Variety Gains from Trade Integration in Europe☆

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Abstract

This is the first paper that investigates the welfare gains from trade integration in the CEE after the fall of the *iron curtain*, and the role of variety growth in determining the magnitude of those gains. We apply the methodology of Feenstra (1994), Broda and Weinstein (2006) and Soderbery (2013) to international trade data for Latvia for the period 1990-1994. The estimated variety gains are substantial, ranging from 0.874% to 2.890% of GDP per year.

Keywords: Variety gains, trade integration, CEE, heterogeneous firms.
JEL code: C68, F12, F14, F17, R12, R23.

☆The authors acknowledge helpful comments from Marton Csillag, Aleksandra Parteka, Jan Van Hove and participants of the Workshop on Firm and Product Heterogeneity in International Trade in Leuven. We are grateful to Smirnov Sergey Olegovich and Laila Ekharde for their help in accessing the OKP data for Latvia. The authors are solely responsible for the content of the paper. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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1. Introduction

The fall of the *iron curtain* in the beginning of the nineties has led to one of the largest trade integration shocks in the postwar history. It made it possible for the integration of foreign trade in around a dozen of former centrally planned communist countries in Central and Eastern Europe (CEE) into the world trading system. Such examples of abrupt and rapid trade integration provide an interesting 'laboratory' for a quantitative assessment of the welfare gains from trade integration. This paper uses the example of Latvia's breakout of the politically imposed isolation and provides the first estimates of variety gains from CEE's integration into the world trading system, by comparing the immediate period before and after the fall of the *iron curtain*.

Krugman (1980) was among the first, who noticed that an enhanced set of differentiated varieties may increase the economic welfare. Since then, both the methodology (Romer, 1994; Feenstra, 1994; Feenstra and Kee, 2004; Broda and Weinstein, 2006; Arkolakis *et al.*, 2008; Soderbery, 2013), and the empirical evidence (Broda and Weinstein, 2004; Hummels and Klenow, 2005; Broda and Weinstein, 2010; Kancs, 2010; Blonigen and Soderbery, 2010) have improved significantly.

Most of the existing empirical studies have calculated variety gains from imports in developed economies – usually the USA and the EU – and find substantial welfare gains ranging between 0.1 and 0.5 percent of GDP per year. These variety gains from trade are in addition to the traditional gains from trade, suggesting that the true gains from trade integration, particularly in cases of large and sudden trade integration shocks such as the fall of the *iron curtain* in the CEE, might be even higher than commonly assumed.

Given that variety gains from trade are substantial in developed economies (Broda and Weinstein, 2004; Hummels and Klenow, 2005; Broda and Weinstein, 2010; Blonigen and Soderbery, 2010), where foreign trade is widely liberalised, likely, they are even higher when autarkic economies open their markets to foreign trade. A prominent example in the postwar history is the fall of the *iron curtain* in the CEE, where trade with the West was prohibited for politically-ideological reasons. During the Soviet period, the quantity and the variety of goods produced, traded and consumed were not decided by the relative prices and consumer preferences, but instead, by central planners, who in many cases rationed both the quantity and the variety of traded goods. The opening of the CEE to trade and the launch of restructuring of centrally planned economies to free market economies changed production, trade and consumption patterns significantly in the beginning of the nineties. On the one hand, consumers and producers gained access to a considerably larger variety of Western goods, which were unavailable under the central planning. On the other hand, fiercer competition from Western firms reduced the scope and scale of domestic firms operating in the CEE, decreasing in such a way the number of domestically produced varieties. In addition, consumption patterns were affected also by centrifugal shifts in the distribution of real income across income groups of population.

The present paper attempts to quantify the variety gains from trade integration in the CEE by calculating and comparing the variety-adjusted exact price indices for imports from the West before and after the fall of the *iron curtain*. In the empirical analysis we employ a detailed seven digit trade data on domestic sales and imports in Latvia from 1990 until 1994, using the methodologies developed by Feenstra (1994); Broda and Weinstein (2006); Soderbery (2013). We define varieties as product lines at 7-digit level, because this is the only data available for Latvia for the period before and after fall of the *iron curtain*.

We estimate the cumulative welfare gains from import variety growth during the analysed five year period are equal to 10.341% of GDP, which corresponds to an average annual variety gain of 2.068% of GDP. These results are new, no directly comparable estimates are available in the literature. To our knowledge the two closest studies to ours are Levchenko and Zhang (2012) and Berlingieri (2013). Levchenko and Zhang (2012) estimate the welfare gains from trade integration in a hypothetical scenario, with a baseline assumption of preserving the *iron curtain*. The authors obtain substantial cumulative welfare gains for the CEE economies ranging up to 15% of GDP in Latvia and 20% of GDP in Estonia. Berlingieri (2013) estimates variety gains associated with the fall of the *iron curtain* for trading partners in the West, and finds substantial variety gains from trade liberalisation with the CEE, e.g. the cumulative variety gains for the UK are estimated at 2% of GDP. In light of these findings, our cumulative estimates of around 10% of Latvian GDP seem to be reasonable. In the context of previous empirical findings for developed economies (Broda and Weinstein, 2004; Hummels and Klenow, 2005; Broda and Weinstein, 2010; Blonigen and Soderbery, 2010), these estimates are rather large. However, they need to be seen in light of the initial pattern of foreign trade in Latvia, which was heavily biased and restricted towards the West.

To the best of our knowledge, this is the first paper to estimate the variety gains from trade integration associated with the fall of the *iron curtain* in the CEE in the beginning of the nineties. Our findings are important not only for the assessment of the true benefits from the CEE integration into the world trading system, but they also provide an important 'laboratory' feedback about the behaviour of estimators of variety gains also in extreme trade liberalisation scenarios, such as the fall of the *iron curtain*.

