The Sources and Magnitudes of Switzerland's Gains from Trade

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SUMMARY

This paper uses the modern workhorse model of quantitative trade theory (EATON and KORTUM, 2002) as a measurement tool to quantify Switzerland's gains from trade. I find that individual trading partners matter surprisingly little for Switzerland's welfare because of reallocation effects: if trade between Switzerland and some partner country is inhibited, other supplier countries step into the breach so that the losses are limited and typically amount to less than 1 %. The conclusions are different if one considers groups of countries such as for example the EU: participating in a multilateral 25 % trade cost reduction increases Swiss welfare by 11 % relative to the status quo. However, it must also be noted that in the case of non-participation, the actual welfare losses relative to the status quo are modest with less than 1 %.

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1. Introduction

Switzerland is firmly integrated into the global trade network and the importance of international trade for Swiss prosperity is broadly recognized – witness for example the intensity at which movements in the Euro-Swiss Franc exchange rate are debated in public. This paper attempts to uncover some more details about the channels through which Switzerland's participation and integration in the global trade network determines Swiss welfare. In particular, it asks where Switzerland's gains from trade originate from and of what magnitude they are. As we will see, answers to these questions can for example be helpful to think about what one can hope for when passing new bilateral free trade agreements or what the consequences may be when deciding whether to participate or not in multilateral trade liberalizations.

For the task at hand a structural model of the global trade network is indispensable. To see why, consider an example: one observes in the data which goods are shipped from Germany to Switzerland at what quantities and prices. How would Swiss welfare change if Switzerland was not allowed to trade with Germany? To answer this question one needs to proceed in two steps. The first step asks how trade pattern would change in the counterfactual situation. Clearly, Switzerland would not simply stop to consume the goods previously sourced from Germany nor would it start to produce all these goods locally. Rather would most other trading partners expand the range of goods they deliver to Switzerland since they now do not have to compete with Germany in supplying these goods; moreover, prices and quantities may change as well. These changes in trade pattern can only be predicted with a structural model that can account for general equilibrium effects. A second step then calculates real per-capita income under the status quo and compares it to the predicted real per-capita income to predict the welfare implications.

For this purpose I adapt the workhorse model of modern quantitative trade theory – the Ricardian framework first introduced by (EATON and KORTUM, 2002).[1] The advantage of using a workhorse model lies in the fact that by now this model has been quantified in a large set of papers and applied to many different questions. Committing to a well-established framework and a standard quantification approach disciplines the researcher and gives the reader the certainty that the model has not been tailored to deliver particular results, but has

1 See for example (EATON and KORTUM, 2012) and (EATON and KORTUM, 2010) for surveys of the relevant literature and applications.

rather been taken as a measurement tool whose results have to be accepted the way they come. The quantification uses data on global trade pattern from the year 2003. Within this quantified version of the model I can then assess the effects of experiments similar to the one described above on trade pattern and Swiss welfare. In particular I consider two types of experiments. The first experiments ask how Swiss welfare depends on trade (imports, exports, or both directions) between Switzerland and a particular trading partner being possible. The resulting equivalent variations are measures for how important a country is for Switzerland's gains from trade. The second experiment is concerned with the effects of European economic integration. I compare a situation of falling trade costs among EU27 countries with a situation where trade costs between Switzerland and the EU27 countries fall by equal amounts as they fall within the EU27. Three main conclusions emerge from these two types of experiments. First, the Swiss welfare gains from being able to trade with an *individual country are mostly quite small*: the equivalent variation, i.e. the share of her income that the representative Swiss consumer is willing to pay to be able to trade with a particular country, is below 1 % for all trading partners except Germany, where the equivalent variation is 2.9 %. Second, considering *larger groups of countries*, the *potential gains* from participating in multilateral reductions in trade costs *are large*: in the counterfactual simulation, Swiss real per-capita income increases by 11 % if Switzerland participates in the trade cost reduction. Third, in the case on *non-participation* the *actual welfare losses* relative to the status quo are *limited*: the level of Swiss real per-capita income falls only by 0.6 % if Switzerland chooses not to participate. However, welfare relative to the participating countries decreases more.

Previously Egger, Gassebner, and Lassmann (2009) and Mohler (2011) applied the methodology outlined in Feenstra (1994) to Switzerland. They measured by how much Switzerland's imported varieties grew over time and translated this into implied welfare gains (Mohler, 2011). This paper on the other hand quantifies a model of the global economy using cross-sectional data on trade flows and assesses the origins and magnitudes of Switzerland's gains from trade with counterfactual experiments within the quantified model. This approach allows going beyond the reduced form approaches used previously. In particular, I can account for general equilibrium effects such as endogenous changes in global trade pattern, factor prices, and price indices. This allows me to not only assess observed changes, but to also make predictions and analyze hypothetical situations such as the ones discussed above.

Section 2 briefly outlines the model. Section 3 describes how I quantify the model. Section 4 presents the results and Section 5 provides a concluding discussion of the results.

2. The EATON and KORTUM (2002) Model as a Measurement Tool

The Structure of the Model. I adapt the quantitative Ricardian model due to EATON and KORTUM (2002) as described in WAUGH (2010).[2] In the following I briefly describe the model and refer the interested reader to WAUGH (2010) for further details. The model describes a world of N countries. A country i is populated by L_i agents each endowed with h_i units of labor (human capital) and k_i units of capital. Labor and capital are internationally immobile, but perfectly mobile within countries.

