.

5.1.1 Shock 1: dissolution of Switzerland's FTA network

The first tariff shock evaluates the scenario in which the FTA network between Switzerland and its favored trading partners is dissolved. In the absence of an FTA, Switzerland should apply most-favored nation (MFN) tariffs according to WTO rules.[15] The counterfactual tariffs are thus the

[15] Under the WTO agreements, countries cannot normally discriminate among their trading partners. If a special favor is granted to some trading partner (such as a lower customs duty rate for one of their products), then it should be given to all other WTO members. Some exceptions are allowed. In particular, countries can set up a free trade agreement that applies only to goods traded within a specific group of trading partners–discriminating against goods from outside of the group.

(trade-weighted) MFN tariffs that should be applied at the sector level between Switzerland and its former FTA trading partners based on 2014 tariff data.[16] Figure 3 details the initial and counterfactual tariffs between Switzerland and its FTA partners.

As expected, initial tariffs between Switzerland and its FTA partners are low. On the Swiss side, the average (trade-weighted) tariff applied by Switzerland to its FTA partners is 2.1%. There are two notable exceptions to low tariffs: agriculture and the food industry. Switzerland applies relatively high tariffs to imports from these sectors (19.4 and 28.8%, respectively). FTA partners also apply low tariffs to Swiss exports. The average tariff is 0.5%. Like Switzerland, FTA partners also apply higher-than-average tariffs to imports from the agriculture and food sectors (6.3 and 8%, respectively).

Following the FTA network's dissolution, tariffs increase but remain relatively low. Switzerland applies a 5.1% counterfactual average tariff rate. The first tariff shock thus implies a 3 percentage points tariff increase by Switzerland on former FTA partners, from 2.1 to 5.1%. The textile and paper industries see the largest tariff increases: +11.7 and +9.4 percentage points. As on the Swiss side, the average MFN tariff applied by Switzerland's FTA trading partners to Swiss exports also remains relatively low: 2.5%. The first tariff shock implies a 2 percentage points average tariff increase by former FTA partners on Swiss exports, from 0.5 to 2.5%. The textile and food industries see the largest tariff increases: +7.5 and +5.6 percentage points, respectively.

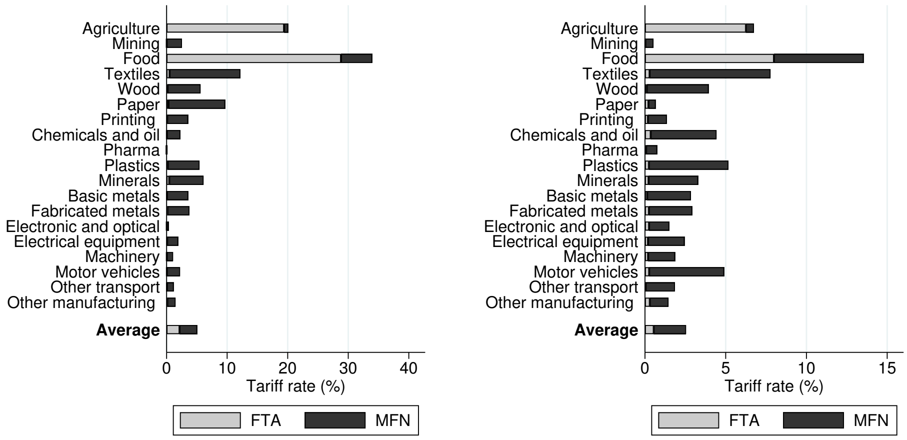
On average, the first tariff shock is relatively small in terms of magnitude. However, it impacts a large share of Swiss trade. As shown in Figure 2, more than 80% of 2014 Swiss imports come from FTA partners, while more than 70% of 2014 Swiss exports go to FTA partners.

5.1.2 Shock 2: conclusion of a CH-US FTA.

Switzerland does not have an FTA with the US, but preliminary meetings have taken place to begin exploratory talks towards an eventual agreement. The second shock considers the welfare and trade effects of concluding such an agreement with the US. To construct counterfactual FTA rates, I assume that Switzerland concludes an FTA agreement with the US on similar terms as with its other favored trading partners. Formally, I take the average product-level tariff rate applied by Switzerland to its actual FTA partners and then construct the corresponding trade-weighted average FTA tariff rate that would be applied to US exports given observed 2014 trade flows. I follow the same approach for US tariffs on Swiss goods. Figure 4 details the

[16] I consider all countries with which Switzerland has an FTA in 2014. I thus exclude the more recent FTAs concluded with Brazil and Indonesia. Note that MFN tariffs may differ across origin countries because of the trade weights used in the construction of sectoral tariffs.

Figure 3: Shock 1 – dissolution of Switzerland's FTA network



(a) Swiss tariffs on FTA partners (b) FTA tariffs on Switzerland

Notes: This figure shows the initial and counterfactual tariffs associated with the first tariff shock: the dissolution of Switzerland's FTA network. Figure (a) reports average (trade-weighted) tariffs applied by Switzerland to FTA partners. Figure (b) reports average (trade-weighted) tariffs applied by Switzerland's FTA partners to Switzerland. The list of Switzerland's FTA partners is reported in Appendix A. FTA tariffs refer to the initial tariffs applied by Switzerland to its favored trading partners in 2014, and conversely. MFN (most-favored nation) tariffs refer to the counterfactual bilateral tariffs that would apply without an FTA.
Sources: World Bank WITS, UN Comtrade, own calculations.

initial and counterfactual tariffs applied between Switzerland and the US.

Even without an FTA, initial tariffs are low. Switzerland applies a 1.6% average tariff to US exports. Most tariff rates are below 5%. A notable exception is food imports, which are subjected to a 34% (trade-weighted) tariff rate. At the other extreme, pharmaceutical products are free from tariffs.[17] Like Switzerland, the US applies relatively low initial tariffs to Swiss exports. The average tariff is 1.2%. The highest tariffs are applied to the textile industry (7%), while products from several industries (e.g., pharmaceuticals, agriculture, other transport, or paper) can be imported at a very low tariff rate (less than 1%).