2. Methodology for estimating variety gains

2.1. Love of variety

Following Broda and Weinstein (2006), we assume a two-tier utility function, where, at the first tier, consumers decide how much to consume domestic and imported goods according to Cobb-Douglas preferences, and, at the second tier, how much to consume of each variety of these goods according to CES preferences.[1] Suppose that I_g is the set of imported varieties of some good g available to consumers and $i \in I_g$ is a variety of good g. As shown by Dixit and Stiglitz (1977), an asymmetric second tier sub-utility function for imports can be represented by:

$$U_{gt} = \left(\sum_{i \in I_{gt}} d_{git}^{\frac{1}{\sigma_g}} x_{git}^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}} \tag{1}$$

where $\sigma_g > 1$ is the elasticity of substitution between varieties of good g, x_{git} is the quantity consumed of variety i in period t, and d_{git} is a taste or quality parameter, which can be asymmetric across varieties. Assume that quantities, $\mathbf{x}_{gt}$,[2] are optimally chosen such as to minimise $\sum_{i \in I_g} p_{git} x_{git}$ subject to achieving utility $\overline{U}\left(\mathbf{x}_{gt}, \mathbf{d}_{gt}\right) = 1$. As shown by Diewert (1976), the solution to this minimisation problem yields the corresponding minimum unit cost function:

$$c_{gt}\left(\mathbf{p}_{gt}, \mathbf{d}_{gt}\right) = \left(\sum_{i \in I_{gt}} d_{git} p_{git}^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}} \tag{2}$$

where p_{git} is the price of variety i. The minimum unit cost function (2) is decreasing in the number of consumed varieties, and in taste for a particular variety. The unit cost is increasing in price and the elasticity of substitution between varieties.

[1] Given that the structure of domestic and import nests is identical, we spell out only one of the two – for imports.

[2] Throughout the paper we use **bold** face to denote vectors of varieties.

Differentiating (2) yields expenditure shares, s_{git}, implied by taste parameters $\mathbf{d}_{gt}$:

$$\begin{aligned} s_{git} &= \partial \ln c\left(\mathbf{p}_{gt}, \mathbf{d}_{gt}\right) / \partial \ln p_{git} \\ &= c\left(\mathbf{p}_{gt}, \mathbf{d}_{gt}\right)^{1-\sigma_g} d_{git} p_{git}^{1-\sigma_g} \end{aligned} \tag{3}$$

2.2. Conventional exact price index

First, we derive a benchmark price index against which to measure the variety gains. Following Diewert (1976), we assume that there are two periods, $t-1$ and t, and that the quantity vectors $\mathbf{x}_{gt}$ and $\mathbf{x}_{gt-1}$ are the cost-minimising bundles of good g's varieties given the prices of all varieties in both periods, $\mathbf{p}_{gt}$ and $\mathbf{p}_{gt-1}$, and the vectors of variety tastes $\mathbf{d}_{gt}$ and $\mathbf{d}_{gt-1}$. Following Diewert (1976), we define the *exact* price index as the ratio of expenditures needed to obtain a fixed level of utility at two different prices:[3]

$$P_g^{CEPI}\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}\right) = \frac{c_{gt}\left(\mathbf{p}_{gt}, \mathbf{d}_{gt}\right)}{c_{gt-1}\left(\mathbf{p}_{gt-1}, \mathbf{d}_{gt}\right)} \tag{4}$$

Following Sato (1976) and Vartia (1976), we assume CES unit cost function with constant tastes, $d_{git} = d_{git-1} = d_{gi}$, and a constant set of available product varieties available in both periods, $I_{gt} = I_{gt-1} = I_g$, which allows us to derive a conventional exact price index, P_g^{CEPI}:

$$P_g^{CEPI}\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}\right) = \prod_{i \in I_g} \left(\frac{p_{git}}{p_{git-1}}\right)^{w_{git}} = \frac{c_{gt}\left(\mathbf{p}_{gt}, \mathbf{d}_{gt}\right)}{c_{gt-1}\left(\mathbf{p}_{gt-1}, \mathbf{d}_{gt}\right)} \tag{5}$$

where the ideal log-change weights, w_{git}, – functions of expenditure shares, s_{git-1} and s_{git} – are equal to the ratio of unit costs:[4]

$$w_{git} = \left(\frac{s_{git} - s_{git-1}}{\ln s_{git} - \ln s_{git-1}}\right) \Bigg/ \sum_{i \in I_g} \frac{s_{git} - s_{git-1}}{\ln s_{git} - \ln s_{git-1}}\Bigg) \tag{6}$$

[3]The cost-of-living price index is called *exact*, because the cost-of-living price index, P_g^{CEPI}, exactly matches changes in the minimum unit-costs, c_g.

[4]According to Sato (1976) and Vartia (1976) (1976), w_{git} captures the share of differences in cost shares over time normalised by the difference in logarithmic cost shares over time in the aggregate differences in cost shares over time normalised by the difference in logarithmic cost shares over time.

with the corresponding expenditure share, s_{git}, on each variety

$$s_{git} \equiv \frac{p_{git} x_{git}}{\sum_{i \in I_g} p_{git} x_{git}} \tag{7}$$

As shown by Sato (1976) and Vartia (1976), the conventional exact price index (5) is equal to the geometric mean of price ratios in the two periods with weights w_{git}. However, a critical assumption of the Sato (1976) and Vartia (1976) exact price index is that all varieties are available in both periods, i.e., the set of available varieties does not change.

Krugman (1980) was among the first who noted that an enhanced set of horizontally differentiated varieties may contribute to an increase in economic welfare. Assuming symmetric CES preferences, $d_{gi} = 1 \forall i \in I_g$, Krugman (1980) has shown that for a given $p_{gt} \left(= p_g\right)$,[5] an increase in the number of available varieties, I_{gt}, e.g. through more types/sources of imports, reduces the minimum cost, c_{gt}:

$$c_{gt}\left(I_{gt}\right) = I_{gt}^{\frac{1}{1-\sigma_g}} p_{gt} \tag{8}$$

which is required to achieve a given level of utility. Or alternatively, an increase in the number of available varieties increases the utility, which can be achieved at cost c_{gt}.

