Globalization and the Gains from Variety
The Case of a Small Open Economy

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Abstract

In this paper, the methodology of Feenstra (1994) and Broda and Weinstein (2006) to estimate the gains from imported variety is extended: Two bounds are proposed and it is argued that the true gains fom variety lie within these values. The bounds differ with respect to the extent of the growth at the extensive margin that one is willing to assume. Using these bounds, it is shown empirically that the gains from variety in Switzerland account to between 0.3% and 7.7% of the GDP for the period of 1990 to 2006, while for the U.S. these gains lie between 0.4% and 4.9%. Thus, depending on the specification used, the gains from imported variety in Switzerland can be smaller or larger compared to the U.S. This result is explained carefully: First, the import price index bias as derived by Feenstra (1994) is always lower in Switzerland which is mainly due to the lower growth in imported variety. Nonetheless, the gains from variety may be higher in Switzerland because the higher import share magnifies the price index bias relative to the large economy. It is also argued that the higher the assumed extensive margin growth the more likely is Switzerland to have higher gains from variety compared to the U.S. It is further shown that this result may hold quite generally for other small and large OECD countries. (JEL F12, F14)

1 Introduction

This paper empirically quantifies the gains from variety for Switzerland, a small open economy (SOE), and the U.S. between 1990 and 2006. The main approach is taken from the seminal work of Feenstra (1994) which is extended by Broda and Weinstein (2006), henceforth BW2006. Applying this methodology, very disaggregated trade data is used to estimate elasticities of substitution for every product category available. By computing an import price index that is corrected for net variety growth within these product categories, the gains from imported variety are then calculated.

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There is however one important issue that is not sufficiently covered by the existing literature: Using disaggregated trade data, the researcher is forced to assume the Armington (1969) definition of a variety: That is, no growth at extensive margin at the level of varieties is possible. This is a stark assumption. By extending the approach of Feenstra (1994), this paper proposes the opposite case where full growth at the extensive margin is assumed. Said more generally, two bounds of the gains from traded variety are set up and it is argued that the true gains lie within these bounds.

Using these two extreme cases, the gains from variety are calculated empirically for Switzerland and the U.S.: For the period of 1990 to 2006 the gains from variety in Switzerland lie between 0.3% and 7.7% of the GDP. For the U.S., these gains account to between 0.4% to 4.9% of the GDP. Furthermore, a best estimate is presented. Using this specification, the gains from variety amount to 1.9% of the GDP in Switzerland and to 1.8% in the U.S.

It is then analysed where the differences in the gains from imported varieties between Switzerland and the U.S come from: They can be attributed to three different sources, namely the import share, variety growth and the magnitude of the elasticities of substitution. A higher import share leads to a magnification of the price index bias by a factor of five in Switzerland relative to the U.S. economy. The bias in the price index of its own is always larger in the U.S. economy. This difference can itself be attributed to the two remaining sources: 55% to 90% of the differences are due to lower variety growth in Switzerland while the rest of the differences stems from the higher elasticities of substitution of Swiss import goods compared to U.S. import goods. This results implies that the lower growth in imported variety in SOEs matters from a welfare perspective.

Despite the lower bias in the price index, the gains from imported variety may be higher in Switzerland due to the magnification effect stemming from the higher import share. It is then shown that the higher the assumed extent of extensive margin growth, the more likely is Switzerland to exhibit higher gains from variety. Furthermore, using data from other OECD economies, it is shown that all these results may hold quite generally for other small and large OECD economies.

In the next section, the existing theory and empirical evidence about the evaluation of the gains from variety is reviewed. Section 3 derives and discusses the methodology used to determine the gains from imported variety, primarily referring to Feenstra (1994) and BW2006. Section 4 derives the two bounds for the bias of the aggregate import price index. Section 5 presents the gains from variety in Switzerland between 1990 and 2006. The contribution of countries and goods to the total gains are calculated as well. Finally, in Section 6 Switzerland is compared to the U.S. and the differences of the gains from variety are analyzed and attributed to the different sources. Section 7 concludes.

2 Gains from Variety - Theory and Empirical Evidence

In the empirical literature, gains from trade liberalization almost never top a few percent of the GDP, even when trade barriers are significantly reduced. An overview over some results is for example give in Feenstra (1992). While this may be surprising, many authors remarked that most approaches do not incorporate the changes in traded variety upon trade liberalization. In Romer's (1994) numerical example, fixed costs exist for the introduction of a new product into a foreign market and therefore trade barriers will lower the profits of the firms. As a consequence, some goods are not profitable enough to export when trade barriers are high and this may lead to a smaller variety in the importing country. The gains from trade liberalization can then account to up to 20% of the GDP if many goods are prevented from being imported.

This seems to be especially true for small open economies, since the fixed costs are more important if only small quantities can be sold in a market and since the imports are relatively important compared to the GDP. A very modern approach to model this would be Melitz (2003). In his and other models, heterogeneous firms face fixed costs of exporting and decide whether to enter a foreign market or not. Higher fixed costs can then lead to a lower imported variety since some firms decide not to enter thus particular market.

Klenow and Rodriguez-Clare (1997) provide further evidence for the calibration exercise of Romer (1994). In their paper, the gains from trade liberalization using Costa Rican data can account for up to 2% of the GDP. These gains incorporate the gains from variety which raise the overall gains from trade by 50% to 300%, depending on the specification. Hence, although the gains from trade liberalization still seem small, the increase in the number of goods is an important of these gains.

Taking another approach, Hausman (1981), based on Hicks (1940), shows that using microdata, the value of new goods for the consumer can be calculated as the area under the demand function that is added if the price of a good falls from its reservation price to its actual price. Unfortunately, to estimate the reservation prices very detailed data is needed. Consequently, the empirical evidence is restricted to a few single products like breakfast cereals (Hausman 1994) or cell phones (Hausman 1997). Thus, for calculating the gains from imported variety in all product categories this method is not appropriate.

Taking one step backwards it can be stated that theoretically, the incorporation of a change in product variety is quite troublesome using an economic model. The traditional demand theory as in Arrow and Debreu (1954) uses a fixed set of goods by construction. Changing the number of goods means, in principle, changing the utility specification with all relationships between all goods. Hotelling (1929) and Lancaster (for example 1966 and 1975) provide some approaches to incorporate new goods. Lancaster presents a whole new theory, which he calls the New Demand Theory. The essence of his approach is that there is a fixed number of characteristics that a good can have. New goods with different levels of these characteristics can then be added easily. The substitutability between the new goods and the existing ones are then defined by the characteristics *ex ante*. A qualitative assessment of welfare effects of new goods for developing countries is available from James and Stewart (1981). Unfortunately, demand systems are difficult to get using this approach. As a consequence it never had a large impact on the empirical literature. Nonetheless, conceptually this approach can be useful to bear in mind.

A much larger impact had the theory developed by Spence (1976), Dixit and Stiglitz (1977), and, applied to trade, Krugman (1979 and 1980). Using monopolistic competition, one good is available in different varieties, each produced by a different firm. Consumers value additional varieties depending on the substitutability between varieties. This substitutability is captured by one parameter, the elasticity of substitution. Thus, instead of having to deal with many characteristics, one parameter incorporates all relationships between varieties. Of course, this greatly simplifies the analysis and explains the empirical success of these models. Within these models, trade leads to more varieties available in every country and therefore to gains for the consumers stemming from the love for variety. Based on these monopolistic competition models, Feenstra (1994) developes a price index for imports that is corrected for new and disappearing varieties. New varieties lower the unit-costs, depending on their substitutability with other varieties and their expenditure share. The difference between a conventional price index and the import price index taking the variety growth into account can then be used to compute the gains from imported variety.

This is then applied by BW2006 for the U.S using disaggregated trade data for the period of 1972 to 2001. They find that the upward bias uf the conventional import price index is 1.2 percent per year. This leads to a gain from imported variety of 2.6% of the GDP between 1972 and 2001. Considering the fact that SOEs have import shares that are many times larger than the one of the U.S., one could imagine larger gains for these economies. On the other hand, if SOEs do have disadvantages regarding the import of new varieties, the gains could turn out to be lower. This, among other things, shall be evaluated in this paper.

3 Empirical Strategy and Estimation

This section reviews the methodology used to estimate the gains from imported variety as developed by Feenstra (1994) and BW2006. The utility model, the exact price index and the stochastic specification are derived in turn.

