Variety Gains from Trade in Switzerland[a]

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1. Introduction

The monopolistic competition models developed by Spence (1976), by Dixit and Stiglitz (1977), and, applied to trade, by Krugman (1979, 1980, and 1981) have had a great impact on the theoretical as well as the empirical literature in international economics. One aspect of these models is the plurality of channels for welfare gains through trade. Feenstra (2006) provides a literature review that concentrates on these different channels: Scale economies represent the first source of trade gains in these models. They have been explored in a large number of contributions since the 1980s. The second source is concerned with efficiency gains due to the selection of firms as introduced by Melitz (2003); an issue which has been investigated by many economists more recently. The third source of welfare gains, namely the gains from an increased variety set, has probably received the least amount of attention, especially when it comes to empirical work. My contribution pertains to this latter source of welfare gains.

The importance of these gains has been realized by authors like Harris (1984), Feenstra (1992) or Romer (1994), but the most influential work regarding the empirics in this field is found in Feenstra (1994b). In his seminal contribution,

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he shows how new and disappearing varieties change the costs of living depending on their substitutability with other varieties and their expenditure share. This allows FEENSTRA (1994b) to quantify the upward bias in conventional import price indices that ignore changes in the set of imported varieties. He shows that these biases can be severe, basing his evidence on a small sample of imported goods.

KLENOW and RODRÍGUEZ-CLARE (1997) provide additional empirical evidence using this approach. They find that the variety gains are an important part of overall trade gains. According to their study, one third of the gains from trade, which in total account for up to 2% of GDP in Costa Rica between 1986 and 1992, is due to the larger imported variety set that implicitly decreased the import prices. However, the authors require a number of simplifying assumptions, for example that the elasticity of substitution between varieties is the same for all product categories.

The most thorough empirical work to date was conducted almost a decade later, by BRODA and WEINSTEIN (2006). These authors were the first to structurally calculate the gains from imported variety (GFV) using highly detailed trade data, also estimating the substitutability between varieties for each product category directly from this data.[1] Applying the FEENSTRA (1994b) methodology, the authors find that the upward bias in the conventional import price index in the United States between 1972 and 2001 is 1.2% per year. This leads to gains from imported variety of 2.6% of GDP over the whole period. These are sizeable variety gains from trade for consumers in a country that exhibits small import shares and where domestic production is still dominant in many product categories.

In the light of these findings, the case of Switzerland as a small open economy (SOE) promises to be of interest. Switzerland is strongly integrated within the world market, a notion that can be expressed by its large import and export shares relative to GDP. Hence, the gains from trade relative to total economic activity are potentially large, the import share being three times higher than in the United States. However, other factors determine the variety gains from trade, most notably the degree of substitutability between imported varieties as well as structural changes in the imported variety set.

To explore how these channels affect the variety gains in a SOE, I first estimate the GFV in Switzerland for the period from 1990 to 2006. I find that over the whole period, the GFV account for just 0.3% of GDP. These gains are not

1 I would like to note here that other authors have quantified the value of new varieties using domestic micro data: Examples are HAUSMAN (1997a, 1997b, and 1999) or PETRIN (2002).

substantial. To put this result into perspective, I estimate the GFV in the United States for the same period and compare them to the Swiss results. It is found that these gains are twice as large as in Switzerland despite the low U.S. import share.

Two reasons are responsible for this result: First, relative to the United States, Switzerland imports product categories whose varieties are less differentiated, meaning that the value of a new variety to consumers is – on average – less than in the United States. Secondly, variety growth in Switzerland is much less pronounced than in the United States.[2] I then show that this latter factor is far more important in explaining the relatively low GFV in Switzerland while the effect of the substitutability differential is limited.

The paper is structured as follows: Section 2 reviews the methodology used to determine the GFV. In Section 3, descriptive statistics are discussed and the empirical results are presented; and in Section 4, the GFV in Switzerland are analyzed regarding countries and industries of origin. Furthermore, a comparison with results for the United States is carried out, pointing out the major differences between the two countries. Section 5 concludes.

2. Modeling and Empirical Strategy

Following Broda and Weinstein (2006), utility M_{gt} of an imported good g composed of varieties c can be written using the following CES specification:

$$M_{gt} = \left(\sum_{c \in C} d_{gct}^{\left(\frac{1}{\sigma_g}\right)} m_{gct}^{\left(\frac{\sigma_g - 1}{\sigma_g}\right)} \right)^{\frac{\sigma_g}{\sigma_g - 1}} ;\ \sigma_g > 1 \ \ \forall g \in G, \quad (1)$$

where m_{gct} is the quantity of variety c consumed at time t and σ_g is the elasticity of substitution between the varieties of good g. G is the set of goods and C is the

2 This finding is presented in a recent article in this journal by Egger, Gassebner, and Lassmann (2009) who calculate the lambda ratios for Switzerland, the United States and Japan. I calculate the lambda ratios at a more disaggregated level for a more recent period of time and extend the analysis by accounting for the substitutability between varieties. This allows me to calculate the GFV from the perspective of a consumer with a CES utility function. In contrast to theirs, my study includes all major trading partners of Switzerland during the whole period (a total of 151 countries), most notably Germany which is the most important exporter to Switzerland.