Analogously to (4), the ratio of minimum unit costs can be measured by the cost-of-living exact price index, P_g^{CEPI}:

$$P_g^{CEPI}\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g\right) = \frac{p_{gt}}{p_{gt-1}} = \frac{c_{gt}\left(I_{gt}\right)}{c_{gt-1}\left(I_{gt-1}\right)}. \tag{9}$$

According to the price index (9), trade integration will not change the number of available varieties, and hence it will not capture a fall in minimum costs, or equivalently, a rise in utility due to a variety growth.[6]

2.3. *Variety-adjusted exact price index*

Romer (1994) proposes an extension of the Krugman (1980) model to allow for fixed

[5] Assuming symmetric CES preferences, $d_{gi} = 1 \forall i \in I_g$, implies that all varieties i of good g are equally priced at p_g. Alternatively, given that all suppliers are symmetric, all varieties have the same price and there is no need for weights.

[6] In the model of Krugman (1980) the key source of price reductions is increasing returns to scale. As tariffs are reduced between two countries, some firms exit the market and the remaining firms expand their output and lower their average costs through economies of scale. The reduction in average costs also leads to a reduction in prices in the zero-profit equilibrium.

costs of accessing foreign markets so that the number of available varieties can rise with declining tariffs. In order to account for variety growth, Romer (1994) multiplies the conventional exact price index, P_g^{CEPI}, by the ratio of available varieties in the two periods, which yields a symmetric variety-adjusted exact price index:

$$P_g^{VEPI}\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_{gt}, I_{gt-1}\right) = P_g^{CEPI}\left(\frac{I_{gt-1}}{I_{gt}}\right)^{\frac{1}{\sigma_g - 1}} \tag{10}$$

As in Krugman (1980), the imported varieties are symmetric (the same price and quantity) also in (10), implying that the extensive import margin equals the number of imported varieties. An increase in the number of varieties, I_{gt}, in period t compared to the number of varieties, I_{gt-1}, available in period $t-1$ leads directly to a fall in the exact price index, P_g^{VEPI}, relative to the conventional price index, P_g^{CEPI}. In other words, an increasing number of varieties, I_g, for good g will lower the ratio of old to new varieties, I_{gt-1}/I_{gt}, and hence the variety-adjusted exact price index, P_g^{VEPI}.

The downside of the Romer (1994) approach is that the variety-adjusted exact price index (10) can yield substantial bias (which are different from (5)). For example, if new varieties represent only a small share of the total expenditure in a good, then a simple count of varieties will grossly overestimate the true impact of new varieties.

Feenstra (1994) provides a more general framework for the case when the (overlapping) set of asymmetric varieties changes between the periods. In deriving the relationship between the conventional price index (without variety changes) and the exact price index (which accounts for variety changes over time), Feenstra (1994) relaxes the symmetry assumption of Krugman (1980) and Romer (1994), and the assumption of a constant set of varieties of Krugman (1980), implying that $I_{gt} \neq I_{gt-1}$. As above, the assumption that taste parameters are constant over time, i.e. $d_{git} = d_{git-1} = d_{gi}$, is maintained.

In line with the definition of the *exact* cost-of-living price index, the asymmetric variety-adjusted price index of Feenstra (1994) equals the ratio of unit costs and uses weights which are functions of the expenditure shares s_{git-1} and s_{git},

$$P_g^{VEPI}\left(\mathbf{p}_g, \mathbf{x}_g, I_g\right) = \frac{p_{git} s_{git}\left(I_{gt}\right)^{\frac{1}{\sigma_g - 1}}}{p_{git-1} s_{git-1}\left(I_{gt-1}\right)^{\frac{1}{\sigma_g - 1}}} = \frac{c_{gt}\left(d_{git}, I_{gt}, p_{git}\right)}{c_{gt-1}\left(d_{git-1}, I_{gt-1}, p_{git-1}\right)} \tag{11}$$

Defining two new variables $\lambda_{gt} \equiv \sum_{i \in I_g} p_{git} x_{git} / \sum_{i \in I_{gt}} p_{git} x_{git}$ and

$\lambda_{gt-1} \equiv \sum_{i \in I_g} p_{git-1} x_{git-1} / \sum_{i \in I_{gt-1}} p_{git-1} x_{git-1}$,[7] and using the definition of s_{git} given in (7), the expenditure share on each variety can be expressed as $s_{git}\left(I_{gt}\right) = s_{git}\left(I_g\right)\lambda_{gt}$ and $s_{git-1}\left(I_{gt-1}\right) = s_{git-1}\left(I_g\right)\lambda_{gt-1}$. Substituting $s_{git}\left(I_g\right)\lambda_{gt}$ and $s_{git-1}\left(I_g\right)\lambda_{gt-1}$ into equation (11), allows us to rewrite the asymmetric variety-adjusted price index as:

$$P_g^{VEPI}\left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_{gt}, I_{gt-1}\right) = P_g^{CEPI}\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g - 1}} \tag{12}$$

where λ_{gt} equals the fraction of expenditure on varieties that are available in both periods, $\sum_{i \in I_g} p_{git} x_{git}$, relative to the entire set of varieties available in period t, $\sum_{i \in I_{gt}} p_{git} x_{git}$. Analogously, λ_{gt-1} equals the fraction of expenditure on varieties that are available in both periods, $\sum_{i \in I_g} p_{git-1} x_{git-1}$, relative to the entire set of varieties available in period $t-1$, $\sum_{i \in I_{gt-1}} p_{git-1} x_{git-1}$.[8] Term $\left(\lambda_{gt}/\lambda_{gt-1}\right)^{1/(\sigma_g - 1)}$ measures the deviation (bias) of conventional exact price index, P_g^{CEPI}, variety-adjust exact price index that takes variety growth into account, P_g^{VEPI}, and it is inversely related to product variety.