3.1 A Three-Level Utility Model

Imported varieties are grouped into goods (1), while these goods are then aggregated into a composite import good (2) which is consumed alongside a composite domestic good (3). The three levels of utility are

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

$$M_t = \left(\sum_{g \in G} M_{gt}^{(\gamma - 1)/\gamma} \right)^{\gamma/(\gamma - 1)} \quad ; \quad \gamma > 1, \tag{2}$$

$$U_t = \left(D_t^{(\kappa-1)/\kappa} + M_t^{(\kappa-1)\kappa} \right)^{\kappa/(\kappa-1)} \; ; \; \kappa > 1, \tag{3}$$

where κ, γ and σ_g are the elasticities of substitution between the goods or varieties of the respective level. G is the set of goods and C is the set of varieties. d_{gct} is a taste or quality parameter. Utility is separable and homothetic. Note that this utility allows for a representative consumer which will be convenient to derive the price index. Next, the unit-cost function for every level of utility is derived:

$$\phi_{gt}^M(I_{gt}, \vec{d_{gt}}) = \left(\sum_{c \in I_t} d_{gct} p_{gct}^{1-\sigma_g} \right)^{1/(1-\sigma_g)}, \tag{4}$$

$$\phi_t^M(G) = \left(\sum_{g \in G} (\phi_{gt}^M)^{1-\gamma} \right)^{1/(1-\gamma)}, \tag{5}$$

$$p_t = \left[(p_t^D)^{1-\kappa} + (\phi_t^M)^{1-\kappa} \right]^{1/(1-\kappa)}. \tag{6}$$

These unit cost functions are the building blocks for the price index. Also, they demonstrate the love-of-variety approach: Suppose a number of varieties exist and all taste parameters are equal to 1. Then, an increase of the number of varieties for given prices implies a decrease of the unit-costs.

3.2 Derivation of an Exact Price Index

A cost of living index (COLI) measures the total cost for the consumer to achieve his highest possible utility level given a level of income. Therefore, a COLI depends on the cost function given a specific income. With homothetic preferences however, the cost function for every consumer is independent of his income. Thus, a price index of good g can be defined as in Konüs (1921)

$$P_g^M(\vec{p_{gt}}, \vec{p_{gt-1}}, \vec{x_{gt}}, \vec{x_{gt-1}}, I_g) = \frac{\phi_{gt}^M(I_g, \vec{d_g})}{\phi_{gt-1}^M(I_g, \vec{d_g})}, \tag{7}$$

where $\phi_{gt}^M(I_g, \vec{d_g})$ are the unit-costs of that good at time t. Note that for the moment a constant set of varieties, I_g, henceforth called the *common set* is used. It is a remarkable feature that the price index does not depend on the taste parameters as Diewert (1976) shows. The intuition for this result is that all the information contained in the taste parameters is captured by the expenditure shares.

Sato (1976) and Vartia (1976) have derived the *exact* price index for the CES unit-cost function. For a price index to be exact it must equal the ratio of the unit-costs. This is true for the following price index:

$$\frac{\phi_{gt}^M(I_g, \vec{d_g})}{\phi_{gt-1}^M(I_g, \vec{d_g})} = P_g(\vec{p_{gt}}, \vec{p_{gt-1}}, \vec{x_{gt}}, \vec{x_{gt-1}}, I_g) = \prod_{c \in I_g} \left(\frac{p_{gct}}{p_{gct-1}} \right)^{w_{gct}}, \quad \text{where} \tag{8}$$

$$\begin{aligned} w_{gct}(I_g) &= \frac{(s_{gct} - s_{gct-1})/(\ln s_{gct} - \ln s_{gct-1})}{\sum_{c \in I_g}((s_{gct} - s_{gct-1})/(\ln s_{gct} - \ln s_{gct-1}))}, \\ s_{gct}(I_g) &= \frac{p_{gct} x_{gct}}{\sum_{c \in I_g} p_{gct} x_{gct}}. \end{aligned}$$

Thus, the price index is a geometric mean of all the price changes. The weights depend on the expenditure shares s_{gct}. The exact price index defined above demands that all the goods are available at all periods. It is due to Feenstra (1994) that the exact price index for a non-constant set I_{gt} is known:

$$\pi_g(\vec{p_{gt}}, \vec{p_{gt-1}}, \vec{x_{gt}}, \vec{x_{gt-1}}, I_g) = \frac{\phi_{gt}^M(I_{gt}, \vec{d_g})}{\phi_{gt-1}^M(I_{gt-1}, \vec{d_g})}, \tag{9}$$

$$= P_g(\vec{p_{gt}}, \vec{p_{gt-1}}, \vec{x_{gt}}, \vec{x_{gt-1}}, I_g) \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{1/(\sigma_g - 1)}, \quad \text{where} \tag{10}$$

$$\lambda_{gt} = \frac{\sum_{c \in I_g} p_{gct} x_{gct}}{\sum_{c \in I_{gt}} p_{gct} x_{gct}}, \tag{11}$$

$$\lambda_{gt-1} = \frac{\sum_{c \in I_g} p_{gct-1} x_{gct-1}}{\sum_{c \in I_{gt-1}} p_{gct-1} x_{gct-1}}. \tag{12}$$

Hence, the exact or *corrected* price index *with variety change* is a conventional price index times an additional term, henceforth called the *lambda ratio*. Note that λ_{gt} as well as λ_{gt-1} have the expenditure on the common varieties in their numerator, i.e. those varieties that are available in t and $t-1$. In the denominator of λ_{gt} the new varieties are additionally included while in the denominator of λ_{gt-1}, the disappearing varieties are additionally included. Thus, the lambda ratio gets smaller if there are many new varieties and it gets larger if there are many disappearing varieties. It is determined entirely by the *expenditure* for these varieties. This ratio is then weighted by a term negatively related to the elasticity of substitution. Thus, the *upward bias of the price index* gets higher with lower elasticities and lower lambda ratios. Now that the exact price indices for the imported goods are known, they are aggregated to the aggregate exact import price index:

$$\Pi^M(\vec{p}_t, \vec{p}_{t-1}, \vec{x}_t, \vec{x}_{t-1}, I) = \frac{\phi_t^M(I_t, \vec{d})}{\phi_{t-1}^M(I_{t-1}, \vec{d})}, \tag{13}$$

$$= \prod_{g \in G} \left[P_g(I_g) \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{1/(\sigma_g - 1)} \right]^{w_{gt}}, \tag{14}$$

$$= CIPI(I) \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{w_{gt}/(\sigma_g - 1)}, \tag{15}$$

where, $CIPI(I)$ is a conventional import price index that does not account for the change in varieties. The difference between this index and the index incorporating the new varieties is called the *aggregate import price index bias*. Finally, the overall price index is

$$\Pi = \left(\frac{p_t^D}{p_{t-1}^D} \right)^{w_t^D} (\Pi^M)^{w_t^M}. \tag{16}$$

3.3 Deriving the Stochastic Model

To determine the exact price indices that account for the change in varieties, an elasticity of substitution, σ_g, is needed for every good. The specification resembles a gravity model. However, Feenstra (1994) allows for a upward sloping supply curve, a feature not common in these models. First, the demand of a particular variety is derived from the unit-cost function. The specifics are available from Feenstra (1991). Shares instead of quantities are used because this eases the measurement errors due to unit-values:[1]

[1] See for example Kemp (1962).

$$\Delta \ln s_{gct} = \varphi_{gt} - (\sigma_g - 1)\Delta \ln p_{gct} + \epsilon_{gct}, \tag{17}$$

where the difference in the unit-costs is a constant for all varieties c of good g and is summarized by φ_{gt}. The change in unobserved taste parameter, $\Delta \ln d_{gct}$, is assumed to be the stochastic element. Next, defining ω as the inverse supply elasticity, the inverse supply can be written quite generally as

$$\Delta \ln p_{gct} = \psi_{gt} + \frac{\omega_g}{1+\omega_g}\Delta \ln s_{gct} + \delta_{gct}. \tag{18}$$

By choosing a reference variety and taking differences, the unobservable terms φ_{gt} and ψ_{gt} are eliminated:

$$\Delta^k \ln s_{gct} = -(\sigma_g - 1)\Delta^k \ln p_{gct} + \epsilon^k_{gct}, \quad \text{and} \tag{19}$$

$$\Delta^k \ln p_{gct} = \frac{\omega_g}{1+\omega_g}\Delta^k \ln s_{gct} + \delta^k_{gct}, \tag{20}$$

where $\Delta^k \ln s_{gct} = \Delta \ln s_{gct} - \Delta \ln s_{gkt}$ with k as the reference variety. Making the assumption $E(\epsilon^k_{gct}\delta^k_{gct}) = 0$, u_t is defined as $\epsilon^k_{gct}\delta^k_{gct}$:

$$\left(\Delta^k \ln p_{gct}\right)^2 = \theta_{g1}\left(\Delta^k \ln s_{gct}\right)^2 + \theta_{g2}\left(\Delta^k \ln p_{gct}\Delta^k \ln s_{gct}\right) + u_{gct} \quad \text{or} \tag{21}$$

$$Y_{gct} = \theta_{g1}X_{1gct} + \theta_{g2}X_{2gct} + u_{gct}, \tag{22}$$

with the obvious definitions for θ_{g1} and θ_{g2}. Following Feenstra (1994), the σ's can be calculated from the estimated θ's using the following formula.

$$\begin{aligned} &\text{a) if} \quad \widehat{\theta}_{g2} > 0 \quad \text{then} \quad \widehat{p}_g = \tfrac{1}{2} + \left(\tfrac{1}{4} - \tfrac{1}{4(\widehat{\theta}^2_{g2}/\widehat{\theta}_{g1})}\right)^{1/2}, \\ &\text{b) if} \quad \widehat{\theta}_{g2} < 0 \quad \text{then} \quad \widehat{p}_g = \tfrac{1}{2} - \left(\tfrac{1}{4} - \tfrac{1}{4(\widehat{\theta}^2_{g2}/\widehat{\theta}_{g1})}\right)^{1/2}, \end{aligned}$$

and in either case

$$\widehat{\sigma}_g = 1 + \left(\frac{2\widehat{p}_g - 1}{1-\widehat{p}_g}\right)\frac{1}{\widehat{\theta}_{g2}}. \tag{23}$$

As for $\widehat{\sigma}_g$, negative values can occur as well as complex numbers.