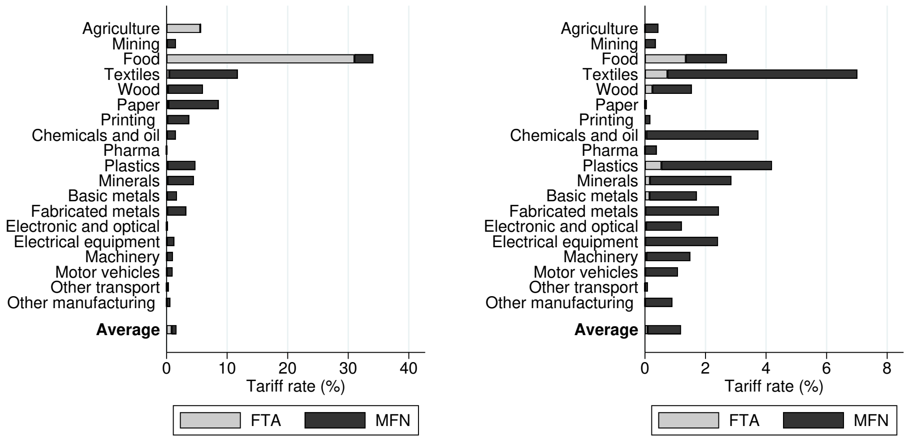
With a CH-US FTA, tariffs decrease. The average import tariff applied by Switzerland to US exports is halved, from 1.6% to 0.8%. Decreases at the sector level could be significant; for example, the textile industry sees an 11.3 percentage points decrease. The average import tariff applied by the US to Swiss exports decreases by 1.1 percentage points, from 1.2% to

[17]Switzerland and the United States are both members of the "zero-for-zero" initiative for pharmaceutical products at the WTO.

0.1%. Swiss exports would thus have access to the US market while bearing almost no import tariff burden. On the US side, the textile industry also sees the largest tariff reduction (−6.3 percentage points).

A CH-US FTA leads to overall close-to-zero tariffs with a few exceptions on the Swiss side (agriculture, or the food industry). However, initial tariffs between Switzerland and the US are already low. The scope of tariff decreases is thus limited.

Figure 4: Shock 2 – conclusion of a CH-US FTA.



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

Notes: This figure shows the initial and counterfactual tariffs associated with the second tariff shock: the conclusion of a CH-US FTA. Figure (a) reports average (trade-weighted) tariffs applied by Switzerland to the US. Figure (b) reports average (trade-weighted) tariffs applied by the US to Switzerland. MFN (most-favored nation) tariffs refer to the initial tariffs applied by Switzerland to the US in 2014, and conversely. FTA tariffs refer to the counterfactual bilateral tariffs that would apply between Switzerland and the US under an FTA.
Sources: SFSO, SIIOT, WIOT, own calculations.

5.2 Quantitative results

This section turns to the results of the counterfactual analysis associated with both policy-oriented trade shocks. I first present aggregate and sectoral welfare effects. Then, I examine aggregate and sectoral trade effects by focusing on changes in real exports.

5.2.1 Welfare effects

By losing its FTA network, Switzerland experiences welfare losses. Column (1) of Table 6 shows that Swiss real GDP declines by 0.58%. As Columns

(2) to (4) show, the real GDP decline is first driven by the intermediate goods effect (-0.41%) and second by the final goods effect (-0.21%). The sectoral linkages effect partly offsets the real GDP decline ($+0.04\%$).

Other countries also experience welfare losses. Compared to that of Switzerland, however, the magnitude of these losses is smaller. For instance, real GDP declines by 0.04% in Germany and by 0.02% in France and in Italy. The welfare losses of Switzerland's closest neighbors are largely driven by the intermediate and final goods effects, while the sectoral linkages effect mitigates the welfare losses. As in the Swiss case, this suggests that productivity losses in some sectors are attenuated by lesser declines in other sectors through input-output linkages.

Overall, losses are confined to Switzerland and its neighbors. Other trading partners with which Switzerland has an FTA are largely unaffected. For instance, real GDP in Japan and China remains stable. Trading partners with which Switzerland does not have an FTA are similarly largely unaffected. Such countries are only indirectly affected by the higher tariffs. The model suggests that such indirect effects are small.

If Switzerland and the US conclude an FTA, both countries experience welfare gains, albeit small ones. As shown in Column (5) of Table 6, Swiss and US real GDP increase by 0.04% and 0.01%, respectively. The gains are largely driven by the intermediate goods effect and by the final goods effect. Other countries are largely unaffected by the CH-US FTA.

The small welfare gains associated with the second tariff shock can be explained by the relatively small tariff shock on both the Swiss and US sides. Modest bilateral tariff reductions thus drive small welfare effects. The tariff shock furthermore affects only two countries. However, the model generates larger effects when trade shocks affect a large number of trading partners. As seen with the first tariff shock, Swiss real GDP declines by a larger magnitude following a similarly small tariff shock, which affects a large number of trading partners. If a shock affects two countries, trade reallocation offsets the loss of productive goods in a given market. Welfare effects are thus smaller. If a shock affects many countries, trade reallocation is more difficult, as countries cannot easily find cheap alternatives. This lack of trade reallocation leads to larger welfare effects.

Decomposing aggregate welfare effects into sectoral contributions sheds light on the underlying sources of welfare changes. The aggregate welfare change of equation (27) is the average of the sectoral labor productivity changes of equation (28) weighted by consumer expenditure shares. Table 7 reports the change in sectoral labor productivity associated with the dissolution of Switzerland's FTA network and with the conclusion of a CH-US FTA.