The inverse measure of product variety, $\left(\lambda_{gt}/\lambda_{gt-1}\right)^{1/(\sigma_g - 1)}$, depends on two parameters: λ_g and σ_g. First, note that λ_{gt} is decreasing in the expenditure share of new varieties. Hence, the higher the expenditure share of new varieties, the lower is λ_{gt}, and the lower is the variety-adjusted exact price index, P_g^{VEPI}, compared to the conventional exact price index, P_g^{CEPI}. Second, the variety-adjusted exact price index (12) of Feenstra (1994) depends also on the good-specific elasticity of substitution between varieties, σ_g. The higher is σ_g, the lower is the exponent, $1/\left(\sigma_g - 1\right)$, implying that the inverse measure of product variety, $\left(\lambda_{gt}/\lambda_{gt-1}\right)^{1/(\sigma_g - 1)}$, approaches unity. When existing varieties are close substitutes to new or disappearing varieties, changes in variety between $t-1$ and t will have a small impact on the exact price index. In contrast, when σ_g is small, varieties are far substitutes, consumers value new varieties a lot, and the disappear of varieties is very costly. In this case the exponent, as the whole bias term, approaches infinity implying that the difference between the conventional price index, P_g^{CEPI}, and the exact price index, P_g^{VEPI}, will be large.

[7] The numerators of λ_{gt} and λ_{gt-1} comprise the expenditure on varieties available at both time t and $t-1$. The set containing these varieties, I_g, is referred to as the common set. The denominators of λ_{gt} and λ_{gt-1} consist of expenditures on varieties belonging to the sets I_{gt} and I_{gt-1}, respectively. In the first set, common and new varieties are included, while in the second set, common and disappearing varieties are included. Hence, high expenditures on new varieties lower the lambda ratio, while high expenditures on disappearing varieties increase it.

[8] Alternatively, this can be interpreted as one minus the share of period t expenditure on new goods (not in the set I), $\sum_{i \in I_{gt}, i \notin I} p_{git} x_{git}$.

2.4. *Aggregated price index and welfare gains*

Aggregating the variety-adjusted price indices over all product categories yields a variety-adjusted import price index:

$$P_m^{VEPI}\left(I_{gt}, I_{gt-1}\right) = \prod_{g\in G}\left(P_g^{VEPI}\left(I_{gt}, I_{gt-1}\right)\right)^{w_{gt}} \tag{13}$$

Price index (13) is dual for domestic varieties. In line with the Cobb-Douglas preferences at the first tier, the aggregated variety-adjusted exact price index is:

$$P^{VEPI} = \left(P_d^{VEPI}\right)^{w_{dt}} + \left(P_m^{VEPI}\right)^{w_{mt}} \tag{14}$$

where w_{gt} and w_{mt} are aggregated log-ideal weights.

An increase in the variety of goods available for consumption reduces the value of a cost-of-living price index, and hence increases consumer 'standard of living'. In order to calculate the bias resulting from ignoring changes in the variety, we follow (Broda and Weinstein, 2006) and take the ratio of the variety-adjusted import price index, P^{VEPI} from section 2.3, to the aggregated conventional import price index, P^{CEPI}, from section 2.2, which yields the so called *endpoint ratio* (EPR):

$$EPR_m = \frac{P_m^{VEPI}\left(I_{gt}, I_{gt-1}\right)}{P_m^{CEPI}\left(I_{gt}\right)} = \prod_g\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{w_{gt}}{\sigma_g-1}} \tag{15}$$

Equation (15) suggests that the EPR is a weighted geometric mean of the lambda ratios.

Given the CES preferences at the second tier, the welfare gains from import variety growth can be written as:[9]

$$\begin{aligned}\triangle W_m &= \left[\frac{1}{EPR_m}\right]^{w_{mt}} - 1\\ &= \left[\prod_g\left(\frac{\sum_{i\in I_{gt-1}} p_{git-1}x_{git-1}}{\sum_{i\in I_{gt}} p_{git}x_{git}}\frac{\sum_{i\in I_g} p_{git}x_{git}}{\sum_{i\in I_g} p_{git-1}x_{git-1}}\right)^{\frac{w_{gt}}{\sigma_g-1}}\right]^{-w_{mt}} - 1\end{aligned} \tag{16}$$

where w_{gt} and w_{mt} are aggregated log-ideal weights of Sato (1976) and Vartia (1976):

[9] Applying the same measure (16), variety growth and the associated welfare gains can be measured both for imports and for exports, and either comparing a country (set of countries) across time or comparing countries at a point of time.

$$w_{gt} = \frac{\frac{s_{gt}-s_{gt-1}}{\ln s_{gt}-\ln s_{gt-1}}}{\sum_{g\in G}\frac{s_{gt}-s_{gt-1}}{\ln s_{gt}-\ln s_{gt-1}}} \quad \text{with} \quad s_{gt} = \frac{\sum_{i\in I_g} p_{git}x_{git}}{\sum_{g\in G}\sum_{i\in I_g} p_{git}x_{git}}$$

$$w_{mt} = \frac{s_{mt}-s_{mt-1}}{\ln s_{mt}-\ln s_{mt-1}} \quad \text{with} \quad s_{mt} = \frac{\sum_{g\in G}\sum_{i\in I_g} p_{git}x_{git}}{GDP_t}$$

where G is the set of goods which remains constant over the whole period, I_g is the set of common varieties over the periods, $p_{git}x_{git}$ is the value of imports of a particular i variety in year t, and GDP_t is the gross domestic product.

According to equation (16), the welfare gains from import variety growth are calculated by weighting the inverse of the weighted aggregate lambda ratios with the fraction of imported goods relative to the total economic activity, w_{mt}. Gains from variety growth are increasing in import share in the total economic activity as, ceteris paribus, consumers care more about variety growth in sectors that occupy large share of consumption than in small sectors. Gains from variety are increasing in the number of new varieties. The more new varieties are imported, the larger is consumer choice and the bigger are welfare gains from variety. Gains from variety are decreasing in the elasticity of substitution between varieties. If varieties of a particular good are perfectly substitutable, then having two varieties of that good will have no impact on welfare.