set of all varieties potentially available. d_{gct} is a taste or quality parameter.[3] The price for one util, henceforth called the unit-cost[4] ϕ_{gt}^{M} of utility M_{gt}, for every good g is:

$$\phi_{gt}^{M}(I_{gt}) = \left(\sum_{c \in I_{gt}} d_{gct} \, p_{gct}^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}}, \tag{2}$$

where I_{gt} is the set of imported varieties *available* at time t within good g, and p_{gct} is the unit price of a variety. Note that for given prices and taste parameters, a larger variety reduces the unit-costs for consumers. These unit-cost functions are the building blocks of the price index. DIEWERT (1976) uses these unit-cost functions to define the cost of living index for homothetic utility functions:

$$P_g^M(I_g) = \frac{\phi_{gt}^{M}(I_g)}{\phi_{gt-1}^{M}(I_g)}, \tag{3}$$

given a constant set of varieties, I_g, henceforth called the *common set*. SATO (1976) and VARTIA (1976) have derived this index for CES unit-cost functions to be

$$P_g^M(I_g) = \prod_{c \in I_g} \left(\frac{p_{gct}}{p_{gct-1}} \right)^{w_{gct}}, \tag{4}$$

where

$$w_{gct}(I_g) = \frac{\left(\dfrac{s_{gct} - s_{gct-1}}{\ln s_{gct} - \ln s_{gct-1}} \right)}{\sum_{c \in I_g} \left(\dfrac{s_{gct} - s_{gct-1}}{\ln s_{gct} - \ln s_{gct-1}} \right)}, \tag{5}$$

$$s_{gct}(I_g) = \frac{p_{gct} x_{gct}}{\sum_{c \in I_g} p_{gct} x_{gct}}. \tag{6}$$

3 The parameter d_{gct} allows the representative consumer to consume different amounts of the varieties even if prices are equal.

4 This price is called *unit-cost* since it represents the *cost of living* of a representative consumer.

Thus, the price index is the geometric mean of all price changes.[5] The weights depend on the expenditure shares s_{gct}. The price index defined above demands a common set I_g; i.e., is valid only for a constant variety set. FEENSTRA (1994b) has shown that the exact price index for a *non-constant* set of varieties, I_{gt}, is

$$\pi_g^M(I_{gt}, I_{gt-1}) = \frac{\phi_{gt}^M(I_{gt})}{\phi_{gt-1}^M(I_{gt-1})}, \tag{7}$$

$$= P_g^M(I_g)\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g - 1}}, \tag{8}$$

where

$$\lambda_{gr} = \frac{\sum_{c \in I_g} p_{gcr} x_{gcr}}{\sum_{c \in I_{gr}} p_{gcr} x_{gcr}}, \; r = t, t-1. \tag{9}$$

Hence, the *corrected* price index allowing for *variety change*, π_g^M, is a *conventional* price index P_g^M times an additional term. Note that the numerators of λ_{gt} and λ_{gt-1} comprise the expenditure on the common varieties; i.e., those varieties that are available at t *and* $t-1$. In the denominator of λ_{gt}, the common *and* new varieties are included, while in the denominator of λ_{gt-1}, the common *and* disappearing varieties are included. Thus, the *lambda ratio* becomes smaller than one if expenditure on new varieties at time t is relatively high, and it becomes larger than one if expenditure on disappearing varieties at time $t-1$ is relatively high. This ratio is then weighted by a term negatively related to the elasticity of substitution. Thus, there is a greater correction in the conventional price index if the elasticity is small. If the elasticity is large, however, the lambda ratio term converges to one. Stated differently, consumers only care about variety changes within differentiated product categories.

Now that the corrected price indices for the imported goods g are known, they are aggregated into the corrected import price index Π^M for all $g \in G$:

5 It is a remarkable feature that the price index does not depend on taste parameters. The intuition for this result shown by DIEWERT (1976) is that all the information contained in the taste parameters is captured by the expenditure shares.

$$\Pi^M(I_t, I_{t-1}) = \prod_{g \in G} \left(\pi_g^M (I_{gt}, I_{gt-1}) \right)^{w_{gt}}, \tag{10}$$

$$= \prod_{g \in G} \left[P_g^M (I_g) \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{1}{\sigma_g - 1}} \right]^{w_{gt}}, \tag{11}$$

$$= CIPI(I) \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{w_{gt}}{\sigma_g - 1}}, \tag{12}$$

where *CIPI*(*I*) is a conventional import price index that does not account for the change in varieties. The ratio of the corrected import price index to the conventional import price index expresses the bias from ignoring the change in variety. This ratio is called the *endpoint ratio (EPR)* and it is defined as

$$EPR = \frac{\Pi^M(I_t, I_{t-1})}{CIPI(I)} = \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{w_{gt}}{\sigma_g - 1}}. \tag{13}$$

Thus, the EPR is a weighted geometric mean of the lambda ratio terms. The weights w_{gt} depend on the expenditure shares s_{gt} and are built analogously to the weights w_{gct} of equation (5).