Table 6: Welfare effects

Country	No FTAs				CH-US FTA			
	Total	Final Goods	Intermediate Goods	Sectoral Linkages	Total	Final Goods	Intermediate Goods	Sectoral Linkages
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Switzerland	-0.58	-0.21	-0.41	0.04	0.04	0.01	0.03	-0.00
US	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.00
Germany	-0.04	-0.02	-0.04	0.03	-0.00	0.00	-0.00	0.00
France	-0.02	-0.01	-0.03	0.02	-0.00	0.00	-0.00	0.00
Italy	-0.02	-0.01	-0.02	0.01	-0.00	0.00	-0.00	0.00
Rest EU	-0.01	-0.00	-0.01	0.00	-0.00	-0.00	-0.00	0.00
China	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	0.00
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other FTAs	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00
Non FTA	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
World	-0.01	-0.00	-0.01	0.00	0.00	0.00	-0.00	-0.00

Notes: This table reports the welfare change, in percent, measured by the change in real wage (real GDP) $\frac{\hat{w}_n}{\hat{P}_n}$, associated with two counterfactual exercises: (1) the dissolution of Switzerland's FTA network and (2) the conclusion of an FTA with the US. Both shocks are described in Section 5.1. It further reports the decomposition of the welfare effect into the final goods effect, the intermediate goods effect, and the sectoral linkages effect as given by the welfare equation (27). It reports GDP-weighted averages of welfare changes for groups of countries: Rest EU comprises all EU countries of the sample without DEU, FRA, and ITA; Other FTAs (CAN, MEX, KOR, NOR, TUR); Non FTA (AUS, BRA, IDN, IND, ROW, RUS, USA).

If Switzerland reneges on its FTA network, the model suggests sharper sector-level losses compared to the aggregate results. In particular, labor productivity decreases by up to 7.1% in the textile sector. The paper and plastics industries also suffer larger-than-average productivity losses (−5% and −3.6%, respectively). The sectors experience larger welfare losses because of comparatively higher tariff increases, as seen in Figure 3a.

If Switzerland and the US conclude an FTA, sectoral welfare effects are considerably higher than the aggregate effects. However, they remain relatively small. The textile industry sees the largest productivity increase (+0.38%). The paper and other manufacturing industries also see larger-than-average productivity gains (+0.3% and +0.22%, respectively). Again, larger productivity gains in those sectors may be explained by the relatively higher tariff shocks in those sectors.[18]

5.2.2 Trade effects

Although welfare effects tend to be small, the model may generate significant trade effects. In particular, Table 8 reports the change in Swiss real trade flows across trading partners associated with each tariff shock.

Switzerland's aggregate real exports decline by 6.9% following the dissolution of its FTA network. The decline is driven by a drop in real exports to Switzerland's neighboring countries: −14.3% to Germany, −12.3% to France, and −10.8% to Italy. Real exports to other FTA partners decline as well: −9.6% to other EU countries and −8.9% to non-EU FTA partners. Real exports increase slightly only to non-FTA trading partners: +1.0% to the US and +0.7% to other trading partners.

Switzerland's aggregate real imports decline by 7.6%. The decline is again driven by Switzerland's closest trading partners: −11.7% from Germany, −10% from France, and −11.2% from Italy. However, imports from other favored trading partners also see a significant decline: −15.9% from non-EU FTA partners. Real imports from non-FTA trading partners increase: +1.7% from the US and +9.1% from other trading partners.[19]

Real import and export increases to non-FTA trading partners cannot compensate for the deterioration of access to Switzerland's favored trading partners. The model thus challenges the notion that Switzerland could ride out a trade shock by reallocating imports and exports across trading partners.

Based on bilateral real exports, a CH-US FTA benefits both countries.

[18] Table B.5 in the Appendix shows the welfare change resulting from both shocks under other assumptions for the trade balance (e.g., under balanced trade or exogenous trade balances). Overall, the results are broadly aligned, but endogenous trade balances and balanced trade tend to generate larger effects than exogenous trade balances.

[19] In particular, real exports to Turkey and China decline significantly. On the import side, real imports from India and Indonesia increase significantly.

Table 7: Sectoral labor productivity effects

	No FTAs	CH-US FTA
Agriculture	-0.7	0.08
Mining	-0.8	0.13
Food	-2.0	0.11
Textiles	-7.1	0.38
Wood	-1.8	0.08
Paper	-5.0	0.30
Printing	-0.9	0.06
Chemicals and oil	-1.6	0.17
Pharma	-0.8	0.12
Plastics	-3.6	0.21
Minerals	-2.4	0.12
Basic metals	-3.3	0.19
Fabricated metals	-2.0	0.11
Electronic and optical	-0.9	0.12
Electrical equipment	-1.8	0.14
Machinery	-1.8	0.16
Motor vehicles	-2.5	0.21
Other transport	-1.3	0.16
Other manufacturing	-1.8	0.22
Services	-0.3	0.02

Notes: This table reports the change in Swiss sectoral labor productivity associated with two counterfactual exercises: (1) the dissolution of Switzerland's FTA agreements and (2) the conclusion of an FTA with the US. Both shocks are described in Section 5.1. The sectoral change in labor productivity is given by equation (28).

Swiss real exports to the US increase by 7.2%. US real exports to Switzerland increase by 7.6%. Nevertheless, the increase in Swiss real exports to the US is mostly at the expense of other export destinations: Swiss real exports decline across all other trading partners (e.g., -0.6% to Germany and to France, or -0.5% to Italy). Overall, the increase in Swiss real exports is slight: $+0.4\%$. The aggregate trade effects of a CH-US trade deal would be modest according to the model.

As with welfare effects, it is useful to report changes in real exports across sectors to illustrate the significant sectoral heterogeneity that is present. Figure 5 shows the change in sectoral real exports across country groups associated with both trade shocks.

At the sector level, there are clear losers (e.g., textiles) and clear winners (e.g., agriculture) following the dissolution of Switzerland's FTA network.