3.4 Estimation

There is a simultaneity bias present in the stochastic model above. Normally this is attacked by defining additional instruments. However, instruments for the prices and the shares in the above stochastic model cannot be found easily. The panel structure of the data allows for another solution: As Verbeek (2004) and others[2] note, the (unbalanced) panel structure can be used to get unbiased estimators without the use of external instruments. Intuitively, the data is averaged over time and weighted with the number of periods available. This is equivalent to running a WLS on

$$\bar{Y}_{gc} = \theta_1 \bar{X}_{1gc} + \theta_2 \bar{X}_{2gc} + \bar{u}_g, \tag{24}$$

where $\bar{X}_{gc}$ is the mean over time. By defining moment conditions GMM (Hansen 1982) can also be applied.

4 Proposing two Bounds for the Gains from Variety

Having obtained the estimated elasticities of substitution, the corrected import price indices can be calculated applying equations (8) to (16). This technique allows to estimate the impact of new varieties on an import price index using widely available data. As will be clear in the results sections below, the gains from variety depend heavily on the *definition of a variety*: Using disaggregated trade data sets, varieties are always defined as a particular good stemming from distinct countries of origin. This Armington (1969) definition, although widely used, is very special and has its weaknesses: One country is always providing one variety of a specific good, there is no growth at the extensive margin for the imports of a good from a particular country. Depending on the definition of the goods or product categories however, there may be more than one variety coming from a particular country within a product category. And even more importantly, this number of the *actual* varieties coming from a country may *change over time.*

This potential problem is adressed by Feenstra (1994). He shows that a change in the unobserved taste parameter d_{gct} can be caused by the fact that an Armington variety may actually consist of more varieties. An example can be used to illustrate this point: One variety may be toys from China. In reality however, more than just one variety of toys is imported from China. If this number of *actual* varieties increases (decreases) over time, this may cause a rise (fall) in the expenditure that is due to more (less) variety.

[2]For example Hsiao (1985) or Griliches and Hausman (1986)

Technically, this is expressed by a rise in the taste parameter in equation (1). If the taste parameter changes over time however, Feenstra (1994) shows that the bias in the price index is not computed correctly: Using the example from above, since toys from China are imported *in 1990 as well as in 2006*, this variety is included in the set of the numerator and as well in the set of the denominator of equations (11) and (12): As a consequence, the expenditures on Chinese toys cancel out and do not contribute to a decrease of the lambda ratio even though they should. This is one consequence of the inflexible definition of a variety under the Armington approach.[3]

Feenstra (1994) then proves that varieties which experience a change in the taste parameters due to a change in *actual* variety should be *excluded from the common set*, that is from the numerators of equations (11) and (12). In the light of the lambda ratios this means that those varieties should be treated as *new and disappearing* at the same time. This corresponds to allowing the extensive margin of varieties to increase or decrease over time. Intuitively, this means full growth at the extensive margin in the following sense: A rise in the expenditure on a specific variety is always interpreted as a corresponding rise in actual variety

The problem in practice is the identification of these varieties since the taste parameters are unobserved: In the U.S. there are over 60'000 varieties that are available in 1990 *and* in 2006. In principle this means that a researcher has to decide for each of these varieties whether to include or exclude it from the common set. Obviously, this is not possible in an objective way. Thus, two clear cut cases are proposed here: One where all varieties possible are included into the common set. This is the benchmark case proposed by Feenstra (1994) and will be called the *lower bound case*. It corresponds to the case with no extensive margin growth. The second case with no discretion is to exclude as many varieties as possible. This leads to an *upper bound* of the import price index bias and can be interpreted as the case with full growth at the extensive margin. Proposition 1 summarizes:

Proposition 1 *The lambda ratio is defined as*

$$\frac{\lambda_{gt}}{\lambda_{gt-1}}, \textit{ where}$$

$$\lambda_{gt} = \frac{\sum_{c \in I_g} p_{gct} x_{gct}}{\sum_{c \in I_{gt}} p_{gct} x_{gct}} \quad \textit{and} \quad \lambda_{gt-1} = \frac{\sum_{c \in I_g} p_{gct-1} x_{gct-1}}{\sum_{c \in I_{gt-1}} p_{gct-1} x_{gct-1}}.$$

To obtain a lower bound of the price index bias, the set I_g contains all varieties that are available in the

[3]In adddition, quality changes can also be expressed by a change in the taste parameters. A variety which is available in a better quality can be seen as a *new* variety as well. Thus, changes in the taste parameter due to quality changes should in principle also be reflected in changes of the lambda ratios. Again, these changes are ignored when including a variety into the common set.

start and the end period. This is the benchmark case proposed by Feenstra (1994). To obtain an upper bound, the set I_g contains but one artificial variety with constant expenditure. Then, the lambda ratio simplifies to

$$\frac{\lambda_{gt}}{\lambda_{gt-1}} = \frac{\sum_{c\in I_{gt-1}} p_{gct-1}x_{gct-1}}{\sum_{c\in I_{gt}} p_{gct}x_{gct}}. \tag{25}$$

This new definiton of the lambda ratio contains some nice intuition: Note that equation (25) is the ratio of total expenditures on one good in the final period over all expenditures on this good in the first period. This means that the lambda ratio lowers the price index whenever expenditures raise over time. This is what is meant by full growth at the extensive margin. For example, doubling the expenditures will result in a lambda ratio of 0.5 regardless of the product group one is looking at.[4] This is also the reason for calling it the upper bound: If we are confronted with raising expenditures for imports over time, this definition will yield higher gains from traded variety.

Certainly, the resulting gains from variety will most likely be too high since not every increase in the expenditure reflects a growth in variety.[5] On the other hand, using the original definition where *all* varieties are put into the common set, the gains from variety will be too small since increases in quality and *actual* varieties are not considered. As a consequence, I argue that the true gains from variety will lie whithin these two values.[6]

5 Estimating the Gains from Variety

The application of the methodology described in Sections 3 and 4 can be divided into three parts: First, the elasticities of substitution are estimated. In a second step, the lambda ratios are computed and the corrected import price index is calculated. Then, the gains from imported variety for the whole economy is computed by accounting for the domestic sector.

[4]Note that this is not the whole story: To obtain the import price index bias, the lambda ratio gets weighted by a term incorporating the elasticity of substitution. Thus, if the elasticity is large, the price index will not be corrected by much; a feature that is desirable.

[5]Additionally there is a problem with inflation: If positive inflation is present, then this artificially increases the expenditures and leads to a correction of the import price index that is too large. Note however that this is not a problem of the upper bound proposed here but an issue that is also present in Feenstra (1994).

[6]Technically speaking, the terms *lower* and *upper* bound are not entirely correct: Since there are varieties that exhibit *decreasing* expenditures over time, *excluding* varieties from the common set could also *lower* the bias of the aggregate import price index. Thus, theoretically the upper bound bias can be lower than the lower bound bias. In practice however, when increasing expenditures for imported goods are observed, the upper bound case will yield the higher bias. Thus, as a practical terminology, I think these terms are appropriate.

5.1 Data

The Swiss trade data are available from the Swiss Federal Customs Administration.[7] The data include import values and and imported quantity for all HTS-8 country pairs. This allows the calculation of unit prices. For the U.S., data is available from the Center of International Trade Date at UC Davis.[8] The US data is available at an even more disaggregated level, namely HTS-10. The definition of goods and varieties follows directly from the data: Goods are defined as HTS product categories and varieties are defined as HTS - country pairs as in Armington (1969).

5.2 The Growth in Imported Variety

In the last 20 years the fraction of imports of goods compared to the GDP has risen from 30% to 40% in Switzerland. The value of all imports of goods has risen from roughly 80 billion Swiss Francs to over 170 billion, an annual growth rate of over 4% while the GDP has risen by only 1.8% per year.[9] This more than proportional rise of imports is commonly attributed to three different sources: The reduction of trade costs, free capital movement and high growth of economies in East Asia or Eastern Europe.