In order to relate this bias in the conventional import price index to total economic activity, it is weighted by the import share of the economy.[6] Hence, the GFV as a percentage of GDP can be expressed as

$$GFV = \left[\frac{1}{EPR} \right]^{w_t^M} - 1. \tag{14}$$

Thus, the welfare gains can be computed by weighting the inverse of the weighted aggregate lambda ratios with the fraction of imports relative to total economic

6 This corresponds to the assumption of Cobb-Douglas separability between domestic and imported goods.

activity.[7] The elasticity of substitution required for the calculation of the GFV is estimated for each product category as in Feenstra (1994b).[8]

3. Empirical Results

In this section, the methodology laid out in Section 2 is applied to Swiss data. The import data are available from the Swiss Federal Customs Administration (SFCA).[9] The data include import values and imported quantities for all 8-digit Harmonized System (HS) product categories from all countries of origin.[10] The definitions of goods and varieties follow directly from the data: Goods are defined as HS-8 product categories[11] and varieties are defined as good-country pairs, analogous to Armington (1969).[12] I first present various descriptive statistics on the imported variety growth over the last two decades in Switzerland.

3.1 Variety Growth in Switzerland

The fraction of imports relative to GDP rose from 26% to almost 40% in Switzerland between 1990 and 2006. The value of all imports increased from roughly 80 billion Swiss Francs to over 170 billion, an annual growth rate of

7 This equation is derived by taking the ratio of the economy-wide conventional price index that ignores variety changes and the economy-wide corrected price index. Due to the separable structure of this Krugman economy, the domestic price index vanishes from this expression.

8 Interested readers are also referred to Feenstra (1994a) and an unpublished appendix of the same author where this methodology is discussed in further detail. An interesting point to note is that the panel nature of the data (time and country dimension) allows one to solve the endogeneity problem that arises since prices and quantities are determined simultaneously by unobserved supply and demand shocks. The intuition behind this approach is explained in a very comprehensible manner by Feenstra (2006).

9 See *www.admin.ezv.ch.*

10 Examples of HS-8 product categories are “onions, fresh or chilled”, “television receivers, color, incorporating a video recorder or reproducer” or “crane lorries”.

11 The terms “good” and “product category” are used interchangeably in the text.

12 Countries are defined according to their status in 1990, and this definition is held fixed over the whole period. Countries that were divided after 1990 are treated as one entity. For example, Slovakia and the Czech Republic are combined into “Former Czechoslovakia”, countries of the former Soviet Union into “Former USSR”. A special case is Germany, which was reunified in 1990. In this study, “Germany” consists of both its Eastern and Western parts.

over 4%, while GDP rose by 1.8% per year.[13] While the fast growth of imports is a widely acknowledged fact, the change in the variety set of traded goods enjoys less interest. This seems to be unjustified since this changing structure of trade is a manifestation of the growing integration of countries throughout the world.

Table 1 displays statistics on the variety of Swiss imports in 1990 and in 2006. One dimension of the variety change is shown in column (1). The number of HS-8 product categories rose from 6,672 to 7,933. Also observe that many product categories disappeared (1,372), and about twice as many appeared for the first time during this period (2,633).[14] Furthermore, 5,300 goods were imported in 1990 as well as in 2006; these are called the *common* goods. The second dimension of variety growth observed in this trade data is the number of varieties per product category, i.e., the number of countries that supply Switzerland within a specific product category. In columns (2) and (3), the median and mean number of varieties per product category is shown. Note that when using all goods, the mean number of supplying countries increased from 12.2 to 14.7. This change is even more striking if only the common goods shown in rows (3) and (4) of the table are considered. The mean number of varieties has increased by 30% from 12.7 to 16.9 for these categories. The two dimensions add up to the total variety shown in column (4). Between 1990 and 2006, total variety increased by 42% from 81,688 to 116,361. For the common goods, variety increased from 67,405 to 89,424.

While column (4) shows statistics on the varieties of the new, disappearing and common *goods* of column (1), column (5) displays those of new, disappearing and common *varieties*, independent of goods.[15] In column (5), a high turnover

13 In real terms. The data are taken from the Swiss Federal Statistical Office (SFSO), http://www.bfs.admin.ch. The SFSO uses its own GDP deflator to adjust for price changes. The basket of goods of the deflator is adjusted in each year to account for quality changes and the introduction of new goods.

14 Partly, this is a consequence of a number of redefinitions of the HS classification. The approach presented above, however, is robust towards such redefinitions. See FEENSTRA (1994b) for more information.

15 This can be clarified by an example: Assume that the good "television receivers" is imported from Germany in 1990 and 2006 and from China in 2006 only. In column (4), both varieties would be counted as "common", since they both belong to a good that is available in both periods, regardless of their country of origin. In column (5) however, only the German television receivers would be counted as "common", since the Chinese television receivers appeared only after 1990. Both statistics are useful. While the first offers insights about the importance of new and disappearing goods and their composition, the latter is informative about all the available good-country pairs.

Table 1: Variety of Swiss Imports 1990–2006

	Year	Number of HS-8 goods	Median no. of countries per good	Mean no. of countries per good	Number of varieties within the HS-8 goods of column (1)	Total number of varieties	Share on total imports
		(1)	(2)	(3)	(4)	(5)	(6)
All 1990	1990	6,672	10	12.24	81,688	81,688	1.00
All 2006	2006	7,933	11	14.67	116,361	116,361	1.00
Common 1990–2006	1990	5,300	11	12.72	67,405	52,332	0.74
Common 1990–2006	2006	5,300	13	16.87	89,424	52,332	0.70
1990 not in 2006	1990	1,372	8	10.41	14,283	29,356	0.26
2006 not in 1990	2006	2,633	8	10.23	26,937	64,029	0.30

Note: This table is based on 8-digit level HS product classification trade data. Varieties are defined as HS-8 good-country pairs. The data are available from the SFCA.

of varieties is observed: 64,029 varieties that were not available in 1990 were imported in 2006, while 29,356 varieties imported in 1990 vanished subsequently. This means that even in the common product categories, many countries started exporting to Switzerland during this period for the first time, while others stopped exporting these goods. Column (6) reveals that a large share of total imports in 2006, about 30%, can be attributed to new varieties, while disappearing varieties account for 26% of 1990 imports. If these statistics are analyzed with respect to countries of origin, it is found that most of the new varieties stem from China, India, Poland, countries of the former USSR and the former Czechoslovakia as well as from Turkey and Hungary. Hence, some major emerging countries contributed substantially to the new set of imported varieties. This stresses the changing structure of Swiss imports: Imports originate from a larger number and a different set of countries today compared with two decades ago.