Table 8: Change in Swiss real trade flows

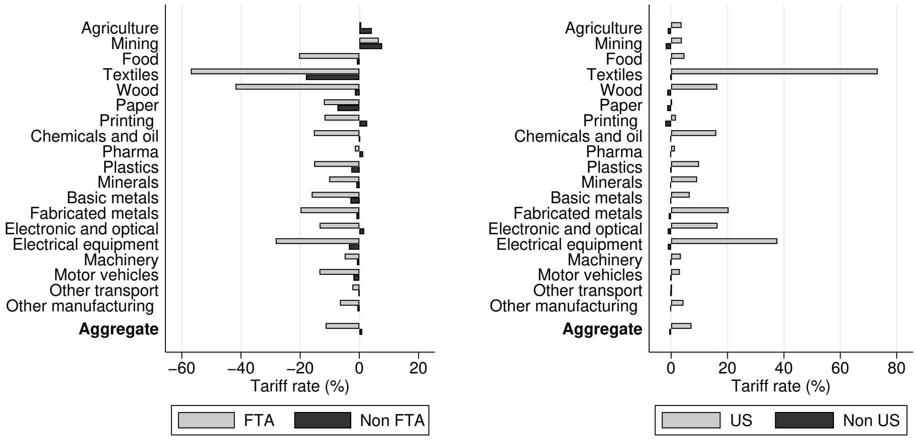
	No FTAs		CH-US FTA	
	Exports	Imports	Exports	Imports
US	1.0	1.7	7.2	7.6
Germany	-14.3	-11.7	-0.6	0.2
France	-12.3	-10.0	-0.6	0.1
Italy	-10.8	-11.2	-0.5	0.0
Rest EU	-9.6	-8.9	-0.5	0.1
Other FTAs	-8.9	-15.9	-0.6	0.0
No FTAs	0.7	9.1	-0.7	0.2
World	-6.9	-7.6	0.4	0.4

Notes: This table reports the change, in percent, in aggregate Swiss real trade flows (exports and imports) associated with two counterfactual exercises: (1) the dissolution of Switzerland's FTA agreements, and (2) the conclusion of an FTA with the US. Both shocks are described in Section 5.1.

Declines in real exports to FTA partners reach up to 57%, 42%, and 28% in the textile, wood, and electrical equipment industries, respectively. In contrast, real exports to FTA partners from the agriculture and mining sectors increase: +0.6% and +6.5%, respectively. The performance of sectors regarding trade to non-FTA partners is not uniform. First, real exports to non-FTA trading partners decrease significantly in some sectors: −18%, −7.4%, and −3.4% in the textile, paper, and electrical equipment industries, respectively. Second, increases in real exports to non-FTA partners are concentrated in only a few sectors. For example, the agriculture and mining sectors again see increases in real exports: +4.2% and +7.7%. Thus, a few sectors drive the small aggregate increase in Swiss real exports to non-FTA partners that is reported in Table 8. This implies that most Swiss sectors experience only decreases in real exports, both to FTA and non-FTA trading partners.

All sectors experience an increase in real exports to the US following the CH-US FTA. The magnitude, however, varies significantly. Figure 5b reports the change in real exports from Swiss sectors to the US and other trading partners following the conclusion of the CH-US FTA. Real exports to the US increase by up to +73% in the textile industry, but by less than +1% in the paper and other transport industries. Furthermore, all sectors experience a decrease in real exports to non-US trading partners. However, this decrease is small (up to −2% for the printing industry).

Figure 5: Change in Swiss sectoral real exports



(a) No FTAs (b) CH-US FTA

Notes: This table reports the change, in percent, in Swiss sectoral real exports. Figure (a) pertains to the dissolution of Switzerland's FTA agreements. It shows the change in real exports to FTA partners and non-FTA partners. The list of FTA and non-FTA partners is reported in Appendix A. Figure (b) pertains to the conclusion of an FTA with the US. It shows the change in Swiss real exports to the US and to non-US trading partners. Both shocks are described in Section 5.1.

6 Conclusion

This paper conducts a counterfactual analysis to assess Switzerland's gains from trade using a quantitative general equilibrium Ricardian trade model. Using a novel data source for Switzerland's sectoral linkages, it shows that gains from trade are typically underestimated. Other datasets on Switzerland's input-output linkages underestimate Swiss sectors' exposure to foreign markets. In the counterfactual analysis, this translates into a larger sectoral linkages effect and larger welfare gains.

The counterfactual analysis shows that sectoral linkages matter for the level of welfare gains and thus for the transmission of trade shocks to sectors. In particular, the SIIOT highlights gaps in the Swiss data. For a small open economy, this paper suggests that such gaps can lead to quantitatively important deviations in the conclusions of an empirical analysis.

This paper further evaluates two policy-oriented counterfactual exercises that capture specific dimensions of Switzerland's trade integration. I find that without its wide FTA network, Switzerland's real GDP would be lower. Trade reallocation cannot offset the loss of favored access to its largest trading partners. Both real exports and real imports decrease by approximately 7%. Furthermore, the conclusion of a CH-US FTA would raise GDP in both countries, albeit to a small extent. Aggregate real exports for each country see modest increases. However, CH-US bilateral trade increases by approximately 10%.

This paper quantifies the gains from Switzerland's trade integration. However, the results are tightly tied to the model, which has several limitations. First, the model is static. Thus, it cannot account for dynamic effects, such as investment decisions and technological spillovers. The model also focuses on a single transmission channel for the benefits of an FTA on real activity: tariffs. However, there are other dimensions to an FTA. For instance, an FTA may have chapters on services trade and investment policies. These aspects of bilateral economic relationships may impact real activity and lead to larger welfare gains. In particular, the interplay between trade and investment could lead to significant multiplicative effects, especially if embedded in a dynamic setting. When considering the results, the scope of the model should be therefore kept in mind.