A competitive intermediate industry produces differentiated intermediate inputs that are internationally tradable using a Cobb-Douglas technology

$$y(j) = z(j)\left(k(j)^{\alpha}\, l(j)^{1-\alpha}\right)^{\beta} q(j)^{1-\beta},$$

where $y(j)$ is output in intermediate industry j, $z(j)$, $k(j)$, and $l(j)$ are productivity, capital, and labor employed in the intermediate industry j, and $q(j)$ is a CES aggregator over all intermediates $j \in [0,1]$. α is the capital share and $1-\beta$ the intermediate share in the intermediate industry.[3] Perfect competition and iceberg trade costs – $d_{ni} \geq 1$ units need to be shipped in i for one unit to arrive at the destination market n – imply that the price at which country i offers variety j in the destination market n is $p_{ni}(j) = d_{ni}(r_i^{\alpha} w_i^{1-\alpha})^{\beta} P_i^{1-\beta} / z_i(j)$.[4] For a given variety j, the prices differ because of differences in the producer countries' factor prices and its intermediate price index, r_i, w_i, P_i, because of bilateral trade costs, d_{ni}, and because of country-variety specific productivity differences, $z_i(j)$. An importing country n sources any particular variety only from the country offering the best price; or put differently, international trade emerges whenever the price at which the importing country n could produce the variety itself, $p_{nn}(j)$, is larger than lowest price at which foreign countries $i \neq n$ offer the variety in market n, i.e. if $p_{nn}(j) > \min_{i \neq n}\{p_{ni}(j)\}$.

Country-variety specific productivity, $z_i(j)$, is modeled as the realization of a Fréchet random variable

2 WAUGH (2010) used the Ricardian model to assess how much of the cross-country variation in per-capita incomes is driven by asymmetries in trade costs.

3 The equilibrium wage rates, price indices, and trade pattern do not depend on the elasticity of substitution (see ALVAREZ and LUCAS, 2007), which is why I omit further discussions of the details of the CES aggregator.

4 Here and in the following I omit constants that will be irrelevant in the quantification for readability.

$$\Pr[Z_i(j) \le z] = \exp\{-T_i z^{-\theta}\}.$$

T_i is country specific and governs the expected productivity draw (the higher T_i the higher the expected productivity draw) and therefore represents country i's technology. θ is common to all countries and governs the dispersion of productivity draws – the larger θ, the smaller the dispersion of productivity draws. Therefore, if θ is very large, productivity draws for a given variety j barely vary across countries. Correspondingly, it is very unlikely that the condition for trade to be worthwhile is satisfied and therefore only a small share of global production is traded in equilibrium; and vice versa for a small θ.

The final goods industry is competitive and produces a homogenous non-tradable consumption good by bundling capital, labor, and intermediates using a Cobb-Douglas technology, $y_F = (k_F^\alpha l_F^{1-\alpha})^\gamma q_F^{1-\gamma}$, with an intermediate share $1-\gamma$. k_F, l_F, and q_F are the quantities of capital, labor, and intermediates used in final goods production.

The Equilibrium. The model outlined above yields an instructive expression for real per-capita income in country n

$$y_n = \left(\frac{T_n}{\Omega_n}\right)^{\frac{1-\gamma}{\beta\theta}} k_n^\alpha h_n^{1-\alpha}, \tag{1}$$

where

$$\Omega_n = 1 - \sum_{i \ne n} \pi_{ni}$$

and π_{ni} is the share of country n's total demand for tradables that is met by country i. (1) nicely summarizes the different determinants of a country's real per-capita income. As in a standard development accounting framework (see for example CASELLI, 2005) real income depends on endowments, h_n and h_n, the respective shares α and $1-\alpha$, and TFP represented by $(T_n/\Omega_n)^{(1-\gamma)/(\beta\theta)}$. However, in contrast to the standard development accounting framework where TFP is obtained as a residual, TFP has a structural interpretation in the present framework: whereas T_n is a truly exogenous technology parameter, Ω_n is an endogenous quantity summarizing how much a country gains from trade.

To see this consider a country living in autarky. This country's trade shares are zero so that $\Omega_n^{aut} = 1$. If this country opens up to trade, the trade shares become positive and therefore $\Omega_n < 1$. Using (1), the associated change in real income is given by $y_n / y_n^{aut} = \Omega_n^{-(1-\gamma)/(\beta\theta)}$. In other words $\Omega_n^{-(1-\gamma)/(\beta\theta)}$ represents the equivalent variation with respect to autarky, i.e. the amount of income a country n agent is willing to forgo in order to avoid autarky.[5] More generally, I can assess welfare changes that are implied by any counterfactual situation (that does not affect T_n, k_n, and h_n) by simply calculating the associated change in $\Omega_n^{-(1-\gamma)/(\beta\theta)}$ – a feature that I will use in the counterfactual experiments that follow further below.