3.2 Measuring the Variety Gains from Trade

These numbers imply substantial variety growth in Switzerland and consequently hint at high potential gains for consumers. However, there are two central issues that are not accounted for in Table 1. First, the variety count ignores the *importance* of new and disappearing varieties. New varieties that are not demanded at high values do not yield a high value to the representative consumer. Considering Table 1, in 2006, the 64,029 new varieties account for 30% of total expenditure on imports, while 52,332 of the established varieties account for 70%. The lambda ratios presented in Section 2 take the expenditure shares into account and are therefore a more meaningful measure for variety change. Table 2 displays summary statistics of the lambda ratios calculated as in equation (8).[16] Remember from Section 2 that the lower the lambda ratio, the higher the variety growth in that product category. The median lambda ratio of 0.98 can be interpreted as a weighted variety growth in the median product category of about 2%, a value that puts the numbers presented in Table 1 into perspective.

Table 2: Summary Statistics: Lambda Ratios

Number	2,081
Mean	1.51
5% Percentile	0.54
Median	0.98
95% Percentile	1.42

Note: All calculations are based on the disaggregated HS-8 trade data available from the SFCA.

The second central issue neglected is the level of differentiation within product categories. Intuitively, a large set of varieties within homogeneous product categories, like commodities traded on exchanges, is not valued highly by consumers: Typically, most car owners will be indifferent about the brand or origin of their car fuel. On the other hand, a large number of highly differentiated varieties – like different car models – constitutes an additional benefit to consumers. This is the essence of the monopolistic competition framework from a consumers'

16 Note that for HS-8 goods, the lambda ratio is not defined if there is no common variety in the first and the last period. Where this requirement fails, the lambda ratio of the good defined after the Standard International Trade Classification (SITC-5) is used for all the HS-8 goods within this SITC-5 category. To obtain an elasticity for these aggregated goods, the geometric mean of the sigmas of the HS-8 goods is used. Hence, only 2,081 lambda ratios are defined (not 7,846). Note however, that *all* 7,846 sigmas (see Table 3) are used to calculate the index.

perspective. This level of differentiation is captured by the elasticity of substitution. I estimate such an elasticity for every product category using the methodology presented in FEENSTRA (1994b). Summary statistics are shown in Table 3. The median elasticity is approximately 4.[17] To interpret this figure, assume that in a particular product category, the lambda ratio takes the value of 0.9, and thus the variety increase is about 11%. Calculating the second term of equation (8), I find that this lowers the price index of this product category by $1 - 0.9^{1/(4-1)} = 3.5\%$ and, thus, consumers achieve a given utility level at costs that are about 3.5% lower than without the change in the variety set. Said differently, this means that a conventional price index of this product category that neglects the change in the variety set is biased upwards by $1 / 0.9^{1/(4-1)} = 3.6\%$.

Table 3: Summary Statistics: Elasticities of Substitution

Number	7,846
Mean	11.07
Standard Error	1.55
Median	4.07
Maximum	7,685.96
Minimum	1.05

Note: All calculations are based on the disaggregated HS-8 trade data available from the SFCA.

I then use equations (4) to (13) to obtain the corrected price indices for all product categories and, aggregating over all products, the aggregate import price index as well as the EPR. Table 4 displays the EPR for the aggregated import price index in Switzerland. Over the last 17 years, ignoring the change in the set of imported varieties has led to an upward bias in the import price index of 0.88%, which implies an annual bias of 0.05%. As laid out in equation (14), the bias in the import price index has to be weighted by the import share to obtain the GFV relative to GDP. The average import share in Switzerland for the period from 1990 to 2006 is 30.7%. As a result, the GFV account for 0.27% of GDP.

17 The mean elasticity is large due to a few large outlier elasticities and is therefore difficult to interpret.

Table 4: Bias in the Swiss Import Price Index and GFV

Endpoint Ratio	0.991
Total Bias	0.88%
Annual Bias	0.05%
Variety Gains (% of GDP)	0.27%

Note: All calculations are based on the disaggregated HS-8 trade data available from the SFCA.

What do these gains imply for Swiss consumers? In a hypothetical context, the result means that in the year 2006, Swiss consumers would have been willing to give up about 0.3% of GDP to gain access to the variety set of 2006 instead of having to stick to the variety set of 1990. In absolute value, this accounts to approximately 1.3 billion Swiss Francs in 2006, about 180 Francs per inhabitant. These gains are small and the reasons for this result are discussed in the next section.