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A Data appendix

Countries: The analysis includes 34 countries plus a constructed rest of the world. Tables and Figures report results for country groups based on the existence of an FTA with Switzerland:

- EU countries with an FTA: Germany, France, and Italy plus other EU countries (Austria, Belgium, the Czech Republic, Denmark, Spain, Finland, the United Kingdom, Greece, Hungary, Ireland, Lithuania, the Netherlands, Poland, Portugal, Romania, Slovakia, and Sweden).

- Other countries with an FTA: Canada, China, Japan, Korea, Mexico, Norway, and Turkey.

- Countries without an FTA: the United States and other non-FTA countries: Australia, Brazil, Indonesia, India, Russia, and the composite rest of the world (ROW).

I include as non-FTA partners sample countries with which Switzerland has concluded a FTA post-2014: Brazil and Indonesia. Details regarding the construction of ROW-specific variables is given below.

Sectors: Table A.1 describes the sector classification and its concordance to the ISIC revision 4 classification.

Consumer and production data: The 2016 release of the World Input-Output Tables is the main data source for consumer preferences and production function parameters. I use data relative to 2014. Consumer preferences are the ratio of final consumption expenditure in one sector to total final expenditure. Value-added shares are the ratio of total value-added to total gross production. Swiss data is taken from the SFSO, which publishes gross output and value-added data. The NOGA classification can be directly matched to the ISIC revision 4.

Trade shares: UN Comtrade data contains HS 2012 6-digit level trade flows between countries. I use the business-cycle view of trade, excluding non-monetary gold and other precious metals, coins, precious stones and gems, works of art and antiques. I harmonize the HS classification to the ISIC 4 revision, using the CPC 2.1 classification as a bridge. I rely on STAN gross output data to construct home trade shares π^s_{nn}. If missing, or if it predicts negative home trade shares, I rely on WIOT data to construct the home trade share instead.

Tariffs: The World Bank's WITS database publishes tariff data at the HS 6-digit level, including most-favored nation (MFN) rates and preferential

Table A.1: Sector classification

	ISIC rev. 4	Description	θ^s
1	01–03	Agriculture, forestry and fishing	9.11
2	5–9	Mining and Quarrying	13.53
3	10–12	Food products, beverages and tobacco	2.62
4	13–15	Textiles, apparel and leather	8.1
5	16	Wood	11.5
6	17	Paper	16.52
7	18	Printing and reproduction of recorded media	16.52
8	19–20	Chemicals and coke, refined petroleum products and nuclear fuel	3.13
9	21	Pharmaceuticals	3.13
10	22	Rubber and plastics metals	1.67
11	23	Other non-metallic mineral products	2.41
12	24	Basic metals	3.28
13	25	Fabricated metal products, except machinery and equipment	6.99
14	26	Computer, electronic and optical products	12.95
15	27	Electrical equipment	12.91
16	28	Machinery and equipment n.e.c.	1.45
17	29	Motor vehicles, trailers and semi-trailers	1.84
18	30	Other transport equipment	.39
19	31–32	Furniture and other manufacturing	3.98
20	>32	Services	5

Notes: This table describes the sector classification used in the analysis based on the two-digit level of the ISIC revision 4 classification. It further reports the trade elasticity θ^s taken from Caliendo and Parro (2015).

rates, depending on the trading partner. Those HS-6 level tariffs are constructed as the simple average of HS-8 digit tariff lines within the each HS 6-digit subgroup. Using HS-6 bilateral trade flows, I construct trade-weighted bilateral tariff rates for all sectors and all sample countries. Countries that do not trade between each other for a given sector are assigned an infinite trade cost.

SIIOT: The dataset underlying the SIIOT contains transaction-level trade data from the FCA. To construct SIIOT sectoral linkages, the first step is to construct Swiss importing sectors and foreign exporting sectors. On the import side, the Swiss industries are recorded at the four-digit level of the NOGA classification, which can be directly harmonized with this paper's sectoral classification (see Table A.1). On the export side, trade flows are recorded at the 8-digit level of the HS 2012 classification, which I harmonize to this paper's sector classification using the usual concordance tables. Then, I collapse trade value by exporting and importing sectors such that I have bilateral trade flows from sector to sector between Switzerland and the world.

I then make the following assumptions. First, the dataset identifies the identity of the importing sector for 85% of total import value for Switzerland in 2014. I assign the unidentified 15% of trade using a proportionality assumption. Namely, if based on identified trade, a sector imports half of the total imports of a product, then this sector also imports half of the unidentified trade of that product. Second, I focus on the business-cycle view of international trade: I exclude trade flows of non-monetary gold and other precious metals, coins, precious stones and gems, works of art and antiques. Third, the data identifies imports by wholesale and retail firms. They account for almost 40% of total imports in Switzerland. The difficulty in treating their imports is that input-output tables treat wholesale and retail trade as a "margin" industry. Namely, their gross output in the input-output data does not correspond to their gross sales as it does for the manufacturing sector, but to their gross margin, i.e., the difference between total sales and total purchases. Without this assumption, most consumer spending would be allocated to the retail industry, which would skew the input-output tables away from the manufacturing sector. To compute sectoral linkages, I thus have to assign wholesale and retail trade to intermediate or final consumption. To do so, I use the Classification by Broad Economic Categories to assign imports as intermediate inputs or final goods (including capital formation). Approximately a third of the wholesale/retail imports are intermediate products according to the BEC classification. Imports of intermediate inputs by retail and wholesale firms are then assigned to manufacturing industries using the same proportionality assumption as in the first step.