Specifically, I compute the new equilibrium trade shares, π_{ni}, and based on these the new Ω_n. The trade shares' structural expressions are

$$\pi_{ni} = \frac{\tilde{T}_i (w_i^{\beta} P_i^{1-\beta} d_{ni})^{-\theta}}{\sum_{k=1}^{N} \tilde{T}_k (w_k^{\beta} P_k^{1-\beta} d_{nk})^{-\theta}}, \tag{2}$$

where w_i is country i's wage rate, P_i is a CES price index and $\tilde{T}_i = T_i \left(h_i / k_i\right)^{-\alpha\beta\theta}$ is a country aggregator of endowments and technology that is unaffected by the counterfactual experiments performed later on. Sometimes I will refer to $\tilde{T}_i$ as country i's "capital-technology composite". The wage rates and the price indices are endogenous: the price indices are aggregates of wages, technologies, price indices, and bilateral trade costs of all trading partners

$$P_i = \left(\sum_{k=1}^{N} \tilde{T}_k \left(w_k^{\beta} P_k^{1-\beta} d_{ik} \right)^{-\theta} \right)^{-\frac{1}{\theta}} \tag{3}$$

and the wage rates adjust such that every country's balance of trade equalizes[6]

$$w_n h_n L_n \sum_{i \neq n} \pi_{ni} = \sum_{k \neq n} \pi_{kn} w_k h_k L_k .$$

The counterfactual experiments will consider changes in the global matrix of trade costs, $\{d_{ni}\}_{n,i}$. Given a quantified version of the model I will first calculate the implied changes of the equilibrium wage rates and price indices; then

5 This finding is reminiscent of Arkolakis, Costinot, and Rodriguez-Clare (2012) who show that for a broad class of theoretical models a country's gains from trade – measured as welfare under the status quo relative to welfare in a counterfactual situation with no trade – can be computed via a simple formula that takes a country's domestic expenditure to the power of some exponent, which is a function of the model parameters.

6 One can show that a country's total intermediate demand is proportional to this country's total labor income, which is why the balance of trade can be written in terms of labor income.

compute the implied trade shares and plug them into (1) to quantify the effect on welfare. For example I could set the bilateral trade costs between some country n and a country i to infinity, $d_{ni} \rightarrow \infty$. I then compute the unique set of wage rates that imply price indices and trade shares such that every country's balance of trade equalizes.[7] Plugging the new trade shares in (1) for country n (country i) allows me to quantify how much country n would be willing to pay in order to be able to import (export) from country i (to country n). With experiments like this, the model can be used as a measurement tool to find the sources and magnitudes of Switzerland's gains from trade.

Intuition for the mechanics of the model. In the modern workhorse formulation of the Ricardian trade model outlined above, a fixed set of intermediates is bundled with capital and labor to produce the final consumption good. For every intermediate variety, buyers compare prices at which the variety can be sourced from different countries. Trade emerges whenever a foreign producer offers to supply the variety at a price below the one a domestic producer can offer.

In such a world, one can differentiate between two important determinants of real per-capita incomes. First, physical and human capital endowments together with the local state of technology determine a country's average productivity. The higher productivity, the more can be produced and the higher consumption and therewith welfare tends to be. The second determinant is a country' degree of integration into the global trade network. If a country is well integrated, i.e. has low trade costs to and from other countries, it can on the one hand source varieties cheaply from abroad, which makes local production more efficient and therewith leverages local production factors. On the other hand, it is also able to offer its varieties at a relatively low price in the international markets, which lifts demand for local production factors and therewith factor remuneration. Both channels tend to increase real per-capita incomes and therewith welfare.

In the present application, physical and human capital endowments and the local states of technology are treated as fixed. However, the degree of Switzerland's integration into the global trade network is varied in a number of counterfactual

7 The algorithm is implemented in MATLAB and uses a Tâtonnement-like iterative procedure as outlined in Alvarez and Lucas (2007). I start with a guess for the equilibrium wage rates. Based on this guess I solve for the price indices that are implied by (3). Using the wage rates and the corresponding price indices I compute the trade shares and check if all balances of payments equalize with these trade shares. I increase (decrease) the wages for countries with too large (low) exports and repeat this procedure until I find the equilibrium vector of wage rates. The program is available from the author upon request.

experiments. Using the quantified version of the model I am able to trace out the effects on trade pattern, local price indices, factor remunerations, and ultimately real Swiss per-capita income that emerge under these counterfactual situations.

3. Quantifying the Model

The model's parameters are technologies, $\{\widetilde{T}_i\}_i$, trade costs, $\{d_{ni}\}_{n,i}$, population sizes, $\{L_i\}_i$, endowments, $\{h_i\}_i$,[8] and the parameters α, β, γ, and θ. In the following I outline my strategy to quantify these parameters. In that I follow closely WAUGH (2010).

I quantify the model based on data from the year 2003 and I use a sample of 86 countries, that together represent 87 % of global GDP.[9] Details on the data can be found in the Appendix. I obtain the population sizes, $\{L_i\}_i$, from the World Development Indicators (WORLD BANK, 2010) and the human capital endowments, $\{h_i\}_i$, from CASELLI (2005). The parameters $\alpha = 1/3$, $\beta = 1/3$, $\gamma = 3/4$, and $\theta = 4.87$ I take from WAUGH (2010).