3. Data and empirical implementation

3.1. Data sources

In the present study we use the industrial and agricultural production (IAP) data, which is compiled according to the 'Obshchesoyuznyy klassifikator promyshlennoy i sel'skokhozyaystvennoy produktsii' (OKP). The OKP regroups all goods and services hierarchically into 7-digit product lines. It total, at the sevenths digit's level the IAP contains more than 2 million product lines. However, during the period of our study the number of distinct traded product varieties does not exceed 50,000 at the 7-digit level. Hence, this is our upper level for identifying varieties.

The IAP data covers all non-military goods and services sold in Latvia (Latvian Soviet Socialist Republic until 1991) from 1990 through 1994. Two types of variables are provided in the IAP data: the value of traded goods and the quantity of traded goods for domestic sales and imports. Dividing values by quantities allows us to construct the unit cost (price) variable for each variety of all traded goods. The IAP data are confidential, and, for the purpose of this study, accessed under a special agreement. Given that the data are not available in electronic format, the original typewritten documents were accessed and subsequently digitalised by scanning in the archived data sheets.

Aggregated macro-data, such as GDP by country and bilateral trade flows are drawn from the GTAP database. The evolution of imports from the OECD countries in Latvia from 1990 to 1994 is shown in Figure 1. According to the top dashed line (*value of trade*), the aggregated value of imports from the OECD countries has remained roughly at the same level over the five year period from 1990-1994. In contrast, the average value of imported goods from the OECD countries (*intensive margin*) has decreased steadily between 1990 and 1994. The observed decrease in the prices for Western goods after the fall of the *iron curtain* can be traced back to the Soviet period, when the scarcely available Western goods were considered as luxury goods, and hence were marked-up by a luxury add-on (*intensive margin* in Figure 1). Moreover, if trade costs are in part fixed (as in Romer (1994), see section 2.3), goods with lower value added (and lower prices) will be introduced only gradually over time as tangible and intangible fixed trade costs decrease. Figure 1 indeed suggests that the number of imported varieties (*extensive margin*) has increased continuously during the five years (*extensive margin*). In the context of about the same aggregated import value from the OECD in 1990 and 1994 (*value of trade*), an increase in the number of imported differentiated goods (*extensive margin*) is in line with the observation that the average value of imported good from the OECD countries (*intensive margin*) has decreased between 1990 and 1994.

3.2. Defining the variety

Usually, varieties are defined based on trade data according to the classification of goods, according to the country of origin as in Armington (1969), or both. Adopting a two-way classification – first, by categories of goods and second, by countries of origin – the nest unit of observation on the import side is a certain product category stemming from a particular country.

A more recent firm level evidence suggests that for consumers not only the country of origin is important, but also a particular product produced by a particular firm. This implies that in addition to the set of goods and the number of trading partners (countries of origin), also the number of active firms and the scope of available products within these firms determine the extensive margin of trade. For example, Bernard *et al.* (2009) show that changes in the extensive margin resulting from the entry and exit of firms, but also from product turnover within existing firms, are mainly responsible for import and

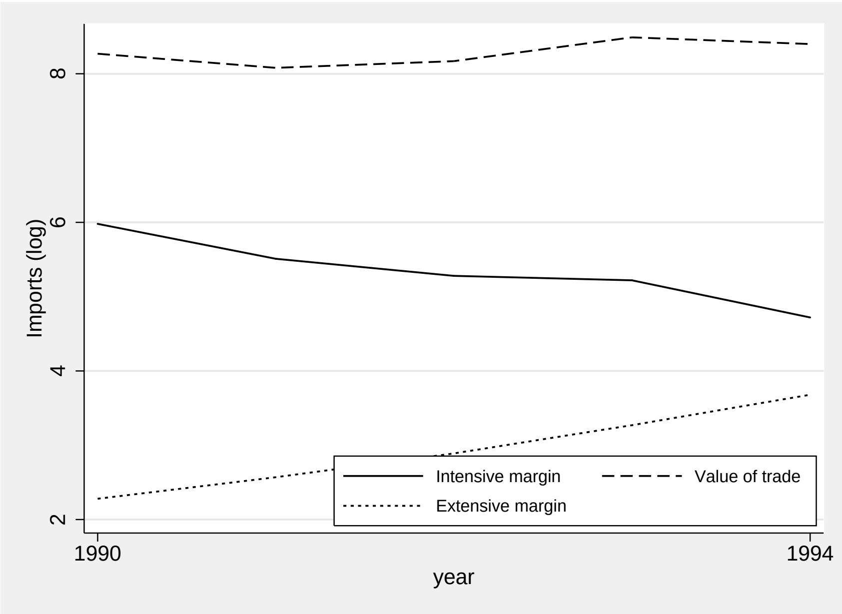

Figure 1: Evolution of imports from the OECD, 1990-1994. Source: GTAP data base.

export growth over longer time spans in the United States. Among others, Broda and Weinstein (2010) and Blonigen and Soderbery (2010) adopt this definition of variety.

As emphasised before, the evidence suggests that the more relevant increase in varieties following the fall of the *iron curtain* was not an increase in the number of source-countries from which the CEE countries could import goods, but rather the fact that truly new varieties became available, such as previously unavailable types of fruit or textiles. We therefore define 'varieties' simply as those goods on a certain lower level of classification within a 'good' at a higher level of classification. A more practical reason for defining variety according to the classification of goods is that this is the only data available for Latvia for the period we are interested in, i.e. before and after fall of the *iron curtain*.