Finally, the SIIOT provides sectoral linkages estimates only between

Swiss and foreign manufacturing sectors. Sectoral linkages relative to the aggregate services sector are taken from the WIOT. Formally, I construct the SIIOT input-output linkages $\rho_n^{sb,SIIOT}$, where n indexes Switzerland, for all exporting sectors $s = 1, \ldots, S-1$ and importing sectors $b = 1, \ldots, S-1$, given that the services sector (i.e., the S^{th} sector) is not available in the dataset underlying the SIIOT. Thus, I assume $\rho_n^{sS,SIIOT} = \rho_n^{sS,WIOT}$ for all s when n is Switzerland, as well as $\rho_n^{Sb,SIIOT} = \rho_n^{Sb,WIOT}$ for all b when n is Switzerland. I finally impose the restriction that $\sum_{k=1}^{S-1} \rho_n^{kb,SIIOT} = 1 - \rho_n^{Sb,WIOT}$ for all $b \neq S$ when n is Switzerland.

Rest of the world: The rest of the world (ROW) encompasses all world countries that are not accounted for in the sample. Exports to ROW by any sample country are constructed as total exports minus exports to other countries in the sample. Exports by ROW to any sample country are calculated as the total imports of that country minus imports from all other sample countries. GDP is world GDP minus the GDP of all sample countries. Employment is world employment minus employment in all sample countries. The import tariffs of ROW are taken as the HS 6-digit level simple average MFN tariff applied by sample countries, then trade-weighted with trade flows of ROW. Consumer preferences and production function parameters are inferred from the WIOT as for the other sample countries. Within the WIOT, a new ROW is constructed as the sum of the WIOT ROW and countries of the WIOT which are not included in the countries considered by this paper. Finally, trade shares are constructed using trade flows for ROW and gross output from the WIOT.

Numerical algorithm: For any change in bilateral trade costs $\hat{\kappa}_{in}^s$, I solve the model in changes with the following numerical algorithm:

1. Guess a (change in the) wage vector $\hat{\mathbf{w}} = (\hat{w}_1, \ldots, \hat{w}_N)$ for all $n = 1, \ldots, n$.

2. Solve for the (change in the) price of the composite good $\hat{P}_n^s$ and the (change in the) input bundle costs $\hat{c}_n^s$ that satisfy equations (19) and (20).

3. Given the initial values of import shares π_{in}^s, solve for the counterfactual import shares ${\pi_{in}^s}'$ with equation (21).

4. Solve for the counterfactual values of income I_n' and the counterfactual supply of manufacturing goods in each sector ${Y_n^s}'$ that satisfy equations (22) through (26).

5. Using the calibrated initial equilibrium values of income I_n, update the guess on the wage vector $\hat{\mathbf{w}}^{\mathbf{k}}$ using $\hat{w}_n = w_n' L_n' / w_n L_n$ for $n = 1, \ldots, N$.

I repeat these steps until $||\hat{w}_n^{k+1} - \hat{w}_n^k|| < \varepsilon$ for all n and for some tolerance level ε. The US wage is set as the numéraire. Initial labor income is calibrated using equations (13) through (18) based on the initial values of trade shares, tariffs and the labor income share allocated to the international portfolio. World employment is normalized to 100.

B Additional tables

Table B.1: Manufacturing sectoral linkages based on the SIIOT

		Importing sector																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Exporting sector																				
1	Agriculture	65.0	0.2	18.4	0.6	1.1	0.0	0.0	0.4	0.1	0.1	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.1
2	Mining	1.8	28.0	0.3	0.1	0.0	0.1	0.0	37.0	0.0	0.1	6.3	0.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0
3	Food	4.0	1.6	47.2	0.0	0.2	1.0	0.2	1.1	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.2
4	Textiles	0.7	0.3	0.6	78.3	0.6	4.9	11.6	0.5	0.1	3.3	2.3	0.1	0.5	1.8	0.6	0.5	0.3	1.2	4.0
5	Wood	1.3	0.8	0.4	1.2	54.8	1.3	0.5	0.2	0.0	2.0	1.8	0.1	0.9	0.5	0.2	0.2	0.4	0.1	2.4
6	Paper	0.5	1.7	5.8	1.6	2.8	46.9	43.4	0.9	0.3	3.0	1.7	0.2	0.3	0.4	0.4	0.4	0.2	0.1	0.9
7	Printing	0.0	0.0	0.1	0.1	0.0	0.7	2.6	0.0	0.0	0.4	0.0	0.0	0.5	0.1	0.0	0.1	0.0	0.0	0.1
8	Chemicals and oil	1.8	1.6	5.8	5.6	4.0	14.6	5.8	47.9	18.0	29.7	13.1	10.6	4.3	1.3	3.6	4.8	0.6	1.1	2.4
9	Pharma	6.4	0.0	1.2	0.0	0.0	1.8	0.0	2.6	77.4	0.1	0.0	0.0	0.0	0.1	0.0	1.1	0.0	0.0	0.8
10	Plastics	3.0	6.5	5.0	4.1	10.7	18.2	6.8	3.4	0.8	28.7	10.3	2.6	5.5	1.3	3.4	3.7	6.2	15.9	4.2
11	Minerals	2.5	30.0	1.3	0.6	4.8	0.7	0.4	1.5	0.2	1.4	45.8	1.8	2.8	0.7	1.2	1.7	1.8	0.7	2.2
12	Basic metals	0.5	0.7	0.6	0.4	1.2	1.1	2.6	0.7	0.1	10.1	2.8	49.6	32.8	1.3	10.4	6.3	11.9	4.1	4.0
13	Fabricated metals	2.2	5.5	5.4	2.1	6.7	1.1	2.8	0.9	0.2	7.7	5.9	5.4	26.9	2.1	7.7	12.4	7.3	7.4	5.2
14	Electronic and optical	0.3	0.5	0.4	0.4	1.4	0.6	7.3	0.3	0.4	1.1	1.4	0.6	3.6	34.5	7.8	6.2	4.3	9.3	8.6
15	Electrical equipment	0.9	0.5	0.9	0.3	2.5	0.5	1.1	0.3	0.1	2.3	0.8	0.9	4.1	9.4	41.4	10.3	6.9	9.1	4.0
16	Machinery	5.6	17.0	5.9	2.0	4.8	6.0	11.9	1.6	0.8	6.0	5.4	6.7	13.3	4.3	22.0	45.2	7.0	6.1	4.2
17	Motor vehicles	1.4	4.9	0.1	0.4	0.4	0.1	0.2	0.1	0.0	2.3	1.1	0.8	2.5	0.3	0.5	5.7	47.4	3.8	0.7
18	Other transport	0.2	0.0	0.0	0.1	0.1	0.0	1.1	0.0	0.0	0.1	0.3	0.2	0.3	0.1	0.2	0.2	5.1	39.5	0.5
19	Other manufacturing	1.9	0.2	0.5	2.1	3.6	0.4	1.6	0.5	1.2	1.6	0.9	19.2	1.1	41.8	0.5	0.8	0.5	1.4	55.3