In a next step, I quantify the bilateral trade costs $\{d_{ni}\}_{n,i}$: first I normalize the bilateral trade share, π_{ni}, in (2) with the home shares of the importers, π_{nn}, to get

$$\frac{\pi_{ni}}{\pi_{nn}} = d_{ni}^{-\theta} \frac{S_i}{S_n}, \tag{4}$$

where $S_i = \tilde{T}_i (w_i^{\beta} P_i^{1-\beta} d_{ni})^{-\theta}$. In a second step I model the unobserved trade costs as a function of observable variables

$$-\theta \log d_{ni} = \delta_k + b + l + ex_i + \varepsilon_{ni}, \tag{5}$$

where I suppressed the associated dummy variables for expositional simplicity. δ_k ($k = 1,\ldots,6$) is the effect of the bilateral distance between countries i and n lying in the k^{th} distance interval. The intervals are (in miles): [0,375), [375,750),

8 I do not need data on physical capital, $\{k_i\}_i$ since it is absorbed into the the capital-technology-composite, $\{\widetilde{T}_i\}_i$.

9 I choose the year 2003 since at the time of writing the first draft, the UNIDO database featured the largest number of observations of gross output for 2003. Also, 2003 is clearly prior to the Great Recession, which has the advantage, that our quantification is not polluted by transitory effects associated to the great trade collapse.

[750,1500), [1500,3000), [3000,6000), and [6000,∞). b is the effect of sharing a border and l the effect of having the same language. ex_i is an exporter fixed effect that allows for asymmetry in bilateral trade costs and ε_{ni} captures all other barriers to trade and is assumed to be orthogonal to the exporter fixed effects, distance, border, and language. Plugging the trade cost function (5) into (4) and taking logs yields an empirically implementable gravity equation

$$\log\left(\frac{\pi_{ni}}{\pi_{nn}}\right) = \delta_k + b + l + ex_i + \log S_i - \log S_n + \varepsilon_{ni}. \tag{6}$$

To estimate (6) I need data for π_{ni}/π_{nn}, δ_k, b, and l. $\log S_i$ can be estimated as a country fixed effect and ex_i as an exporter fixed effect. Note that the model restricts the country fixed effects $\log S_i$ and $\log S_n$ to be same for a given country, which is why one can identify the exporter fixed effect, ex_i. For the gravity variables on the right hand side (δ_k, b, and l) I use data from CEPII (2006). For the left hand side I construct the trade shares π_{ni} following the methodology proposed by Eaton and Kortrum (2002). It is important to note that the trade shares measure the value of a trade flow from i to n relative to importer n's total use of intermediates, i.e. its absorption. Whereas it is straightforward to measure the total value of a trade flow using for example the COMTRADE database, total absorption has to be constructed. For that I first obtain the gross value of a country's manufacturing output from UNIDO (2003). I then subtract the total value of this country's exports to obtain this country's demand that is met by local producers. Adding total imports (from countries in the sample) yields the total value of this country's equilibrium demand, i.e. its absorption. Combining these with the values of the bilateral trade flows gives me the trade shares (the home share, π_{nn}, follows as a residual). Using these and the gravity variables I can estimate (6) with OLS and therewith obtain estimates for the country fixed effects, $\hat{S}_i$. I then solve (4) for the implied bilateral trade costs using the observed normalized trade shares, π_{ni}/π_{nn}, and the estimated values for the country fixed, $\hat{S}_i$.

Having thus quantified the bilateral trade costs, the remaining model parameters are the countries' capital-technology-composites, $\{\widetilde{T}_i\}_i$. Remember that the country fixed effects are $S_i = \tilde{T}_i(w_i^{\beta} P_i^{1-\beta} d_{ni})^{-\theta}$ and that I have estimates for the trade costs and the fixed effects. Given values for the wage rates and the price indices I thus could solve for the implied $\widetilde{T}_i$. In order to to so, I first get the price indices (up to an irrelevant constant) by combining the estimated fixed effects, S_i, and the trade costs, $P_n = (\sum_{i=1}^{N} S_i d_{ni}^{-\theta})^{-1/\theta}$. In a next step, I solve for the implied wage rates. I choose w_1 as the numéraire and rewrite the balances of payments for the countries $n=2,\ldots,N$ as

$$w_n = \pi_{1n}\frac{(h_1 L_1)}{(h_n L_n)} + \sum\nolimits_{k=2}^{N} \pi_{kn} w_k \frac{(h_k L_k)}{(h_n L_n)}.$$

Stacking these equations I get a linear system

$$\begin{bmatrix} 1-\pi_{22} & \cdots & -\pi_{N2}\dfrac{h_N L_N}{h_2 L_2} \\ \vdots & \ddots & \vdots \\ -\pi_{2N}\dfrac{h_2 L_2}{h_N L_N} & \cdots & 1-\pi_{NN} \end{bmatrix} \begin{bmatrix} w_2 \\ \vdots \\ w_N \end{bmatrix} = \begin{bmatrix} \pi_{12}\dfrac{h_1 L_1}{h_2 L_2} \\ \vdots \\ \pi_{1N}\dfrac{h_1 L_1}{h_N L_N} \end{bmatrix}. \tag{7}$$

Since I have data on the labor endowments, $h_n L_n$, and the constructed trade shares, π_{ni}, I can solve for the unique set of wage rates that is implied by this system. Using these together with the previously constructed price indices and the country fixed effects I can finally back out the technologies, $\widetilde{T}_i = S_i (w_i^{\beta} P_i^{1-\beta} d_{ni})^{\theta}$. Therewith the quantification of the model is complete and we can turn to the question of this paper: where do Switzerland's gains from trade originate from and how large are they?