4. Estimation of elasticities

The estimation of variety gains from trade integration according to equation (16) is data demanding and requires, among others, the elasticity of substitution between varieties, σ_g, of good g. We estimate the elasticity of substitution between varieties for each good econometrically, using the methodology of Soderbery (2013) which in turn is based on the work of Feenstra (1994) and Broda and Weinstein (2006). We start by describing the assumptions on the data generating process which is shared by these three contributions. We then turn to a description of the different estimators which have been proposed.

4.1. Data generating process

To obtain estimates of demand elasticities from observed quantities and prices, we need a model for both supply and demand, and assumptions allowing for identification. Reconsider the asymmetric CES utility function which was shown in equation (1) and is reproduced here for easy reference:

$$U_{gt} = \left(\sum_{i \in I_{gt}} d_{git}^{\frac{1}{\sigma_g}} x_{git}^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}}. \tag{17}$$

As shown in equation (7), given a CES utility function at the second tier, the share of expenditure on a single variety $i \in I_g$ relative to the total expenditure on all varieties of good g equals to

$$s_{git} \equiv \frac{p_{git} x_{git}}{\sum_{i \in I_g} p_{git} x_{git}} = \left(\frac{p_{git}}{c_{gt}} \right)^{1-\sigma_g} d_{git}, \tag{18}$$

where c_{gt} is the unit cost function from equation (2). This expenditure share derived from the consumer optimisation problem will be interpreted as the demand equation. We take logarithms and difference over time to obtain

$$\Delta \ln(s_{git}) = \phi_{gt} + (1 - \sigma) \Delta \ln(p_{git}) + \epsilon_{git}, \tag{19}$$

where $\phi_{gt} = (\sigma_g - 1) \ln \left[c_{gt}(d_{gt}) / c_{gt-1}(d_{gt-1}) \right]$ is a random effect common to all varieties within a good, and $\epsilon_{git} = \Delta \ln(d_{git})$ captures remaining idiosyncratic disturbances to demand stemming from changes in taste for single varieties. Before estimating (19), correlation between ϵ_{git}, prices and shares needs to be addressed. As quantities and prices are determined jointly by the intersection of demand and supply, demand shocks would simultaneously affect quantities (shares) and prices, and running OLS on equation (19) would lead to biased estimates.

To address this bias, a supply schedule is introduced as

$$\Delta \ln p_{git} = \psi_{gt} + \frac{\omega_g}{1 + \omega_g} \Delta \ln s_{git} + \delta_{git}, \tag{20}$$

where $\psi_{gt} = -\omega_g \Delta \ln E_{gt} / (1 + \omega_g)$ again is a random effect which depends on both the inverse supply elasticity ω_g (homogeneous across varieties within the good), and the total expenditure on the good, E_{gt}. The error term $\delta_{git} = \Delta \ln(\xi_{git})/(1+\omega_{gt})$ captures all remaining variety-specific supply shocks.

Similar to how differencing over time removes cross-sectional time-invariant effects in a panel-setup, the supply and demand equations are differenced with respect to a reference variety $k \in I_g$ to remove the good-specific terms ϕ_{gt} and ψ_{gt}. Denoting this double differencing operator with Δ^k, we obtain

$$\Delta^k \ln s_{git} \equiv \Delta \ln s_{git} - \Delta \ln s_{gkt} = -(\sigma - 1)\Delta^k \ln p_{git} + \epsilon^k_{git},$$

and

$$\Delta^k \ln p_{git} \equiv \Delta \ln p_{git} - \Delta \ln p_{gkt} = \frac{\omega_g}{1+\omega_g}\Delta^k \ln s_{git} + \delta^k_{git}. \tag{21}$$

A key assumption for identification is that the remaining demand and supply shocks to varieties are independent, such that $\mathrm{E}[\epsilon^k_{git}\delta^k_{git}] = 0$. We can write demand and supply bringing the error terms to one side, and multiply both equations to obtain

$$(\Delta^k \ln p_{git})^2 = \theta_1(\Delta^k \ln(s_{git}))^2 + \theta_2(\Delta^k \ln(s_{git}) \ln(p_{git}))^2 + \epsilon^k_{git}\delta^k_{git}$$

or

$$Y_{git} = \theta_1 X_{1,git} + \theta_2 X_{2,git} + u_{git}, \tag{22}$$

where Y, X_1, X_2 and u are appropriately defined, and

$$\theta_1 = \frac{\omega_g}{(1+\omega_g)(\sigma_g - 1)} \qquad \text{and} \qquad \theta_2 = \frac{1-\omega_g(\sigma_g - 2)}{(1+\omega_g)(\sigma_g - 1)}. \tag{23}$$

Note that the variables in (23) are the second moments of changes in prices and expenditure shares, and the error term is the cross-moment of demand and supply shocks.

4.2. Estimators

As demand shocks are assumed to be independent, we have $\mathrm{E}[u_{git}] = 0$. Unfortunately, the error term is correlated with both prices and expenditure shares contained in X_1 and X_2, causing direct estimation of (23) to produce biased results.

Feenstra (1994) proposes a simple method to obtain estimates for θ_1, θ_2 and thereby for the elasticities σ_g and ω_g, by time-averaging equation (23) to obtain

$$\overline{Y}_{gi} = \theta_1 \overline{X}_{1,gi} + \theta_2 \overline{X}_{2,gi} + \overline{u}_{gi}, \tag{24}$$

which can be estimated by OLS or using WLS with $1/T_{gi}$ as weights for increased efficiency. This between estimation provides unbiased estimates as plim($\overline{u}_{gi}$)=0 such that the error-term (and source of bias) disappears as $T \rightarrow \infty$, under the condition that X_1 and X_2 are not proportional. This estimator is an implementation of the GMM estimator approximating the moment condition $\mathrm{E}[u_{git} = 0]$.