Less attention has been given to the fact that during the same time period not only the import values have risen, but also the imported product variety. Tables 1 displays these remarkable changes between 1990 and 2006 for Switzerland. Column (1) displays that the total number of imported goods has risen from 4'944 to 5'124 within twenty years.[10] 4'470 goods were imported in 1990 as well as in 2006, i.e. these are common goods of both periods. This means that some goods disappeared in the last twenty years and even more goods were imported for the first time as can be seen in the last two rows of column (1).

Columns (2)-(4) of Table 1 displays statistics about the varieties comprised in the goods of column (1). The number of imported varieties has risen from 68'327 in 1990 to 91'439 in 2006. This is an increase of about 34%. Since varieties are defined as goods stemming from different countries, it can be stated that in 1990 one good originated from an average of 13.82 countries whereas 17 years later the average number of supplying countries has risen to 17.85. Column (5) reveals that a large share of total imports, 17%, can be attributed to new goods. Columns (6) and (7) abstract from the goods and considers the varieties imported. In column (6) the total varieties are again displayed in the first two rows. The second two rows

[7] See *www.admin.ezv.ch*.

[8] They are provided by Robert C. Feenstra. Visit *http://cid.econ.ucdavis.edu/*.

[9] In real terms. The data is taken from the Swiss Federal Statistical Office, *http://www.bfs.admin.ch*

[10] In tables 1 and 2, HTS-6 is chosen as the definition of a good. The reason is that at the 6th digit level, the trade statistics are harmonized and consequently the imported variety can be compared across countries. At more disaggregated levels, each country can use its own definitions.

show how many *common varieties*[11] were imported in 1990 and 2006. The last two rows display the new and disappearing varieties. Thus, 27% of all varieties imported in 1990 have disappeared whereas 49% of all varieties present in 2006 have not been imported in 1990. Column (7) shows that about 22% of the total import value can be attributed to new varieties. All the above stresses the changing pattern of Swiss imports in the last 20 years: Imports originate from more and from different countries today compared 17 years ago. Secondly, there are not only many new varieties, but also many disappearing ones.

Table 1: Variety of Swiss Imports 1990-2006

	Year	Number of HTS goods	Median no. of countries per good	Mean no. of countries per good	Total no. of varieties (goods)	Share of total imports (goods)	Total no. of varieties	Share of total imports (varieties)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
All goods (1990)	1990	4944	10	13.82	68327	1.00	68327	1.00
All goods (2006)	2006	5124	11	17.85	91439	1.00	91439	1.00
Common (1990)	1990	4470	11	14.11	63083	0.86	49382	0.83
Common (2006)	2006	4470	13	18.54	82868	0.83	49382	0.78
1990 not in 2006	1990	474	8	11.06	5244	0.14	18945	0.17
2006 not in 1990	2006	654	7	13.11	8571	0.17	42057	0.22

A good is defined after HTS-6. A variety is defined as a good from a particular country.

Table 2: Variety of U.S. Imports 1990-2006

	Year	Number of HTS goods	Median no. of countries per good	Mean no. of countries per good	Total no. of varieties (goods)	Share of total imports (goods)	Total no. of varieties	Share of total imports (varieties)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
All goods (1990)	1990	4987	14	18.46	92048	1.00	92048	1.00
All goods (2006)	2006	5182	18	25.32	131191	1.00	131191	1.00
Common (1990)	1990	4518	14	18.79	84872	0.86	67163	0.85
Common (2006)	2006	4518	18	26.10	117928	0.84	67163	0.79
1990 not in 2006	1990	469	11	15.30	7176	0.14	24885	0.15
2006 not in 1990	2006	664	14	19.97	13263	0.16	64028	0.21

A good is defined after HTS-6. A variety is defined as a good from a particular country.

For the U.S. the pattern of imported variety is very similar, although even more accentuated as Table 2 shows. As a consequence of the harmonized HTS-6 product categories, the number of goods as displayed in column (1) is very similar in the U.S. However, the U.S. imports these goods from more countries on average: In 1990, the average good is imported from 18.46 countries whereas in 2006, an average of 25.32 countries supplied the U.S. This is between 30% and 40% higher than the average in Switzerland. Column (4) reveals that this leads to many more imported varieties in the U.S. compared to Switzerland. In 1990, the U.S. imported 92'048 varieties, 35% more than Switzerland. In 2006, this number raises to 131'191, 43% more

[11] As opposed to the varieties of *common goods* displayed in column (4).

than Switzerland. Also, the U.S. imported 53% more *new* varieties than Switzerland, 13'263 compared to 8'571. This also means that the difference in imported variety even became larger between the two countries in the last 17 years. This is shown by Table 3. Switzerland experienced a growth in total variety of roughly 34%, the U.S. one of 43%. The number of goods remained relatively stable in both countries.

Table 3: Growth in Varieties: U.S. and Switzerland 1990-2006

	Switzerland	U.S.
Growth in all goods	3.64%	3.91%
Growth in all varieties	**33.83%**	**42.52%**
Growth in varieties of common goods	31.36%	38.95%

5.3 Estimating the Elasticities of Substitution

In this paper the linear WLS approach is used to estimate the elasticities of substitution as in Feenstra (1994).[12] And as in Feenstra (1994), equation (24) is estimated with a constant to account for simple measurement errors.[13] To use all available data, a variety is defined as HTS-8 for Switzerland and HTS-10 for the U.S.

Table 4: Sigmas for Different Aggregation Levels

	Switzerland			U.S.		
	SITC-3	SITC-5	HTS-8	SITC-3	SITC-5	HTS-10
Elasticities estimated	248	2784	7842	235	2607	14522
Mean	5.84	11.54	11.07	6.23	7.26	12.00
Standard Error (Mean)	0.27	4.84	1.55	1.82	1.61	1.67
Median	**4.48**	**4.12**	**4.07**	**2.85**	**3.04**	**3.40**
Maximum elasticity	29.84	13447.17	7685.96	409.21	4085.17	15263.29
Minimum elasticity	1.33	1.07	1.05	1.60	1.11	1.01

Swiss and US data from 1990-2006 is used for all estimates. A variety is defined at the HTS-8 level for Switzerland and the HTS-10 level for The U.S..

Table 4 displays the estimated elasticities for different aggregation levels.[14] The table shows that the elasticities of substitution are higher for the Swiss import goods, which is illustrated by both, the mean and the median.[15] Qualitatively, the results are slightly different. As BW2006 point out, it is expected that the elasticities decrease if goods are defined broader since then, the varieties comprised in these goods are more

[12] As mentioned above, GMM can be used to get the estimates for the sigmas. However, many goods only come with a very limited number of observations. Because GMM may be biased in small samples, in my view it is safer to use the above estimator. The downside is that not all of the sigmas will be estimated to be greater than one: Since only sigmas that are greater than one are compatible with the CES utility function, the goods with sigmas smaller than one or with complex values will be excluded from the calculation of the gains from variety. Using a GMM, one could perform a grid search to find values above one for every estimated sigma as in BW2006. The exclusion of these goods can be interpreted as taking a cautious approach to estimate the gains from variety: Using all goods, the gains would be higher.

[13] Many thanks to Robert C. Feenstra who provided me with the STATA-files used for the estimation. I also thank Hui Huang who has written the STATA version of the code.

[14] That is, different definitions of goods are used. For example, SITC-3 means that there are about 250 goods defined. The definition of a variety stays the same, namely HTS-8 for Switzerland and HTS-10 for the U.S. Note that for deriving the corrected import price index, only the sigmas of the last columns are used.

[15] Note that the means are heavily influenced by some outlier elasticities.

differentiated. The U.S. estimates exhibit this pattern as in BW2006. For the Swiss estimates however, the opposite pattern occurs.

Thus, two main differences between Switzerland and the U.S. can already be noted here: First, Switzerland imports less varieties compared to the U.S. Secondly, the mean and the median elasticity of substitution is larger for Swiss imports. This will have implications for the aggregate price index.

5.4 Deriving the Aggregate Price Index

To compute the corrected aggregate price index as in equation (10), the lambda ratios are calculated.[16]

Table 5 shows summary statistics of the lambda ratios under three specifications for Switzerland and the U.S.: The lower bound case, the upper bound case that have both been derived just before and a *best estimate* where countries are identified that did not experience great dynamics in their export behaviour to Switzerland. These countries are then included into the common set.[17] Any other country is never included into the common set.