4. The Swiss Gains from Trade

Gains from trade; country by country. In order to obtain a first idea of the origins of Switzerland's gains from trade, remember the discussion of (1) in Section 2, where we showed that a country's gains from trade are closely linked to $\Omega_n = 1 - \Sigma_{i\neq n}\pi_{ni}$; the lower the home share Ω_n is, the higher a country's gains from trade. Therefore, one may look at Switzerland's trading partners' trade shares, $\pi_{CH,i}$, to obtain a first feeling for where the Swiss gains from trade originate from. Table 1 presents the 10 countries with the highest import shares.

The table is based on trade shares in non-consumption manufactures since the model is one of trade in intermediates. All subsequent results are also based on non-consumption manufactures. However, the results are very similar (within 1–2 %) if we use only intermediates or total trade instead since the corresponding

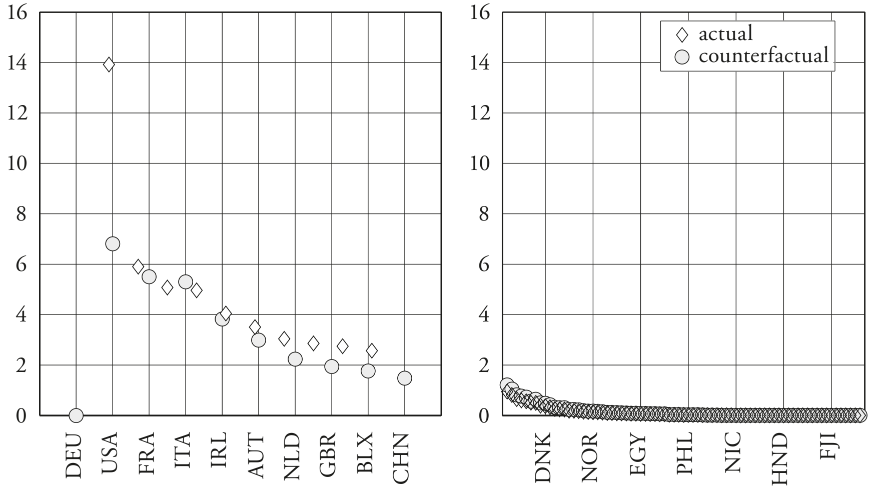
Table 1: Ranking of contributions to Switzerland's gains from trade based on observed trade shares

country	rank	share
Germany	1	15.3
United States	2	5.3
France	3	4.3
Italy	4	4.1
Ireland	5	3.0
Austria	6	2.3
The Netherlands	7	1.7
United Kindom	8	1.5
Belgium and Luxembourg	9	1.4
China and Hongkong	10	1.1

Note: this table presents the trade shares, π_{ni}, as measured in the data and matched in the baseline simulation. Note that the share is defined relative to total intermediate use in production, i.e. goods produced in Switzerland are part of the numerator.

trade shares are very strongly correlated. Switzerland's top origins of gains from trade are the ones one would expect ex ante – close European neighbors and the two large countries, USA and China (Japan ranks 11th). Based on Table 1 and (1), we can therefore directly derive a ranking of Switzerland's trading partners' importance for the Swiss gains from trade. However, if one wants to say something about the quantitative relevance of a given country, this is not sufficient: imagine for example a situation where a particular country, say Germany, was not allowed to send goods to Switzerland. Setting the share of Germany in Switzerland's imports to zero in (1) and using the associated change in Ω_{CH} as a measure of Switzerland's welfare change would assume that all the varieties that had previously been sourced from Germany are now produced locally (in Switzerland). But this is of course not what happens, since most varieties will now simply be sourced from other foreign countries. This is where the structural model becomes relevant – the reallocation effects can only be quantified based on a general equilibrium model. Figure 1 presents the associated changes: the black diamonds represent the trade shares as measured in the data, whereas the red circles are the counterfactual trade shares if Switzerland did not source any imports from Germany. The left panel presents the changes for the 10 most important trading partners. The German share falls from about 15 % to zero since the counterfactual experiments rules out any imports from Germany. However, the shares of all other trading partners increases – in particular countries like the USA, France and Italy experience significant increases, but even the minor trading partners presented in the right panel increase their share in Swiss imports. In total, all other countries together increase their share by 9pp, such that the Swiss home share increases only by 6pp to 57 % as opposed to the 15pp that a "naive interpretation" of (1) would have suggested. Correspondingly, Swiss real per-capita income decreases by $(57\,/\,51)^{(\gamma-1/\beta\theta)}-1=-1.7\,\%$ as opposed to a naive estimate of $\{(51+15)\,/\,51\}^{(\gamma-1/\beta\theta)}-1=-4.0\,\%$.

Figure 1: The reallocation effects associated with inhibiting imports from Germany



Note: This figure plots for Switzerland's main trading partners (left panel) and all other partners (right panel) the actual import shares, $\pi_{CH,i}$, (black diamonds) and the counterfactual import shares (red circles) that are predicted if Switzerland was not allowed to source any goods from Germany, i.e. if the trade costs from Germany to Switzerland are prohibitively high, $d_{CH,DEU}\rightarrow\infty$. The left panel presents the results for the 10 main trading partners and the right panel for the remaining countries.