Before turning to the analysis of the results, note that these gains may be a lower bound. As BLONIGEN and SODERBERY (2010) show, trade data may ignore much of the variety turnover and may thus lead to an underestimation of the variety growth: The authors use detailed market data of the U.S. automobile market and show that the GFV within these product categories using these data are 100% higher compared to an analysis that uses standard trade data. This issue is also addressed in MOHLER (2010), where an alternative measure of variety growth is proposed, based on FEENSTRA (1994b). Further exploration of this issue is beyond the scope of this paper but higher GFV do not seem unrealistic when taking the potential hidden variety growth into account.[18]

18 The GFV in the United States between 1990 an 2006 increase from 0.5% of GDP to over 2% when using the measure of MOHLER (2010) that accounts for hidden variety growth.

4. Analysis of the Results

4.1 Geographical and Sector-Specific Contribution to the Variety Gains from Trade

Switzerland is located in the heart of Europe and is – although not a member of the European Union (EU) – well integrated within the European economy. Particularly well established trade linkages exist with large EU countries such as Germany, France and Italy. However, emerging countries such as China, India and many Eastern European countries have increased their exports to Switzerland substantially over the last few years. To find the drivers of the GFV over the last two decades, I calculate the EPRs for all trading partners of Switzerland. Using the methodology presented above, I can write

$$EPR_i = \prod_g \left[\left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\left(\frac{w_{gt}}{\sigma_g - 1} \right) w_{igt}} \right], \tag{15}$$

where w_{igt} is the ideal log-change weight of country i on good g. Note that by multiplying all these EPR_i's, the total EPR as reported in Table 4 is obtained:

$$EPR = \prod_i EPR_i. \tag{16}$$

As is shown in Table 5, Germany contributes by far the largest share to the GFV in Switzerland, namely 34%.[19] More than 50% of all the GFV are due to imports from Switzerland's most important trading partners Germany, Italy and France. About 80% of all the GFV stem from trade with EU-27 countries.[20]

19 As noted in Footnote 3, Germany was reunified in 1990 and since it is by far the most important trading partner of Switzerland, the question arises as to whether this unification had any effects on the results. To address this issue, I estimate the GFV for Switzerland starting in 1991 and in 1992. The exercise confirms that the potential data issues related to the unification process do not qualitatively change the results: Starting in 1991, the total variety gains amount to 0.24% of GDP. In that case, imports from Germany contribute 40% to these gains. Starting in 1992, the GFV are 0.19% of GDP. German exports to Switzerland then account for 37% of the total gains.

20 The relative contribution of a single country to the variety gains is calculated as $\ln(EPR_i) / \ln(EPR)$. These individual shares sum up to one.

On one hand, this is a surprising result since Switzerland already imported most product categories from countries like Germany, France or Italy in 1990 and hence the potential of these countries to export many new varieties to Switzerland was small. Remember the result mentioned in Section 3, where emerging countries provided most of the new varieties. A glance at the data, however, reveals that new varieties from the "traditional" trading partners were imported at much larger values and thus contributed far more to the welfare gains than new varieties from other countries.

Table 5: Contribution of Individual Countries to the GFV

Country	Rank	Contribution
Germany	1	34.0%
Italy	2	11.9%
China	3	8.2%
France	4	7.5%
United Kingdom	5	7.0%
Ireland	6	6.2%
Austria	7	4.3%
Former Czechoslovakia	8	3.0%
Former USSR	9	3.0%
Spain	10	2.2%
Japan	11	2.0%
USA	12	2.0%
Poland	13	1.9%
Netherlands	14	1.7%
Sweden	15	1.6%
Denmark	16	1.2%
Hungary	17	0.9%
Canada	18	0.8%
Former Yugoslavia	19	0.6%
Turkey	20	0.6%

Note: All calculations are based on the disaggregated HS-8 trade data available from the SFCA.

Apart from Switzerland's three most important trading partners, the other major contributors are China, the United Kingdom, Ireland, Austria, Slovakia and the Czech Republic as well as the countries of the former USSR, Japan and the

United States. The contributions of many emerging countries stand as an example of the growing importance in world trade that these nations have acquired over the last two decades. A further interesting point to note is that oil exporting countries such as Libya, Nigeria or Saudi Arabia, which all hold a relatively large share of total imports, do not contribute to the gains at all. This is due to the homogeneous nature of their exports. To give an example, Libya accounts for 1% of the total Swiss import value in 2006 which is more than countries like the Czech Republic, Finland, Denmark, Poland, Hungary or even Canada, India or all the former USSR countries combined. Thus, although all these countries are not as important regarding the total value of imports, their strong contribution to the variety increase in *differentiated* product categories leads to positive GFV for Swiss consumers.

The second point of interest concerns the different manufacturing industries. Which of these industries contribute most to the GFV? To answer this question, I use the same approach as in equation (15), now calculating separate EPRs for each HS-2 industry. The contributions of the most important industries to the GFV are presented in Table 6. As expected, most if not all industries contain supposedly differentiated varieties. This further increases my confidence in the elasticity estimates. In Switzerland, chemicals, various machinery, clocks and watches, vehicles, articles of plastic, various instruments, furniture, beverages, footwear and apparel are the major contributors to the GFV. Categories like "mineral fuels" or other homogeneous commodities do not contribute to the gains, even though they account for a large part of total imports.