Table 5: Descriptive Statistics of Lambda Ratios

	Switzerland		
Statistic	Lower Bound	Best Estimate	Upper Bound
Number	2080	2080	2080
Mean	1.51	3.79	3.20
Percentile 5	0.54	0.26	0.15
Median	**0.98**	**0.91**	**0.78**
Percentile 95	1.42	3.52	5.05
	U.S.		
Statistic	Lower Bound	Best Estimate	Upper Bound
Nobs	1291	1291	1291
Mean	1.52	1.73	1.92
Percentile 5	0.15	0.06	0.03
Median	**0.93**	**0.72**	**0.36**
Percentile 95	1.87	3.83	3.66

Note the differences in the lambda ratios between the three specifications: The medians get lower

[16] Note that for HTS-8 (SITC-5) goods the lamda ratio is not defined if there is no common variety in the start and in the end period. Where this requirement fails, the lambda ratio of the SITC-5 (SITC-3) good is used for all the HTS-8 (SITC-5) goods within this SITC-5 (SITC-3) category. To get an elasticity for these aggregated goods, the geometric mean of the sigmas of the HTS-8 (and only the HTS-8) goods is used. For example for Switzerland there are not 7'752 lambda ratios defined, but only 2'080, a combination of SITC-3, SITC-5 and HTS-8 goods. Note however, that *all* 7'752 sigmas are used for the calculation of the index. This is the way BW2006 implemented it. It leaves open the question *which* lambda ratios should be chosen in the upper bound case where an artificial variety is included into the common set. Using an artificial variety, in principle every lambda ratio could be defined. However, the most obvious choice is to use these lambda ratios that are defined in the lower bound case. This is very convenient since then the two specifications are comparable as they exhibit exactly the same lambda ratio structure.

[17] I choose to exclude those countries from the common set that experienced the highest absolute growth in the *number* of varieties. All the countries that make up for 50% of the raise in variety are excluded. I deliberately ignore the values that these countries export to Switzerland. Thus, also a small not so important country with high variety growth can be excluded from the common set, while a large country that exports high values to Switzerland but in always the same product categories is included into the common set. Note that I consider absolute values. Thus, countries that experience negative growth on variety can also be excluded from the common set.

if more countries are excluded from the common set. These varieties lower the lambda ratios since the expenditure is increasing for most varieties. Comparing Switzerland with the U.S. it is apparent that under every specification, the lambda ratios are lower in the U.S. This is a consequence of the many more new product varieties that were imported at high values by U.S. during these 17 years.

Using equations (8) to (15) and these lambda ratios, the conventional import price index as well as the corrected import price index can be computed. The ratio of these indices expresses the bias from ignoring the change in variety. This ratio is called the endpoint ratio (EPR) and it is defined as

$$EPR = \frac{\Pi^M}{CIPI(I)} = \frac{CIPI(I)}{CIPI(I)} \prod_g \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{w_{gt}/(\sigma_g - 1)} = \prod_g \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{w_{gt}/(\sigma_g - 1)}. \tag{26}$$

Thus, the endpoint ratio is the weighted average of the lambda ratios weighted by a term incorporating the elasticity of substitution. Table 6 displays the endpoint ratios for both countries under all three specifications. The bias in the lower bound case is small. Within the last 17 years, ignoring the change in the number imported varieties has led to an overestimation of the import price index of 0.88% in Switzerland, an annual bias of 0.05%. For the U.S. the total bias is 4.65%, 0.27% annually. The corrected import price index in the upper bound case however is 14.65% lower than the conventional import price index in Switzerland, an annual bias of 0.81%. For the U.S. the total bias amounts to 37.90%, 1.91% annually. The best estimate case lies between the upper and the lower bound cases, 3.84% in Switzerland and 15.98% in the U.S.

Table 6: Bias in the Swiss and U.S. Import Price Indices

	Switzerland			U.S.		
	EPR	Total bias	Avg. bias	EPR	Total bias	Avg. bias
Lower Bound	0.991	**0.88%**	0.05%	0.954	**4.65%**	0.27%
Best Estimate	0.962	**3.84%**	0.22%	0.840	**15.98%**	0.88%
Upper Bound	0.853	**14.65%**	0.81%	0.621	**37.90%**	1.91%

The total bias is defined as $TB = 1/EPR - 1$. Thus, it is the percentage by which the conventional price index is biased upwards. Average values are always per-annum averages.

5.5 The Gains from Variety in Switzerland and the U.S. 1990-2006

To quantify the welfare gains, assumptions about the structure of the domestic economy have to be made. Since the data does not allow it to model any complex interactions between imported goods and the domestic economy, the same structure as in Krugman (1980) is assumed. That is, using equation (16), the conventional and corrected price indices for the whole economy can be calculated. Taking the ratio of these indices results in the welfare gains. Since the two indices only differ by a multiplicative term, the gains from variety can be written as

$$GFV = \left(\frac{1}{EPR}\right)^{w_t^M} - 1, \tag{27}$$

where w_t^M is the log-change weight of the imports. Thus, the welfare gains can be calculated by weighting the inverse of the weighted aggregate lambda ratios with the fraction of imported goods relative to total economic activity. The problem here is that the imported goods also incorporate middle products and investment goods. It will hence be difficult to choose an appropriate measure for total economic activity. For a large economy like the U.S this may not be very important. BW2006 just use the share of domestic consumption on the GDP. They consequently get a share of the imports of around 10% for the period of 1990 to 2001. Doing the same for an SOE has more severe consequences: Imports as a fraction of the total GDP amount to 36% on average between 1990 and 2006 in Switzerland using a log-change weight. However, using only consumption instead of GDP, the share of imports amounts to 47%. Of course, this is a consequence of many investment goods and middle products imported, used in the production process and then partially exported to other countries. These imported and exported goods may not play such an important role in the U.S., but for Switzerland they matter a lot. Because neither of the two shares can be justified convincingly, I assume that a sensible weight lies between 36% and 47% for Switerland and between 8% and 10% for the U.S.

5.5.1 The Results

Using these weights and the three different biases of the price index above, the gains from variety can be calculated. Using the lower bound bias and the smaller weight, the gains from variety account for 0.32% of the GDP in Switzerland as Table 7 displays. Using the upper bound bias and the higher weights, the highest gains from variety account to 7.73% of the GDP in Switzerland. For the U.S. the gains from variety lie between 0.38% and 4.88% of the GDP depending on the specification. The best estimate lies between these extreme values. Hence, depending on the specification used, the gains from variety can be higher or lower in Switzerland relative to the U.S.

Table 7: Gains from Imported Variety, Switzerland and U.S., 1990-2006

Switzerland				U.S.			
		Weights				Weights	
		36%	47%			8%	10%
	0.991	**0.32%**	0.41%		0.954	**0.38%**	0.48%
EPR	0.962	1.42%	1.86%	EPR	0.840	1.40%	1.76%
	0.853	5.87%	**7.73%**		0.621	3.89%	**4.88%**

These gains from imported variety can be further analyzed: First, it can be assessed which trading partners contribute the largest part to these gains. Secondly, the gains from imported variety can be attributed to the different imported product categories.

5.5.2 Which Countries Contribute Most to the Gains from Variety?

To split up the gains from variety with respect to countries of origin, each lambda ratio is weighted by the share a particular country owns on that good. Then, these country-weighted lambda ratios are aggregated over all goods for each country. Thus, the endpoint ratio resulting by taking into account just the imports of a particular country i can be written as

$$EPR_i = \prod_g \left[\left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{(w_{gt}/(\sigma_{g-1}))W_{igt}} \right], \tag{28}$$

where W_{igt} is the ideal log-change weight of country i on this specific good g. The contribution of a single country relative to the whole gains from variety is then defined as $(1 - EPR_i)/(1 - EPR)$, where EPR is the endpoint ratio of the aggregated indices used above. Note that multiplying all the biases, the endpoint ratio from equation (26) results:

$$EPR = \prod_i \left\{ \prod_g \left[\left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{(w_{gt}/(\sigma_g - 1))W_i gt} \right] \right\}. \tag{29}$$

Considering Table 10 for the lower bound case and Table 11 for the upper bound case, it is striking that under both specifications Germany contributes by far the largest part to the gains from variety in Switzerland, namely around 40%. 60% to 70% of all the gains are due to imports from Switzerland's most important trading partners Germany, Italy and France. Austria, the United Kingdom, Japan, Spain, the Netherlands and the U.S. also appear on the first few ranks under both specifications. For the U.S., Canada is the most important trading partner regarding gains from imported variety with a 20% share on the total gains. Japan, Mexico, China, Germany, France, Italy, the U.K., Taiwan and South Korea are all in the top ten under both specifications. It is striking that Switzerland seems really dependent on its three large neighbouring countries whereas for the U.S. the gains from variety are more equally distributed among many major trading partners. Note that in the upper bound case, the contributions of those partner countries are higher which trade *high values* with Switzerland or the U.S. For example: Germany contributes 37.20% to the gains from variety in Switzerland in the lower bound case but 46.14% in the upper bound case. For a smaller country like Austria with lower trade *value*, this is just reversed: The contribution is higher in the lower bound case. This is a direct consequence of the new definition of a variety: Higher absolute expenditure leads to higher gains from variety.