Table 2 presents the results of similar experiments for Switzerland's main trading partners. I perform three types of experiments; Column 2 presents the welfare changes when imports are inhibited ($d_{CH,n}\rightarrow\infty$); Column 3 presents the welfare change when Swiss exports to a given country are inhibited, ($d_{n,CH}\rightarrow\infty$); and Column 4 represents the welfare changes when both – imports and exports – are inhibited ($d_{CH,n} = d_{n,CH} \rightarrow \infty$). For comparison, Column 5 present the (incorrect) "naive" estimates, that simply sets the bilateral trade share in (1) to zero.

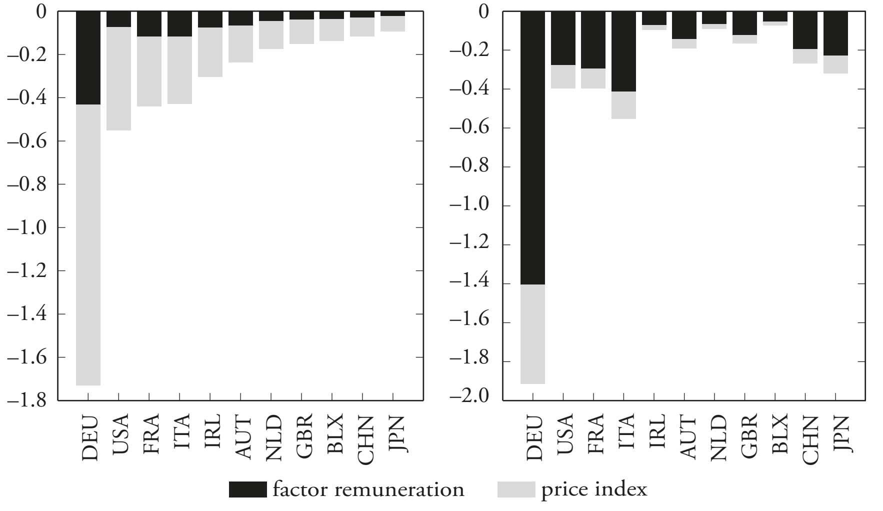
Table 2: Welfare losses associated with inhibited trade with top 10 trading partners

trading partner	no imports	no exports	no trade	"naive" estimate
Germany	1.7	1.4	2.9	4.2
United States	0.6	0.3	0.8	1.6
France	0.4	0.3	0.7	1.3
Italy	0.4	0.4	0.8	1.2
Ireland	0.3	0.1	0.4	0.9
Austria	0.2	0.1	0.4	0.7
The Netherlands	0.2	0.1	0.2	0.5
United Kindom	0.2	0.1	0.3	0.5
Belgium and Luxembourg	0.1	0.1	0.2	0.4
China and Hongkong	0.1	0.2	0.3	0.3

Note: this table presents the changes in real per-capita income in Switzerland that is associated with inhibiting trade with one of Switzerland's top 10 trading partners. "No imports" ("no exports") refers to a situation, where Switzerland is not allowed to import from (export to) a particular country; "no trade" is a counterfactual situation where neither imports nor exports are allowed. The "naive" estimate is the (incorrect) welfare effect that one would obtain if all varieties that were previously sourced from the country under consideration had to be produced locally.

Clearly, the "naive" estimate strongly overstates the gains associated with being able to trade with particular countries. This is because the reallocation effects outlined above in the case of Germany are quite strong. A second finding is that for Switzerland's main trading partners the welfare gains from being able to import from a particular country are larger than the gains from being able to export to this country (except for China). The gains from being able to import come mainly from lower prices, which translate into lower unit costs in the production of both final goods and intermediates. The lower unit costs in intermediates in turn increase demand for Swiss production factors and therewith their remuneration. The gains from being able to export to a country are primarily due to an increased demand for local production factors and the associated increase in their remuneration. The Swiss price index, however, tends to be less affected. Figure 2 presents the contributions of factor income and price effects to the welfare changes.[10]

Figure 2: Decomposition of welfare change into a factor remuneration effect and price effect if no imports to (left) or exports from (right) a particular country are possible



Note: this figure plots in the left (right) panel the contributions of changes in Swiss factor remuneration and the Swiss price index to the total welfare change that results when imports from (exports to) the country on the x-axis are inhibited. The welfare change is presented in log-points.

A third finding is concerned with the actual size of the gains from trade. Here, Germany stands out from the other countries: according to the model, the representative Swiss consumer would be willing to pay every year up to 2.9 % of her annual income for Switzerland to be able to engage in trade with Germany. The welfare losses associated with inhibiting trade with other countries, however, decrease quite fast. Only for the immediate neighbors Germany, France, and Italy and for the United States do I find welfare losses that are larger than 0.5 %. This result is again related to the strong reallocation effects. Were we to consider only finite increases in the trade costs, the results would even be smaller. This suggests that the gains from trade agreements such as the one recently negotiated with

10 In the context of changes in the price index and factor remuneration, a useful expression for equilibrium real per-capita income is $y_n = (w_n / P_n)$. Based on this formula I calculate the welfare changes and the contributions as

$$100 \log\left(\frac{y_n}{y_n^{counterf.}}\right) = 100(1-\gamma)\left(\log\left(\frac{w_n}{w_n^{counterf.}}\right) - \log\left(\frac{P_n}{P_n^{counterf.}}\right)\right).$$

China may be overstated in the public debate. However, I now turn to a second class of counterfactual experiments that demonstrates that whereas changes in trade costs for individual partner countries do not seem to matter too much, multilateral changes in trade costs matter very much for Switzerland's welfare.