4.2 An International Comparison

Broda and Weinstein (2006) find GFV for the United States between 1972 and 2001 that amount to 2.6% of GDP. This result suggests – although a longer period is considered – much larger GFV than observed in Switzerland. I re-estimate the variety gains from trade for the United States for the time period used above, i.e., from 1990 to 2006. The detailed results can be found in Tables 10 to 13 in the Appendix. Table 7 provides a comparison of the two countries' results.[21]

21 U.S. trade data can be obtained from the Center of International Trade Data (CID) at UC Davis, *http://cid.econ.ucdavis.edu/*. It is available at a more disaggregated level, namely at HS-10. Since Swiss data is only available at HS-8, for the sake of comparability, I use HS-8 data for the United States as well.

Table 6: Contribution of HS-2 Industries to the GFV

HS-2	Rank	Contribution	Description
29	1	16.6%	Organic chemicals
84	2	14.8%	Machinery, nuclear reactors, boilers, etc.; parts thereof
91	3	8.1%	Clocks and watches and parts thereof
28	4	7.8%	Inorganic chemicals, etc.
85	5	7.2%	Electrical machinery, sound and tv recorders, etc.
87	6	7.1%	Vehicles other than railway or tramway, parts thereof
39	7	6.6%	Plastics and articles thereof
92	8	6.4%	Musical instruments, and parts thereof
93	9	4.4%	Arms and ammunition, and parts thereof
90	10	4.0%	Optical, photographic, medical and other instruments
88	11	3.9%	Aircraft, spacecraft, and parts thereof
94	12	3.7%	Furniture; bedding, mattresses, etc.
22	13	2.7%	Beverages, spirits and vinegar
74	14	2.6%	Copper and articles thereof
64	15	2.3%	Footwear, gaiters and the like; parts of such articles
70	16	2.3%	Glass and glassware
62	17	2.2%	Articles of apparel, not knitted or crocheted
59	18	2.1%	Impregnated, coated, covered or laminated textile fabrics
68	19	2.1%	Articles of stone, plaster, cement, asbestos, etc.
73	20	2.0%	Articles of iron or steel
34	21	1.8%	Soap, washing preparations, lubricating preparations, candles, etc.
63	22	1.6%	Other made-up textile articles; sets; rags
44	23	1.4%	Wood and articles of wood; wood charcoal
96	24	1.4%	Miscellaneous manufactured articles
4	25	1.2%	Dairy produce; birds' eggs; natural honey, etc.

Note: All calculations are based on the disaggregated HS-8 trade data available from the SFCA.

Table 7: A Comparison of Swiss and U.S. Results

	Switzerland	United States
Median Sigma	4.07	3.06
Median Lambda Ratio	0.98	0.96
Endpoint Ratio	0.991	0.951
Total Bias	0.88%	5.13%
Import Share	30.69%	10.62%
Variety Gains (% of GDP)	0.27%	0.53%

Note: Swiss results are based on the disaggregated HS-8 trade data available from the SFCA. U.S. results are based on the disaggregated HS-8 trade data available from CID at UC Davis.

The variety gains account for 0.53% of GDP in the United States. The table sheds some light onto this result: As displayed in the first row, Switzerland's median elasticity of substitution takes the value of 4.07 and is higher than the one for the United States which is estimated to take a value of 3.06. This implies that U.S. imports are more differentiated on average and as a consequence, new varieties are more valuable to consumers than in Switzerland. Secondly, as is shown in the second row of Table 7, the median lambda ratio is lower for U.S. imports with a value of 0.96 compared to a median lambda ratio of 0.98 for Swiss imports. Since the lambda ratios are a measure of the variety increase, these numbers reveal more substantial variety growth in the United States over the last 17 years.

It can thus be stated that – qualitatively – the large difference in the endpoint ratio as displayed in the third row of Table 7 is a consequence of lower elasticities of substitution *and* higher variety growth in the United States. These two effects lead to a more than five times larger bias in the import price index of the United States; i.e., a bias of 5.13% compared to one of 0.88% for Switzerland. Even the almost three times larger import share of Switzerland (fifth row) cannot compensate for these differences and hence the GFV as a percentage of GDP are twice as high in the United States, as displayed in row six.

Table 7 does not indicate which one of these two channels – product differentiation or variety growth – is mainly responsible for the large difference in the import price index bias in quantitative terms. In Table 8, I approach this issue by holding either the elasticities of substitution or the lambda ratios fixed across the two countries. In the first two columns of the table, I calculate the GFV using an elasticity of substitution of 2.00 for all goods in both countries. The bias is still almost four times larger in the United States, 14.05% compared to 3.63%, even though the effect of different elasticities is eliminated. This exercise is repeated for elasticities taking values of 4.00 and 8.00 in columns (3) to (6).[22] The total bias in the import price index remains four to five times larger in the United States.