5.5.3 Which Goods Contribute Most to the Gains from Variety?

To find out which SITC-3 goods contributed the largest share to the gains from variety, the lambda ratios of the HTS-8 or the SITC-5 goods have to be aggregated. For every SITC-3 good g this is done by calculating

$$EPR_g = \prod_k \left[\left(\frac{\lambda_{gkt}}{\lambda_{gkt-1}} \right)^{(w_{gkt}/(\sigma_{gkt}-1))} \right], \tag{30}$$

where k is either a HTS-8 or a SITC-5 good depending on the structure of the lambda ratios. Again, $(1 - EPR_g)/(1 - EPR)$ delivers the contribution of good g relative to the total gains from variety. Tables 12 and 13 again show the results for the lower and the upper bound case. The ranking of goods in the two tables is quite different. Also, assumingly differentiated as well as homogeneous goods are in the top ranks. However, some goods appear in the top ranks under both specifications. For Switzerland, these are Watches and Clocks, Furniture, Manufactures of Base Metal, Paper and Paperboard, Articles of Plastic as well as Motor Vehicles. For the U.S., Motor Vehicles, Parts of Motor Vehicles, Aluminium, Electrical Apparatus, Alcaholic Beverages, Electrical Machinery, Articles of Apparel, Printed Matter as well as Rotating Electric Plant. All of these goods seem fairly differentiated which makes sense. The only real exception is Aluminium.

6 Analyzing the Gains from Variety in the SOE Case

This section analyzes the differences in the gains from variety between the U.S. and Switzerland more closely. Specifically, the following questions shall be answered: What factors exactly determine the differences in the gains from variety between countries and what is the relative importance of these factors? And: When and under what circumstances are the gains from variety higher or lower in Switzerland, relative to the U.S.? Additionally, it is shown that the results that found for Switzerland and the U.S. may also hold generally for other small and large OECD countries.

6.1 Small vs. Large Country: What's the Difference?

First, the differences in the import price index bias, which is always large in the U.S., are explained. Within the model, these differences can generally be attributed to two sources: There is the expenditure on new and disappearing varieties and there is the magnitude of the elasticities of substitution. The more new varieties imported at high values, the higher the bias in the import price index. The lower the elasticities of substitution, the higher the magnification of the lambda ratio. [18]

To separate these two sources, the import price index bias is estimated under fixed elasticities of substitution. Thus, the resulting difference can only be due to the differences in the growth of variety. Table 8 below displays the results. The endpoint ratios vary considerably with the choice of the fixed elasticities of substitution. Note however, that no matter which specification is used or how large the fixed elasticities are, *the bias in the import price index is always larger for the U.S.*

Table 8: Bias in the Swiss and US Import Price Indices Under Fixed Elasticities

	Switzerland					U.S.				
	variable	$\sigma = 2$	$\sigma = 4$	$\sigma = 8$	$\sigma = 15$	variable	$\sigma = 2$	$\sigma = 4$	$\sigma = 8$	$\sigma = 15$
Lower Bound	0.88%	3.50%	1.18%	0.51%	0.25%	4.65%	7.82%	2.68%	1.16%	0.58%
Best Estimate	3.84%	10.62%	3.67%	1.59%	0.80%	15.98%	29.93%	11.18%	4.96%	2.51%
Upper Bound	14.65%	46.84%	18.99%	8.63%	4.41%	37.90%	71.93%	34.52%	16.60%	8.67%

Table 9 shows the bias in the price index in Switzerland relative to the bias in the U.S. In the lower bound case for example, the bias in Switzerland if variable sigmas are used is 81.1% lower than the one in the U.S. If fixed sigmas are used, the bias in Switzerland is between 55.3% and 56.2% lower, depending on the the size of the fixed sigma. Thus, for the lower bound case, between 68.1% and 69.3% of the difference in the price index bias between Switzerland and the U.S. are due to lower imported variety in Switzerland as is displayed in the last 4 columns of Table 9. The rest, about 30% of the difference is due to the higher elasticities of Swiss import goods. For the upper bound case, between 56.9% to 80.1% of the difference in the bias of the price index stems from the differences in variety growth, the rest is due to higher elasticities of substitution. Thus, depending on the specification, between 55% to 90% of the difference in the aggregate import price index bias between Switzerland and the U.S. is due to the fact that Switzerland imported less new varieties between 1990 and 2006. The rest which is always smaller than 45% is due to the higher elasticities of substitution of Swiss import goods.

Table 9: Share of the Difference in the Bias Explained by the Lower Imported Variety in Switzerland

		Relative differences in the bias				% explained by lower imp. variety			
	variable	$\sigma = 2$	$\sigma = 4$	$\sigma = 8$	$\sigma = 15$	$\sigma = 2$	$\sigma = 4$	$\sigma = 8$	$\sigma = 15$
Lower Bound	-81.14%	-55.27%	-55.94%	-56.13%	-56.20%	**68.12%**	**68.94%**	**69.18%**	**69.27%**
Best Estimate	-75.95%	-64.52%	-67.15%	-67.89%	-68.17%	**84.95%**	**88.41%**	**89.39%**	**89.75%**
Upper Bound	-61.34%	-34.89%	-44.99%	-48.00%	-49.13%	**56.87%**	**73.35%**	**78.25%**	**80.10%**

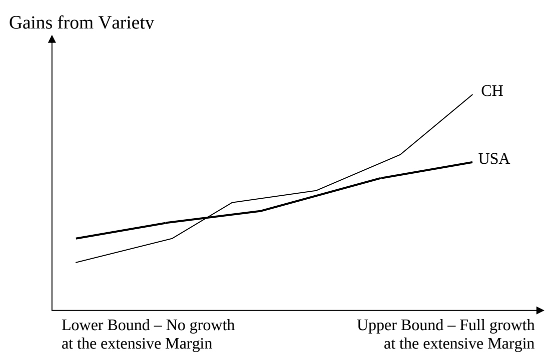
Why is this result interesting or important at all? It says that the U.S. consumers profit more from the imported variety mainly because more new varieties are imported at high values and not because the

[18]Illustration: The lambda ratio is weighted by $1/(\sigma_g - 1)$, resulting in the term $\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{1/(\sigma_g-1)}$. For example, if $\frac{\lambda_{gt}}{\lambda_{gt-1}} = 0.8$, with a low elasticity, $\sigma = 1.5$, the mentioned term becomes $0.8^2 = 0.64$. With a higher elasticity, for example $\sigma_g = 5$, the term gets closer to one, $0.8^{0.25} = 0.95$.

imported products are generally more differentiated. This is an interesting result in the light of the current literature: It says that the lower number of imported varieties in Switzerland, which *may* be a consequence of fixed export costs as in Melitz (2003) or others, matters from a welfare perspective. Said differently, the gains from variety in Switzerland would be much higher with the same imported variety growth as in the U.S.

The second point worth analyzing is displayed in Table 7: It is striking that depending on the definition of the lambda ratios the gains from variety can be larger or lower in Switzerland relative to the the U.S. Note that between the two polar cases there are thousands of possibilities of defining the lambda ratios differently be excluding some varieties from the common set and keeping some others in the common set. Figure 1 shows how this may look qualitatively.[19] The main point is, because we do not not the true growth at the extensive margin, it is not clear whether Switzerland or the U.S. enjoy higher gains from variety.

Figure 1: Gains from Variety for Different Extent of Extensive Margin Growth



However, the figure shows that the more action we allow at the extensive margin, the higher are the gains from variety in Switzerland relative to the U.S. This is no coincidence: Considering equation (27), the term in parantheses gets bigger, if more and more varieties are excluded from the common set. And the bigger this term, the larger is the effect of a higher import share w_t^M. In other words, if we assume more growth at the extensive margin, the higher import share in Switzerland (or any SOE) will more likely dominate the lower growth in variety. As a consequence the gains from variety in Switzerland surpass those in the U.S.

[19]This figure is "drawn by hand" for expositional purposes. Note that hundreds of different paths between the two bounds are possible depending on the order that the varieties are excluded from the common set. Also, the paths, can intersect more than once.

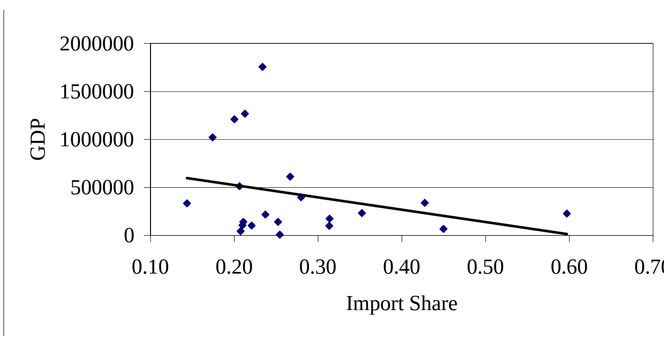
6.2 How General are these Results?

At least for Switzerland and the U.S., the following is found in the section above: In the SOE, the bias in the import price index is always lower. This is mainly due to the lower growth in imported variety in the SOE. It is also shown that the more happens at the extensive margin, the more likely is it for the SOE to exhibit higher gains from variety. Thus, two main ingredients are required to argue that these results are also valid for other small and large countries: SOE should have higher import shares ans less imported variety growth. The differences in the magnitude of the elasticities of substitution is not that important as shown above but will also be considered.