The welfare effects of a further European trade integration. A second instructive experiment is concerned with the (indirect) effects of a European trade integration on Switzerland. Consider for example the world as calibrated for 2003. What is the welfare effect on Switzerland if the trade costs among EU27 countries uniformly decrease by 50%? To put this in perspective, Anderson and Van Wincoop (2004) put the average ad valorem trade costs among OECD countries at around 170%, i.e. $d_{ni} = 2.7$. A 50% reduction is therefore a significant step towards full integration. There are three channels how this reduction in trade costs affects Swiss welfare: first, lower trade costs among EU27 countries implies that the price indices in these countries decrease. Therefore the prices of Switzerland's imports decrease as well, which is good for both intermediate and final goods production. Second, lower trade costs imply that EU27 production factors become more productive, so that their remuneration rises, which in turn tends to increase the prices of Switzerland's imports. Third, since the trade costs between EU27 countries and Switzerland are now larger relative to within-EU27 trade costs, EU27 demand is diverted away from Switzerland – for example there are varieties that Germany previously sourced from Switzerland but now, due to lower intra-EU27 trade costs buys from France. This reduces demand for Swiss production factors and therefore lowers the Swiss factor remunerations.

According to the counterfactual simulation, the total effect is a 0.6% decrease in Swiss welfare: the falling factor remunerations due to lower demand for Swiss goods and the tendency for higher import prices due to higher factor prices in the EU27 dominate the effect of lower import prices prices due to falling price indices in EU27 countries.

How strong are these channels separately? Table 3 answers this question in column 2 ("no participation").

The table first presents the total change in the Swiss price index due to European trade integration. Then I computed the Swiss price index (3) keeping the initial wage rates constant but using the counterfactual (lower) price indices of the trading partners. This would suggest a 1.8% decrease of the Swiss price index. If, on the other hand, the trading partners' price indices are left constant, but one uses the trading partner's new (higher) wage rates, one gets an increase in the Swiss price index of 2.3%. Since the latter effect dominates, overall, the Swiss price index increases by about 0.9%. The third effect outlined above is the

Table 3: The welfare effects of a further European trade integration

	No participation	Participation
Effect on Swiss price index	0.9 %	–7.6 %
EU price indices	–1.8 %	–1.9 %
EU factor remuneration	2.3 %	2.4 %
lower import trade costs	–	–11.5 %
Effect on Swiss factor incomes	–1.6 %	42.5 %
Total effect on Swiss welfare	–0.6 %	11.4 %

Note: this table presents the effects of a 50 % reduction of intra-European trade costs on Swiss real per-capita incomes. "No participation" refers to a situation where trade costs between Switzerland and the EU countries are left unchanged, while in the "participation" scenario trade costs between Switzerland and the EU are also reduced by 50 % so that the relative trade costs remain constant.

fact that trade is diverted away from Switzerland. This leads to lower demand for Swiss production factors and correspondingly Swiss factor incomes decrease by 1.6 %. Together, the higher price index and the lower incomes in Switzerland translate into the 0.6 % decrease of Swiss real per-capita incomes. Put differently, the Swiss representative agent would be willing to forgo each year up to 0.6 % of her annual income to avoid intra-European trade integration.

The obvious question that immediately follows is how much the representative agent would be willing to pay to *participate* in the trade cost reduction. The third column in Table 3 answers this question. In a new counterfactual experiment, I lowered not only trade costs within the EU by 50 %, but trade costs between Switzerland and each EU country by an equal percentage. The resulting equilibrium looks quite different: with respect to the Swiss price index we now have three effects – the two effects that were already present before (higher EU factor remunerations and lower EU price indices) and a new direct effect coming from lower import prices due to the lower trade cost. As can be seen from the Table 3 ("participation"), the quantitative effects of changing EU factor remunerations and price indices are similar to the previous experiment. However, the lower trade costs for Swiss imports from EU countries has a strong dampening effect on the Swiss price index: if I leave the European factor remuneration and price indices unchanged, but use the new trade costs to compute the Swiss price index, I find a 11.5 % reduction in the price index. This direct channel clearly dominates the other two effects leading to a total reduction of 7.6 % in the Swiss price index. Moreover, since the trade costs between Switzerland and the EU27 countries have fallen by similar amounts as intra-EU27 trade costs, demand is not diverted away from Switzerland and lower trade costs simply imply that production factors are now more productive. Correspondingly, Swiss factor remunerations increase by a strong 42.5 %.[11] Together with the lower price index this translates into a 11.4 % increase in real Swiss per-capita income, i.e. the representative Swiss consumer would be willing to forgo up to 11.4 % of her income in order to be able to participate in the reduction of European trade costs.