As argued by Broda and Weinstein (2006), however, this method frequently produces estimates of θ_1 and θ_2 which do not correspond to meaningful values for σ_g and ω_g. As a solution, they suggest to run a grid search over a set of possible values for σ_g and ω_g, translate this into values for θ_1 and θ_2, evaluate the GMM objective function and choose those parameter combination which minimises it. The grid-search itself is not free from problems, however. In practice, it turns out that the simple estimator of Feenstra (1994) fails because of reasons which also cause problems for the grid-search. As a result, the grid-search will very frequently end up with solutions which are close to the boundary of the grid, with very high or very low estimates for the elasticities as a result.

As argued by Soderbery (2013), in turn, the underlying problem of these problems is that the 'second step' of the above estimation method, which starts from the correlation and variation of expenditure shares contained in the time-averaged variables for each variety, gives an equal weight to each variety - apart from weighing by the number of observations. This tends to assign a lot of weight to outliers, especially for those varieties (or entire datasets) where T is small. Soderbery (2010, 2013) shows that a Limited Information Maximum Likelihood (LIML) estimator is less sensitive to such small sample bias, and proposes a hybrid estimator which switches from LIML to constrained nonlinear LIML in cases where standard LIML would produce meaningless estimates of the elasticities. Given these advantages of the LIML estimator, in the present study we follow Soderbery (2010, 2013) and use this estimator.

4.3. Elasticity estimates

Using the hybrid LIML estimator of Soderbery (2013), we estimated the elasticities between varieties of different goods. Figure 2 shows the cumulative distribution function

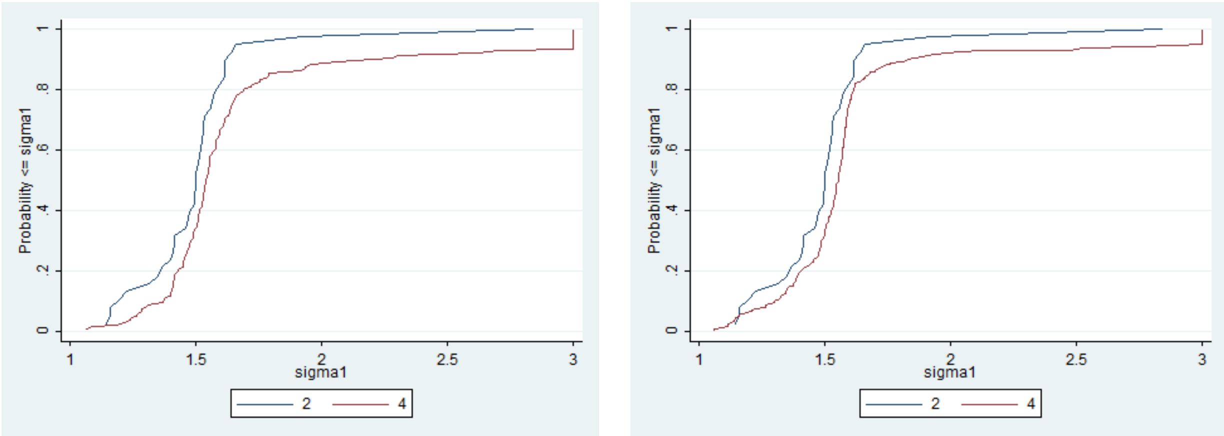

Figure 2: Cumulative distribution function of elasticity estimates

of our elasticity estimates, replacing estimates of σ in excess of 3.[10] The left panel shows the results when defining goods on the 2-digit level, and varieties on the 5-digit level, and compares this to the estimates when defining goods at the lower 4-digit level and varieties on the same 5-digit level. As intuition would suggest, the 5-digit varieties are more heterogeneous to consumers when combining them in a few 2-digit level goods and as a result the estimated elasticity of substitution is lower with goods defined on the 2-digit level. For example, about 20 percent of elasticities are lower than 1.5 with goods at the 4-digit level, whereas this is about 35 percent with goods at the 2-digit level. Reversely, virtually no 2-digit level good has an estimated elasticities above 2.5, whereas about 10 percent of the 4-digit level goods do. The right panel in Figure 2 plots the distribution of elasticities with goods at the 2-digit level and varieties at the 5-digit level, but now compares it with goods defined at the 4-digit level and varieties at the 7-digit. Although, in both choices varieties are 2-levels of classification down from the goods level, we expect 7 digit varieties within 5 digit goods to be more substitutable compared to 5 digit varieties within 2-digit goods. Again this intuition is confirmed by our estimates.

5. Results: variety gains from trade integration in Latvia

5.1. Main results

We estimate the variety gains from trade integration in Latvia based on equation (16) and trade data as described in section 3. Here, which is our main specification, we define

[10]This is done in order to improve the optical tractability of the Figure.

good at the five-digit level and varieties at the seven-digit level. The estimation results are reported in Table 1. The first column reports years (1990-1994), the second column reports the conventional exact price index, P_m^{CEPI}, calculated according to equation (5), the third column reports the variety-adjusted exact price index, P_m^{VEPI}, calculated according to equation (16), column four reports the *endpoint ratio* (EPR) (equation (15)), and columns five and six report the bias and welfare gains due to import variety growth, respectively.

Table 1: Estimated variety gains from trade integration in Latvia, 1990-1994

year	P_m^{CEPI}	P_m^{VEPI}	EPR_m	*bias*	$\triangle W_m$
1990	1.091	1.058	0.971	2.951	1.447
1991	1.154	1.116	0.967	3.430	0.874
1992	1.134	1.090	0.962	3.955	2.890
1993	1.084	1.034	0.954	4.864	2.772
1994	1.129	1.073	0.950	5.312	2.358

Notes: Definition of good: five-digits, definition of variety: seven-digits. Variety gains, $\triangle W_m$, are estimated according to equation (16), by using trade data described in section 3, and elasticity estimates reported in section 4.3. Variables *bias* and $\triangle W_m$ are measured in percent.