Table 8: Analysis of the Differences in the GFV between Switzerland and the United States

Using a constant σ_g	CH (1)	US (2)	CH (3)	US (4)	CH (5)	US (6)
Median Sigma	2.00	2.00	4.00	4.00	8.00	8.00
Median Lambda Ratio	0.98	0.96	0.98	0.96	0.98	0.96
Endpoint Ratio	0.965	0.877	0.988	0.957	0.995	0.974
Total Bias	3.63%	14.05%	1.19%	4.48%	0.51%	2.66%
Import Share	30.72%	10.55%	30.72%	10.55%	30.72%	10.55%
GFV (% of GDP)	1.10%	1.40%	0.37%	0.46%	0.16%	0.28%

Using a constant $\lambda_{gt}/\lambda_{gt-1}$	CH (7)	US (8)	CH (9)	US (10)
Median Sigma	4.07	3.06	4.07	3.06
Median Lambda Ratio	0.98	0.98	0.96	0.96
Endpoint Ratio	0.994	0.993	0.988	0.986
Total Bias	0.58%	0.72%	1.17%	1.47%
Import Share	30.72%	10.55%	30.72%	10.55%
GFV (% of GDP)	0.18%	0.08%	0.36%	0.15%

Note: Swiss results are based on the disaggregated HS-8 trade data available from the SFCA. U.S. results are based on the disaggregated HS-8 trade data available from CID at UC Davis.

22 Naturally, the total bias becomes large if small elasticities of substitution are used and small if large elasticities are used. The objective of this exercise is not to demonstrate the change in the absolute magnitude of the bias, but the stability of the difference in the bias in Switzerland relative to the bias for the United States.

In columns (7) to (10) of Table 8, the lambda ratios are held constant for all goods in both countries using the values 0.98 and 0.96, while the estimated, country- and good-specific elasticities are used. The effect of the different elasticities is moderate with a bias in the United States that is only about 25% larger than in Switzerland; e.g., 0.72% compared to 0.58% if the lambda ratios take a value of 0.98. Also, holding the lambda ratios fixed results in higher GFV in Switzerland due to the larger import share. Hence, variety growth differences between these two countries are mainly responsible for the divergence in the total bias.

Using Table 9, these differences in variety growth are further explored. In the first two columns, the number of HS-8 goods is given for both countries in 1990 and 2006. The United States import more goods in absolute terms. Since the lambda ratios are a relative measure, I am, however, more interested in the relative change in these figures over time. While the number of imported goods increases by 18.9% in Switzerland, the increase in the United States is slightly lower, namely 17.1%.

The picture is different if the number of supplying countries is considered as in columns (3) and (4): The relative increase is much larger in the United States, where in 1990 an average of 14.80 countries exported to the United States in each product category, and where this number rose by 30.7% to 19.34 countries in 2006. In Switzerland, the increase in the average number of supplying countries was 19.9%. This explains the larger increase in total variety in the United States as shown in columns (5) and (6), accounting to 53.0%, whereas it amounts to 42.4% in Switzerland.

It is, however, not sufficient to simply consider the difference in the increase in the *number* of imported varieties. The lambda ratios weight the varieties according to their expenditure. Thus, the expenditure share of new varieties compared to the share of disappearing varieties is of central importance. An inspection of the last column of Table 1 shows that in Switzerland, new varieties contribute 30% to total 2006 imports, while disappearing varieties contribute 26% to total 1990 imports. For the United States, these shares are shown in Table 10 in the Appendix and amount to 38% and 32%, respectively. Hence, *relative* to the share of disappearing varieties, the share of new varieties is slightly larger in the United States.

In summary, the above analysis has shown that the larger bias in the import price index in the United States is mainly due to a more substantial growth in variety – itself caused by a larger increase in the number of supplying countries in the average product category and their larger expenditure share – while the difference in the substitutability between varieties is of minor importance.

Table 9: Variety Increase in Switzerland and the United States

	Number of goods		Mean No. of supl. Countries		Number of varieties	
Year	CH (1)	US (2)	CH (3)	US (4)	CH (5)	US (6)
1990	6,672	8,699	12.24	14.80	81,688	128,745
2006	7,933	10,190	14.67	19.34	116,361	197,044
1990–2006	+18.9%	+17.1%	+19.9%	+30.7%	+42.4%	+53.0%

Note: Swiss results are based on the disaggregated HS-8 trade data available from the SFCA. U.S. results are based on the disaggregated HS-8 trade data available from CID at UC Davis.

4.3 Finding Determinants of Variety Growth

Identifying the underlying reasons for the low variety growth in Switzerland clearly lies beyond the scope of this paper, but a short discussion might offer some ideas. Before turning to variety *growth* however, it is worth noting that there is broad evidence for low *levels* of import variety in small economies. Theoretically, this is for example shown in KRUGMAN (1979), where small countries under autarky are thought to have disadvantages owed to their size with respect to consumed variety. In these models, trade is one way to alleviate these disadvantages. However, as ROMER (1994) argues, fixed costs of entering a foreign market in combination with a small market size lead to fewer varieties being exported to small countries, even if trade is completely free otherwise.

Also, it is an established empirical fact that small countries tend to import fewer varieties. This is for example shown in ARKOLAKIS, DEMIDOVA, KLENOW, and RODRÍGUEZ-CLARE (2008) and ARDELEAN and LUGOVSKYY (2009), who both use a gravity-equation-like specification to explain the variety in trade and find a positive relationship between country size and the number of imported varieties. Furthermore, MOHLER and SEITZ (2010) observe that the number of imported varieties is higher, the larger the importing country is.[23]

However, this does not answer the question as to why the *growth rate* of variety should be lower in a SOE like Switzerland. MOHLER and SEITZ (2010) find

23 To give an example, Germany imported over 110,000 varieties in 1999, while the two SOEs Malta and Estonia imported about 20,000 and 30,000 varieties, respectively.

no *prima facie* evidence for a clear relationship between the size of countries and an increase in the number of imported varieties.[24] Possible explanations for the differences in variety growth among countries may be diverse: They include a simple market-size effect due to different growth rates of real GDP or a different evolution of entry costs, for example because these costs partly depend on the exporter's factor costs.[25] Future research will be necessary to explain these variety growth differentials.