Notes: This table summarizes the sectoral linkages between Swiss tradable sectors and foreign tradable suppliers based on the SIIOT. Rows are the foreign exporting sectors. Columns are the Swiss importing sectors. Shaded areas show the strongest linkages; from the lightest to the darkest: more than 5% of purchases, more than 25% of purchases, and more than 50% of purchases.

Table B.2: Deviation between sectoral linkages based on the SIIOT and the WIOT.

		Importing sector																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Exporting sector																					
1	Agriculture	5.6	0.0	-12.1	-0.1	-5.7	-4.3	0.0	-0.1	-0.0	-0.5	-0.0	0.0	0.1	-0.0	-0.0	0.1	-0.0	-0.0	0.0	-0.0
2	Mining	0.7	0.7	0.1	0.0	0.0	-0.3	-0.0	2.5	-0.0	-0.0	-0.1	-1.9	-0.0	-0.0	-0.0	0.0	-0.0	-0.0	-0.0	-0.0
3	Food	-8.6	-0.3	5.3	-2.1	-0.1	-0.5	-0.2	-1.6	-0.7	-0.6	-0.3	-0.2	-0.1	-0.2	-0.2	-0.1	-0.1	-0.2	-0.1	-0.0
4	Textiles	-0.3	-0.0	0.1	-0.0	0.2	0.5	1.9	0.1	-0.0	-1.1	-0.5	-0.1	-0.0	0.6	0.1	-0.0	-0.8	-0.1	-0.1	-0.0
5	Wood	-0.2	-0.9	-0.1	0.3	-8.7	-1.2	-0.2	-0.1	0.0	-0.4	-0.1	-0.2	-0.1	-0.1	-0.2	-0.2	0.1	-0.2	-3.7	-0.0
6	Paper	0.1	-0.1	0.9	0.3	0.3	-0.8	-1.5	-1.1	-0.2	-0.0	-0.1	0.0	-0.1	0.0	0.0	-0.0	0.0	-0.1	0.1	-0.0
7	Printing	-0.0	-0.0	-0.1	-0.1	-0.0	-0.2	-3.5	-0.0	-0.0	0.1	-0.0	-0.0	0.2	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
8	Chemicals and oil	-4.0	-4.5	1.3	-0.6	0.8	0.7	0.1	2.0	5.0	-1.4	0.3	0.8	0.7	-1.1	0.0	1.6	-0.2	-0.1	0.1	-0.0
9	Pharma	2.1	-0.3	0.2	-0.2	-0.0	0.3	-0.1	0.1	-6.8	-0.7	-0.2	-0.2	-0.1	-0.1	-0.1	0.4	-0.0	-0.1	0.2	-0.0
10	Plastics	0.6	0.2	-0.0	0.5	4.2	4.0	-0.8	0.6	0.1	1.2	0.4	0.8	1.3	-0.3	-0.6	0.1	0.2	4.1	-0.2	-0.0
11	Minerals	0.8	3.4	0.2	-0.0	1.4	0.1	0.1	0.3	-0.2	-1.5	-2.0	0.3	0.4	-0.2	-0.7	0.5	0.3	-0.9	0.4	-0.0
12	Basic metals	0.2	-0.5	0.2	0.1	0.4	-0.0	0.4	0.1	0.0	2.1	0.1	-6.6	0.7	-0.4	0.5	-0.7	3.1	-1.2	-14.0	-0.0
13	Fabricated metals	-0.3	0.3	1.0	0.4	2.0	0.2	0.4	0.1	0.0	0.4	0.4	-2.6	-10.1	-0.8	-3.0	-5.2	-1.7	-5.2	-2.1	-0.0
14	Electronic and optical	0.1	-0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.1	-0.2	0.3	0.1	1.0	-19.2	-6.0	-0.1	-1.1	-0.4	0.2	-0.0
15	Electrical equipment	0.2	0.0	0.3	0.1	1.0	0.1	0.1	0.1	-0.0	0.6	0.1	0.2	1.2	1.0	0.6	0.5	1.6	0.5	0.4	-0.0
16	Machinery	2.0	1.2	2.1	0.5	1.9	1.3	1.6	0.6	0.3	1.1	0.9	1.9	4.3	1.8	10.1	0.9	-12.1	-1.3	1.0	-0.0
17	Motor vehicles	0.5	0.7	0.0	0.0	0.2	-0.0	-0.0	-0.0	-0.0	0.7	0.2	0.1	0.8	0.1	0.0	1.4	9.2	0.7	0.1	-0.0
18	Other transport	0.0	-0.1	-0.0	-0.0	0.0	-0.0	0.2	-0.0	-0.0	-0.0	0.1	-0.1	-0.1	-0.0	-0.0	-0.1	2.1	1.9	0.1	-0.0
19	Other manufacturing	0.7	-0.0	0.1	0.5	1.4	0.1	0.2	0.1	0.5	0.4	0.1	7.8	0.3	18.7	-0.1	0.3	0.2	0.4	17.9	-0.0
20	Services	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.0

Notes: This table summarizes the deviation between sectoral linkages based on the SIIOT and the WIOT.
Rows are the foreign exporting sectors. Columns are the Swiss importing sectors. Shaded areas show the largest discrepancies. In green are positive entries, in which the SIIOT linkage is larger than the WIOT linkage. In red are negative entries, in which the SIIOT linkage is smaller than the WIOT linkage. From the lightest to the darkest shade: more than 10% in absolute discrepancy, more than 5% in absolute discrepancy, and more than 1% in absolute discrepancy.