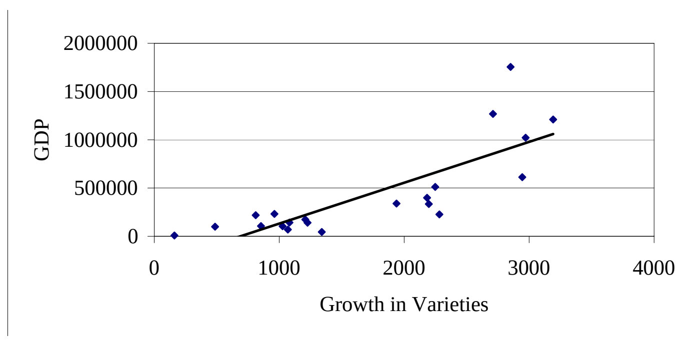
Using OECD data, Figures 2a to 9 display these relationships.[20] Not surprisingly, larger OECD countries exhibit generally a lower import share. Furthermore, one can find a clear positive relationship between the growth in imported varieties and the size of a country measured by its GDP.

Figure 2: Imported Variety and OECD Countries

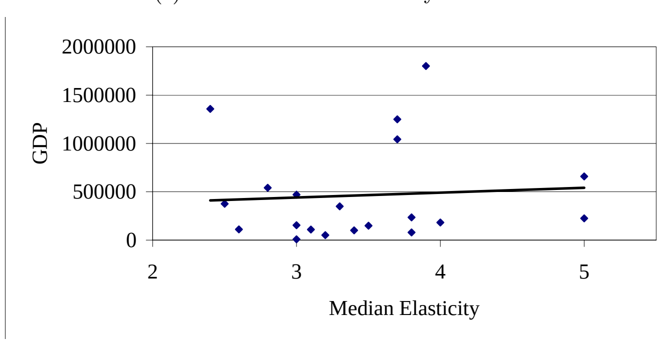
(a) GDP - Import Shares 1991-2000



(b) GDP - Growth in Varieties 1991-2000



(c) GDP - Median Elasticity 1994-2003



What remains to check is whether smaller countries exhibit higher elasticities of substitution in general. Broda et al. (2006) estimate sigmas for 73 countries. Figure 2c shows the median sigmas and the total

[20]Only fully developed and industrialized countries are used: the Czech Republic, Hungary, Mexico, Poland , Slovakia and Turkey are excluded from the sample: Furthermore, the U.S. and Japan are excluded in the figures since with these two extreme outliers in the sample, there seems to be a negative relationship between the GDP and the median elasticity. The positive relationship between GDP and the growth in varieties also holds when these two countries are included.

GDP for the OECD countries. It does not seem to be the case that larger countries generally have lower median elasticities. Note that most countries are estimated to have median elastcities that lie between 3 and 4. Hence the differences in the price index bias resulting from differences in the median elasticities will generally be small. Furthermore, Table 9 showed that the differences in the growth of imported varieties is more important.

As a conclusion, smaller (and more open) economies in the OECD will tend to have a lower bias in the import price index. Since SOEs also have higher import shares by definition, a relationship close to the one pictured in Figure 1 is likely to hold also for other small and large OECD countries. In the appendix, Table 14 shows some regression results to support this “eyeballing”.

7 Conclusion

In this paper, a lower and an upper bound for the bias in the aggregate import price index of Feenstra's (1994) seminal paper is proposed. The bounds are associated with the assumption of low or high growth at the extensive margin of imports. Using these bounds the gains from variety are estimated for Switzerland and the U.S. for the period of 1990 to 2006. In Switzerland, the gains amount to between 0.3% and 7.7% of the GDP while in the U.S. these gains lie between 0.4% and 4.9% Using the best estimate, the consumers would willing to pay 1.9% of the GDP for the new varieties in Switzerland. The gains in the U.S. are slightly lower, amounting to 1.8%.

These gains from variety can then be attributed to countries of origin and product categories: 60% to 70% of the gains from variety in Switzerland are due to imports stemming from Switzerland's direct neighbours, Germany, Italy and France. In the U.S. the gains are more equally distributed among many major trading partners. Looking at product categories, classical differentiated goods like Motor Vehicles contribute large shares to the gains from variety in both countries.

The differences between an SOE and a larger economy regarding the gains from varieties are analysed. The import price index bias is always lower in the SOE. This difference can be attributed to two sources: 55% to 90% of the difference are due to the lower growth in imported variety. The rest is due to the higher elasticities of substitution of Swiss import goods compared to US import goods. However, the much higher import share can overcompensate the lower bias and may lead to higher welfare gains from imported variety in an SOE. It is also shown that the more growth at the extensive margin of imports is assumed, the more likely is Switzerland to exhibit the higher gains from variety. It is then argued that these results may be quite general since SOEs tend to have a lower imported variety growth and a higher share of imports.

Appendix

Table 10: Contribution of Individual Countries to the Gains from Variety, Lower Bound Case

Switzerland			U.S.		
Country	Rank	Contr.	Country	Rank	Contr.
Germany	1	37.20%	Canada	1	20.11%
Italy	2	11.55%	Japan	2	13.02%
France	3	11.08%	Mexico	3	10.31%
Austria	4	6.07%	China	4	9.15%
United Kingdom	5	4.83%	Germany	5	7.62%
Netherlands	6	3.70%	France	6	5.23%
Japan	7	2.98%	United Kingdom	7	4.37%
Hong Kong	8	2.94%	Italy	8	3.97%
Belgium & Luxemburg	9	2.72%	Taiwan	9	3.62%
U.S.	10	2.70%	Korea (South)	10	2.14%
Ireland	11	2.38%	Brazil	11	2.11%
Sweden	12	2.13%	Hong Kong	12	1.91%
Saudi Arabia	13	1.56%	Ireland	13	1.77%
Finland	14	1.35%	Sweden	14	1.62%
Spain	15	1.14%	Netherlands	15	1.30%
China	16	1.14%	India	16	1.08%
Denmark	17	1.03%	Spain	17	0.93%
Thailand	18	0.86%	Indonesia	18	0.85%
Taiwan	19	0.61%	Belgium & Luxemburg	19	0.73%
Former Czechoslovakia	20	0.49%	Chile	20	0.69%

Contr. is the contribution of a good relative to the total gains from variety, expressed in percent. The contribution can also take negative values.

Table 11: Contribution of Individual Countries to the Gains from Variety, Upper Bound Case

Switzerland			U.S.		
Country	Rank	Contr.	Country	Rank	Contr.
Germany	1	46.14%	Canada	1	23.77%
Italy	2	13.38%	Japan	2	14.27%
France	3	11.68%	China	3	11.52%
Austria	4	5.42%	Mexico	4	11.32%
U.S.	5	4.54%	Germany	5	8.87%
United Kingdom	6	4.39%	United Kingdom	6	4.90%
Netherlands	7	3.82%	Taiwan	7	4.66%
Belgium & Luxemburg	8	3.31%	France	8	4.05%
Japan	9	1.77%	Italy	9	3.93%
Spain	10	1.74%	Korea (South)	10	2.91%
Sweden	11	1.68%	Chile	11	2.02%
Denmark	12	1.10%	Brazil	12	2.00%
China	13	0.99%	Hong Kong	13	1.49%
Hong Kong	14	0.88%	South Africa	14	1.35%
Ireland	15	0.87%	Netherlands	15	1.34%
Finland	16	0.57%	Belgium & Luxemburg	16	1.30%
Former USSR	17	0.54%	Israel	17	1.21%
Thailand	18	0.52%	Sweden	18	1.19%
Taiwan	19	0.41%	India	19	1.17%
Canada	20	0.35%	Thailand	20	1.10%

Contr. is the contribution of a good relative to the total gains from variety, expressed in percent. The contribution can also take negative values.