The cumulative welfare gains from import variety growth during the analysed five year period are equal to 10.341% of GDP (sum of column $\triangle W_m$), which corresponds to an average annual variety gain of 2.068% of GDP. The estimates reported in Table 1 also suggest that there is a significant variation in the estimated welfare gains between years and with respect to the source of gains from trade. The highest variety gains are estimated for 1992 (2.890% of GDP), followed by 1993 (2.772% of GDP). A comparison of columns five and six suggests that there is no one-to-one mapping between the bias from neglecting changes in the variety (column *bias*) and welfare gains from variety growth (column $\triangle W_m$). The gains from variety take into account also the share of imports in the GDP, which has increased steadily until 1992.

These results cannot be confirmed (or rejected) based on existing studies, because there are no directly comparable estimates available in the literature. To our knowledge the two closest studies to ours are Levchenko and Zhang (2012) and Berlingieri (2013). Levchenko and Zhang (2012) estimate the welfare gains from trade integration in a hypothetical scenario, with a baseline assumption of preserving the *iron curtain*. The authors obtain substantial cumulative welfare gains for the CEE economies ranging up to 15% of GDP in Latvia and 20% of GDP in Estonia. Berlingieri (2013) estimates variety gains associated with the fall of the *iron curtain* for trading partners in the West, and finds substantial variety gains from trade liberalisation with the CEE, e.g. the cumulative variety gains for the UK are estimated at 2% of GDP. In light of these findings, our cumulative estimates of around 10% of Latvian GDP over the five year period are considerable.

In the context of previous empirical findings for developed economies (Broda and Weinstein, 2004; Hummels and Klenow, 2005; Broda and Weinstein, 2010; Blonigen and Soderbery, 2010), these estimates are rather large. However, they need to be seen in light of the initial pattern of foreign trade in Latvia, which was heavily restricted and biased. As shown in Figure 1, very few commodities were imported in Latvia from the OECD before the fall of the *iron curtain* (1990). In addition, given that imports from the West were scarce, they were marked up as luxury goods. An increase in the availability of Western goods on the post-autarkic markets during the nineties, and a decrease in prices for imported goods both contributed to a rapid increase in the demand for Western goods. Given that most of the observed trade growth took place through the extensive margin of trade (see Figure 1), the estimated variety gains seem to be reasonable.

Table 1 also reports the key variables which were used to compute the variety gains: the conventional exact price index, P_m^{CEPI}, the variety-adjusted exact price index, P_m^{VEPI}, and the ratio between the two, EPR_m. As expected, both prices indices P_m^{CEPI} and P_m^{vEPI} are above one during the whole five-year period, implying that consumer expenditures in Latvia have increased for imports from the OECD countries. However, the variety-adjusted exact price index, P_m^{VEPI}, consistently suggests a smaller increase in the costs-of-living than the conventional exact price index, P_m^{CEPI}, ($EPR_m < 1, \in t$), suggesting that neglecting variety gains would underestimate welfare gains from trade.

5.2. Robustness checks

In this section we estimate variety gains under alternative definitions of goods and varieties. First, variety gains are calculated by defining goods at the four-digit level and varieties at the seven-digit level. Second, variety gains are calculated by defining goods defined at the six-digit level and varieties at the seven-digit level. The results are reported in Tables 2 and 3, respectively.

Generally, the results reported in Tables 2 and 3 suggest the same order of magnitude of the estimated variety gains from trade integration in Latvia. By defining goods at the four-digit level and varieties at the seven-digit level (Table 2) slightly increases the estimated variety gains: the cumulative welfare gains are 11.489% of GDP and the annual gains are 2.298% of GDP. In contrast, by defining goods at the six-digit level and

Table 2: Estimated variety gains from trade integration in Latvia, 1990-1994

year	P_m^{CEPI}	P_m^{VEPI}	EPR_m	bias	$\triangle W_m$
1990	1.077	1.045	0.970	3.089	1.514
1991	1.092	1.052	0.963	3.864	0.985
1992	1.155	1.105	0.957	4.463	3.261
1993	1.182	1.124	0.950	5.244	2.988
1994	1.131	1.063	0.942	6.174	2.741

Notes: Definition of good: four-digits, definition of variety: seven-digits. Variety gains, $\triangle W_m$, are estimated according to equation (16), by using trade data described in section 3, and elasticity estimates reported in section 4.3. Variables *bias* and $\triangle W_m$ are measured in percent.

Table 3: Estimated variety gains from trade integration in Latvia, 1990-1994

year	P_m^{CEPI}	P_m^{VEPI}	EPR_m	bias	$\triangle W_m$
1990	1.138	1.106	0.973	2.783	1.364
1991	1.098	1.063	0.968	3.264	0.832
1992	1.114	1.075	0.964	3.768	2.753
1993	1.071	1.030	0.961	4.045	2.305
1994	1.186	1.126	0.951	5.181	2.300

Notes: Definition of good: six-digits, definition of variety: seven-digits. Variety gains, $\triangle W_m$, are estimated according to equation (16), by using trade data described in section 3, and elasticity estimates reported in section 4.3. Variables *bias* and $\triangle W_m$ are measured in percent.

varieties at the seven-digit level (Table 3) slightly reduces the estimated variety gains: the cumulative welfare gains are 9.554% of GDP and the annual gains are 1.911% of GDP.

6. Conclusions

The fall of the *iron curtain* in the beginning of the nineties led to one of the largest episodes of abrupt trade integration in the postwar history. This is the first paper that estimates the welfare gains from trade integration in the CEE after the fall of the *iron curtain*, and the role of variety growth in determining the magnitude of those gains.

We apply the methodology of Feenstra (1994), Broda and Weinstein (2006) and Soderbery (2013) to international trade data for Latvia for the period 1990-1994. The estimated variety gains are substantial, ranging from 0.874% to 2.890% of GDP per year. Over the period 1990-1994, the extensive margin of trade has contributed to additional 10.341% increase in welfare gains from trade integration in Latvia. These findings suggest that the true gains from trade integration in the CEE after the fall of the *iron curtain* are likely to be higher than it is usually assumed.

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