Table B.3: Sources of Switzerland's gains from trade - sectoral breakdown

	Change in sectoral labor productivity				Contribution to aggregate welfare change discrepancy (% of GDP)		
	Baseline (1)	No I-O linkages (2)	No intermediate inputs (3)	No SIIOT (4)	No I-O linkages (5)	No intermediate inputs (6)	No SIIOT (7)
Agriculture	18.4	8.1	3.4	13.0	0.1	0.1	0.2
Mining	20.5	22.4	10.0	18.0	0.0	-0.0	0.0
Food	26.1	33.9	11.9	21.4	0.3	-0.6	1.0
Textiles	43.9	59.4	27.3	42.2	0.0	-0.5	0.4
Wood	19.4	5.0	1.9	8.3	0.0	0.0	0.0
Paper	18.9	16.4	5.7	13.8	0.0	0.0	0.0
Printing	10.9	0.5	0.2	6.6	0.0	0.0	0.0
Chemicals and oil	42.4	71.4	28.7	39.1	0.1	-1.1	0.3
Pharma	44.7	53.2	22.4	44.1	0.0	-0.2	0.4
Plastics	54.6	77.2	40.8	51.3	0.0	-0.1	0.0
Minerals	27.9	32.8	15.0	25.2	0.0	-0.0	0.0
Basic metals	59.6	79.0	40.0	55.5	0.0	-0.0	0.0
Fabricated metals	29.2	11.4	5.5	20.3	0.0	0.0	0.0
Electronic and optical	34.5	8.8	3.4	14.0	0.2	0.2	0.3
Electrical equipment	34.7	15.8	4.3	21.9	0.0	0.0	0.0
Machinery	70.2	86.9	54.4	66.3	0.1	-0.4	0.2
Motor vehicles	97.6	99.9	93.5	96.8	0.4	-4.9	1.4
Other transport	95.9	99.8	91.8	94.6	0.1	-1.2	0.3
Other manufacturing	71.0	87.0	56.9	66.5	0.2	-0.9	0.4
Services	6.2	0.0	0.0	5.0	1.0	5.3	5.3

Notes: Columns (1) to (4) report the change in sectoral labor productivity associated with moving from autarky, i.e., a world in which all trade is prohibited, to the observed equilibrium. Column (1) reports the change in sectoral labor productivity in the baseline model with calibration as detailed in Sections 2 and 3. Column (2) shuts down sectoral linkages effects, i.e., $\rho_n^{ks} = 0$ if $k \neq s$ and $\rho_n^{ss} = 1$ for all n, s. Column (3) shuts down the intermediate inputs effects, i.e., $\alpha_n^s = 1$ for all n, s. Column (4) reports the welfare change if the calibration does not use the SIIOT data but rather the WIOT estimates for Switzerland's sectoral linkages. Columns (5) to (7) report how much each sector contributes to the aggregate welfare change compared to the baseline. It uses the following approximation: $\ln \frac{\omega_{rob}}{\omega_{base}} = \sum_{s=1}^{S} \beta_n^s (\ln \omega_{rob}^s - \ln \omega_{base}^s)$, where ω is the change in real wage in the baseline model (*base*) or for the robustness checks (*rob*), and ω^s is the change in sectoral labor productivity.

Table B.4: Robustness: source of Switzerland's gains from trade under new calibration of consumption shares

(1) Baseline	16.4
(2) No I-O linkages ($\rho_n^{ks} = 0$ if $k \neq s$, $\rho_n^{ss} = 1$)	14.3
(3) No intermediate inputs ($\alpha_n^s = 1$)	7.3
(4) No SIIOT	14.5

Notes: This table reports the change in real wage (real GDP) associated with moving from autarky, i.e., a world in which all trade is prohibited, to the observed equilibrium under alternative calibrations of consumption shares, following Caliendo and Parro (2015). Formally, $\beta_n^s = (Y_n^s + D_n^s - \sum_{k=1}^{S}(1-\alpha_n^s)\rho_n^{sk}Y_n^k)/I_n$. Row (1) reports the welfare change in the baseline model. Row (2) reports the change in a model without linkages, i.e., $\rho_n^{ks} = 0$ if $k \neq s$ and $\rho_n^{ss} = 1$ for all n, s. Row (3) reports the welfare change in a model without inputs, i.e., $\alpha_n^s = 1$ for all n, s. Row (4) reports the change in the baseline model but without SIIOT linkages.

Table B.5: Robustness: welfare change in Switzerland under varying assumptions for trade balances

	No FTAs	CH-US FTA
	(1)	(2)
(1) Endogenous trade balance (CPRS, 2018)	-0.58	0.04
(2) Endogenous trade balance (CDP, 2019)	-0.53	0.02
(3) Balanced trade	-0.58	0.03
(4) Constant % of GDP	-0.59	0.05
(5) Exogenous trade balance	-0.61	0.06

Notes: This table reports the welfare change in Switzerland under varying assumptions on the trade balances. Column (1) reports the results if Switzerland reneges on its FTAs; Column (2) reports the results if Switzerland concludes an FTA with the US. Each row reports results for a different trade balance assumption: (1) as in the paper, following Caliendo, Parro, Rossi-Hansberg and Sarte (2018), (2) under an endogenous trade balance following Caliendo, Dvorkin and Parro (2019), (3) under balanced trade, (4) under a constant trade balance as a percentage of GDP, and (5) under exogenous trade balances.

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