Table 12: Contribution of SITC-3 goods to the Gains from Variety, Switzerland

			Lower bound case
SITC-3	Rank	Contr.	Description
641	1	11.89%	PAPER & PAPERBOARD
514	2	7.82%	NITROGEN-FUNCTION COMPOUNDS
885	3	7.49%	WATCHES & CLOCKS
898	4	7.18%	MUSICAL INSTRUMENTS
515	5	4.80%	ORGANO-INORGANIC COMPOUNDS, HETEROCYCLIC COMPOUNDS, ETC.
524	6	3.52%	OTHER INORGANIC CHEMICALS
971	7	3.45%	GOLD, NON-MONETARY
821	8	3.30%	FURNITURE & PARTS THEREOF
778	9	3.16%	ELECTRICAL MACHINERY & APPARATUS, N.E.S.
773	10	2.85%	EQUIPMENT FOR DISTRIBUTING ELECTRICITY, N.E.S.
775	11	2.76%	HOUSEHOLD-TYPE ELECTRICAL & NON-ELECTRICAL EQUIPMENT
728	12	2.58%	OTHER MACHINERY & EQUIPMENT FOR PARTICULAR INDUSTRIES
716	13	2.29%	ROTATING ELECTRIC PLANT & PARTS THEREOF, N.E.S.
899	14	2.19%	MISCELLANEOUS MANUFACTURED ARTICLES, N.E.S.
699	15	2.06%	MANUFACTURES OF BASE METAL, N.E.S.
554	16	1.97%	SOAP, CLEANSING & POLISHING PREPARATIONS
735	17	1.96%	ACCESSORIES FOR USE WITH THE MACHINES OF GROUPS 731 & 733
574	18	1.94%	POLYACETALS, OTHER POLYETHERS & EPOXIDE RESINS, ETC.
665	19	1.82%	GLASSWARE
891	20	1.79%	ARMS & AMMUNITION
893	21	1.76%	ARTICLES, N.E.S., OF PLASTICS
749	22	1.51%	NON-ELECTRIC PARTS & ACCESSORIES OF MACHINERY, N.E.S.
851	23	1.47%	FOOTWEAR
781	24	1.47%	MOTOR CARS & OTHER MOTOR VEHICLES
657	25	1.44%	SPECIAL YARNS, SPECIAL TEXTILE FABRICS & RELATED PRODUCTS
			Upper bound case
SITC-3	Rank	Contr.	Description
542	1	21.41%	MEDICAMENTS (INCLUDING VETERINARY MEDICAMENTS)
821	2	3.80%	FURNITURE & PARTS THEREOF
893	3	3.33%	ARTICLES, N.E.S., OF PLASTICS
684	4	2.94%	ALUMINIUM
892	5	2.76%	PRINTED MATTER
885	6	2.61%	WATCHES & CLOCKS
541	7	2.09%	MEDICINAL & PHARMACEUTICAL PRODUCTS
699	8	1.97%	MANUFACTURES OF BASE METAL, N.E.S.
691	9	1.88%	STRUCTURES OF IRON, STEEL OR ALUMINIUM, N.E.S.
582	10	1.83%	PLATES, SHEETS, FILM, FOIL & STRIP, OF PLASTICS
772	11	1.72%	APPARATUS FOR SWITCHING OR PROTECTING ELECT. CIRCUITS, ETC.
872	12	1.51%	INSTRUMENTS FOR MEDICAL, SURGICAL, DENTAL PURPOSES
784	13	1.49%	PARTS & ACCESSORIES OF THE MOTOR VEHICLES OF 722, 781, 782 & 783
681	14	1.49%	SILVER, PLATINUM & OTHER METALS OF THE PLATINUM GROUP
781	15	1.43%	MOTOR CARS & OTHER MOTOR VEHICLES
642	16	1.40%	PAPER & PAPERBOARD, CUT TO SIZE OR SHAPE
764	17	1.33%	TELECOMMUNICATIONS EQUIPMENT
874	18	1.28%	MEASURING, CHECKING, ANALYSING & CONTROLLING INSTRUMENTS
845	19	1.25%	ARTICLES OF APPAREL, OF TEXTILE FABRICS, N.E.S.
695	20	1.23%	TOOLS FOR USE IN THE H& OR IN MACHINES
515	21	1.22%	ORGANO-INORGANIC COMPOUNDS, HETEROCYCLIC COMPOUNDS, ETC.
773	22	1.15%	EQUIPMENT FOR DISTRIBUTING ELECTRICITY, N.E.S.
894	23	1.13%	BABY CARRIAGES, TOYS, GAMES & SPORTING GOODS
641	24	1.12%	PAPER & PAPERBOARD
748	25	1.12%	TRANSMISSION SHAFTS & CRANKS; ETC.

Contr. is the contribution of a good relative to the total gains from variety, expressed in percent. The contribution can also take negative values.

Table 13: Contribution of SITC-3 goods to the Gains from Variety, U.S.

			Lower bound case
SITC-3	Rank	Contr.	Description
784	1	26.46%	PARTS & ACCESSORIES OF THE MOTOR VEHICLES OF 722, 781, 782 & 783
841	2	3.94%	MEN'S OR BOYS' CLOTHING
842	3	3.92%	WOMEN'S OR GIRLS' CLOTHING
743	4	3.91%	PUMPS, AIR OR OTHER GAS COMPRESSORS & FANS
684	5	3.80%	ALUMINIUM
699	6	3.47%	MANUFACTURES OF BASE METAL, N.E.S.
542	7	3.46%	MEDICAMENTS (INCLUDING VETERINARY MEDICAMENTS)
898	8	3.20%	MUSICAL INSTRUMENTS
541	9	3.15%	MEDICINAL & PHARMACEUTICAL PRODUCTS
747	10	3.07%	TAPS, COCKS, VALVES & SIMILAR APPLIANCES
792	11	3.04%	AIRCRAFT & ASSOCIATED EQUIPMENT; SPACECRAFT
641	12	2.89%	PAPER & PAPERBOARD
695	13	2.84%	TOOLS FOR USE IN THE HAND OR IN MACHINES
772	14	2.83%	APPARATUS FOR SWITCHING OR PROTECTING ELECT. CIRCUITS, ETC.
515	15	2.70%	ORGANO-INORGANIC COMPOUNDS, HETEROCYCLIC COMPOUNDS, ETC.
892	16	2.49%	PRINTED MATTER
112	17	2.40%	ALCOHOLIC BEVERAGES
778	18	2.38%	ELECTRICAL MACHINERY & APPARATUS, N.E.S.
682	19	2.34%	COPPER
874	20	2.21%	MEASURING, CHECKING, ANALYSING & CONTROLLING INSTRUMENTS
893	21	2.09%	ARTICLES, N.E.S., OF PLASTICS
716	22	1.87%	ROTATING ELECTRIC PLANT & PARTS THEREOF, N.E.S.
848	23	1.81%	ARTICLES OF APPAREL
781	24	1.74%	MOTOR CARS & OTHER MOTOR VEHICLES
845	25	1.64%	ARTICLES OF APPAREL, OF TEXTILE FABRICS
			Upper bound case
SITC-3	Rank	Contr.	Description
784	1	6.20%	PARTS & ACCESSORIES OF THE MOTOR VEHICLES OF 722, 781, 782 & 783
781	2	5.94%	MOTOR CARS & OTHER MOTOR VEHICLES
682	3	5.70%	COPPER
747	4	4.32%	TAPS, COCKS, VALVES & SIMILAR APPLIANCES
813	5	3.95%	LIGHTING FIXTURES & FITTINGS, N.E.S.
821	6	3.56%	FURNITURE & PARTS THEREOF
684	7	3.21%	ALUMINIUM
681	8	3.08%	SILVER, PLATINUM & OTHER METALS OF THE PLATINUM GROUP
778	9	2.55%	ELECTRICAL MACHINERY & APPARATUS, N.E.S.
742	10	2.10%	PUMPS FOR LIQUIDS
713	11	2.08%	INTERNAL COMBUSTION PISTON ENGINES & PARTS THEREOF, N.E.S.
333	12	2.03%	PETROLEUM OILS & OILS OBTAINED FROM BITUMINOUS MINERALS
112	13	2.01%	ALCOHOLIC BEVERAGES
716	14	1.98%	ROTATING ELECTRIC PLANT & PARTS THEREOF, N.E.S.
892	15	1.91%	PRINTED MATTER
525	16	1.87%	RADIOACTIVE & ASSOCIATED MATERIALS
775	17	1.86%	HOUSEHOLD-TYPE ELECTRICAL & NON-ELECTRICAL EQUIPMENT
773	18	1.63%	EQUIPMENT FOR DISTRIBUTING ELECTRICITY, N.E.S.
845	19	1.59%	ARTICLES OF APPAREL, OF TEXTILE FABRICS
522	20	1.57%	INORGANIC CHEMICAL ELEMENTS, OXIDES & HALOGEN SALTS
874	21	1.56%	MEASURING, CHECKING, ANALYSING & CONTROLLING INSTRUMENTS
772	22	1.51%	APPARATUS FOR SWITCHING OR PROTECTING ELECT. CIRCUITS, ETC.
667	23	1.49%	PEARLS & PRECIOUS OR SEMIPRECIOUS STONES
642	24	1.46%	PAPER & PAPERBOARD, CUT TO SIZE OR SHAPE
748	25	1.36%	TRANSMISSION SHAFTS & CRANKS, ETC.

Contr. is the contribution of a good relative to the total gains from variety, expressed in percent. The contribution can also take negative values.

Table 14: Regression Results OECD Countries

	OECD without USA, Japan			OECD with USA, Japan		
Depvar: GDP	Imp. Share	Var. Growth	Med. Elast.	Imp. Share	Var. Growth	Med. Elast.
	1a	1b	1c	2a	2b	2c
Coefficient	-0.065**	1.528***	0.990	-0.030***	0.427***	-1.243***
Stand. Err.	0.029	0.308	2.800	0.009	0.077	0.270
R-Squared	0.084	0.647	0.005	0.231	0.503	0.119

Significance levels: (**) means significant at the 5% level, (***) means significant at the 1% level.

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