Of course, there exists an even more attractive option from a Swiss perspective. Namely, that the EU countries do not liberalize amongst themselves, but all trade costs between Switzerland and the individual EU countries were lowered. In this case, Swiss welfare would rise by 13.6 %, which is slightly stronger than in the case where EU countries liberalize with Swiss participation. The reason for this result is that since relative trade costs for Swiss exports improve, some of the intra-EU trade is diverted away towards Swiss exports, which raises demand for Swiss production factors and therewith their remunerations. This point will be taken up in the policy conclusions below.

5. Concluding Discussion

This paper adopted the Ricardian multi-country trade model first introduced by Eaton and Kortum (2002) as a tool to measure the Swiss gains from trade with particular countries. It did so by performing counterfactual experiments within a quantified version of the trade model. The advantage of this approach is its ability to account for general equilibrium effects. I found that besides Switzerland's immediate neighbors most countries' contribution to Swiss welfare is surprisingly small – the reason for this result are strong reallocation effects. In a second experiment I found that a large fall in trade costs within the EU leads to a relatively minor welfare loss in Switzerland. If, however, Switzerland would lower its trade costs with the EU simultaneously, this loss would turn into quite a large welfare gain.

What can we learn from these results? The first experiments yield only small gains from being able to trade with particular countries. Correspondingly, the welfare gains coming from free trade agreements with individual countries are

11 This number seems to be very high at a first sight. However, note that nominal wages here imply relative to the numéraire wage, w_1, which is the US wage rate in my implementation. The US wage rate in turn falls since they do not participate in the trade liberalization. Secondly, as mentioned above, a 50 % reduction in intra-EU27 trade costs is a significant step towards free trade and the wage gains are correspondingly large.

rather small.[12] Therefore, one would ideally lower trade costs with a large set of countries so that these small effects cumulate and finally yield a large overall effect. The simulation discussed at the end of the previous section where trade costs between Switzerland and EU countries are slashed is a case in point. However, conducting simultaneously a large number of trade negotiations is not only tedious, but may also make passage in the relevant policy bodies impossible as it multiplies the number of interest groups who try to influence the negotiation process based on their particular interests. The simulation, where trade costs both within the EU as well as between the EU and Switzerland are lowered, suggests an alternative: participating in multilateral rounds of trade cost reductions yields welfare benefits that are only slightly smaller than the first best option, but may be much more realistic to achieve. Finally, the simulation where Switzerland does not participate in the trade cost reduction shows that the negative effects of non-participation on the level of Swiss real per-capita incomes are modest and far from dramatic. The upside from participation, however, is large.

One further conclusions may be drawn: Reading the results from the second counterfactual experiments in reverse suggests that unilaterally increasing trade costs vis-à-vis a large group of countries does in fact affect Swiss welfare in a non-negligible way. Moreover, from the first class of experiments one can conjecture that a few new trade agreements would be unlikely to compensate for the welfare loss associated with the unilateral increase in trade costs.

Appendix

A. Data

The sample consists of 86 countries that together represent 87 % of global GDP. This gives rise to $7310 = 86 * 85$ bilateral trade relations. In the following I describe the data used to quantify the model. I use the trade shares for non-consumption goods. Alternatively one could use total trade or trade in intermediates only. The results do barely change since the shares are highly correlated.

12 If I simulate for example a 50 % reduction in bilateral trade costs with China, Swiss welfare increases by a relatively modest 1.5 %.

A.1 Aggregate values of bilateral trade flows

I use COMTRADE data for 2003 as provided by CEPII (Gaulier et al., 2010). This data provides the dollar values of the bilateral trade flows between 239 economic entities (mostly countries) on the HS6 level of aggregation. Summing over all HS6 categories of non-consumption goods yields the total value of a bilateral trade flow.

A.2 Gross output and manufacturing absorption

I use data from the United Nations Industrial Development Organization (UNIDO, 2003) on gross manufacturing output. For the year 2003 this database provides the gross manufacturing output for 77 countries. Unfortunately, the database does not include gross output for several large countries, most notably Switzerland and China. I therefore choose to impute the gross manufacturing output for countries that belong to the 20 largest economies in 2003 and for which I do not observe gross manufacturing output. I do this by following Eaton, Kortum, and Kramarz (2004) and scaling value added in the manufacturing sector by the average ratio of gross output and value added across countries. Using bilateral trade flows I transform the gross output into total manufacturing absorption as described in the main text. To get at the manufacturing absorption in non-consumption goods only, I proxy their shares in gross output by the shares in a country's total exports.

A.3 Bilateral distances, shared border, and common language

All transportation cost proxies are from the database provided by CEPII (CEPII, 2006). The bilateral distance is measured as the distance between two countries' most populous cities. The common language indicator takes the value one if two countries have the same official language[13] and common border takes the value one if two countries share a common land-border.

13 The results remain basically unchanged when using major languages instead of official languages.

A.4 Endowments and population sizes

Human capital h_i is taken from Caselli (2005) who uses the data of Barro and Lee (2001). These authors compute human capital as a piece-wise log-linear function of average years of schooling of a country's population over 25 year. Population sizes are taken from the Worldbank's World Development Indicators (World Bank, 2010). Note that I do not need data on physical capital stocks, since they are absorbed into the capital-technology composite, $\widetilde{T}_i$.

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