5. Concluding Remarks

The above analysis has shown that variety gains from trade for Swiss consumers amount to 0.3% of GDP over the period from 1990 to 2006. Overall, countries of the European Union contribute most to these variety gains. While established trading partners like Germany, France or Italy are still responsible for the largest shares of these welfare gains, emerging countries like China or from Eastern Europe also contributed substantially over the last two decades. In addition, it is shown that industries producing differentiated goods, such as chemicals, machinery, watches and vehicles, are the drivers behind the variety gains from trade.

For Swiss consumers, these gains are too low to be of great importance. More interestingly, the variety gains from trade in Switzerland are also limited compared to the gains in other countries, despite the high relative openness of the Swiss economy. Shown at the example of the United States, one reason for this result is the low level of product differentiation in Swiss imports. The other – quantitatively more important – reason is the relatively low growth in the variety set of imports as well as the low expenditure share of new varieties. It is then argued that the relation between variety growth and country size remains unclear, and hence the reasons for the relatively low variety growth over the last two decades in Switzerland have still to be explored. This is left to future research.

The literature on gains from variety is expanding rapidly, and there are some additional issues that have to be addressed in subsequent work. A first aspect is the exact measurement of the variety set. As mentioned, available data hide substantial variety growth. This is addressed in Blonigen and Soderbery

24 While in Malta, the number of imported varieties has decreased by about 10% over the last decade, in Estonia, this number soared by 37%; all this compared to an increase of about 9% for Germany.

25 I am grateful to an anonymous referee for pointing this out.

(2010). Using detailed market data for the U.S. automobile sector, they show that conventional trade data underestimate variety growth by 50%. Broda and Weinstein (2010) use barcode data which is even more disaggregated to show that for some product categories the bias in the price index is sizeable. Mohler (2010) proposes a modification of the lambda ratios to allow for hidden variety growth using conventional trade data. As a consequence, variety gains increase substantially.

Secondly, the effect of trade on domestic variety is neglected, since the Cobb-Douglas assumption prevents substitutability between domestic and foreign varieties. There are two noticeable efforts in this direction to date that use quite different modeling approaches. Ardelean and Lugovskyy (2009) use a modified Krugman (1980) model that allows for the substitution between foreign and domestic varieties within a single product category, while Feenstra and Weinstein (2010) use a flexible translog specification. Both contributions indicate a slight reduction in variety gains as a consequence of the crowding-out of domestically produced by imported varieties.

A third issue that I would like to mention is the effect of a change in the variety set on productivity. A large set of imported intermediate goods may improve the production possibilities of firms. This idea is used in Broda et al. (2006), who show that imported variety can explain up to 30% of total factor productivity growth. On the other hand, Feenstra and Kee (2008) find a relationship between the productivity of domestic firms and the exported variety.

Appendix

Table 10: Variety of U.S. Imports 1990–2006

	Year	Number of HS-8 goods	Median no. of countries per good	Mean no. of countries per good	Number of varieties within HS-8 goods	Total number of varieties	Share on total imports
		(1)	(2)	(3)	(4)	(5)	(6)
All 1990	1990	8,699	14	14.80	128,745	128,745	1.00
All 2006	2006	10,190	18	19.34	197,044	197,044	1.00
Common 1990–2006	1990	6,760	14	14.77	99,839	75,612	0.68
Common 1990–2006	2006	6,760	18	20.71	139,978	75,612	0.62
1990 not in 2006	1990	1,939	11	14.91	28,906	53,133	0.32
2006 not in 1990	2006	3,430	14	16.64	57,066	121,432	0.38

Note: This table is based on 8-digit level HS product classification trade data. Varieties are defined as HS-8 good-country pairs. The data are available from the CID at UC Davis.

Table 11: Summary Statistics: U.S. Lambda Ratios

Number	997
Mean	1.14
Median	0.96
5% Percentile	0.23
95% Percentile	1.86

Note: All calculations are based on the disaggregated HS-8 trade data available from the CID at UC Davis.

Table 12: Summary Statistics: U.S. Substitution Elasticities

Number	9,294
Mean	8.38
Standard Error	1.10
Median	3.06
Maximum	7,555.52
Minimum	1.03

Note: All calculations are based on the disaggregated HS-8 trade data available from the CID at UC Davis.

Table 13: Bias in the U.S. Import Price Index and GFV

Endpoint Ratio	0.951
Total Bias	5.13%
Annual Bias	0.29%
Variety Gains (% of GDP)	0.53%

Note: All calculations are based on the disaggregated HS-8 trade data available from the CID at UC Davis.

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SUMMARY

Since the seminal work of Krugman (1979), variety gains from trade are recognized as an important channel of welfare gains. In this paper, the gains from variety are estimated for Switzerland. It is found that despite the openness of the Swiss economy these gains are not substantial and smaller than in other countries; specifically compared to the gains in the United States. It is shown that the reasons for this result are twofold: First, the Swiss imports are shown not to be as differentiated as their U.S. counterparts; consequently, new varieties do not provide the same value to consumers. Second, variety growth of imports in Switzerland is much smaller compared to variety growth in larger countries. It is furthermore shown that this latter effect is quantitatively more important than the first.