The Gains from Import Variety in Two Globalisations: Evidence from Germany*

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Abstract

What are the gains from trade today compared to those in the globalisation hundred years ago? To answer this question I rely on Krugman's (1980) idea that consumers value growing import variety, and very granular German product-level data from the first globalisation (ahead of World War I), and today. First, I derive structural estimates of the elasticity of substitution at the product-level for both globalisation episodes. I find substantial heterogeneity in terms of how elastic demand over goods and their varieties is, especially when compared over the long run. The median elasticity is 3.8 in the first globalisation, but only 2.5 in the second. This suggests that demand was more elastic in the first globalisation. Second, I use these estimated elasticities and calculate the consumer gains from growing import variety ahead of World War I and for today. The welfare calculations suggest that the gains from trade in the first globalisation are twice as much as today. Welfare turns out much lower—falling down to a fifth of the benchmark—when using non-contemporary, that is, inadequate elasticities. Simply taking one single elasticity or a set of ahistorical elasticities can be easily misleading because gains from international trade as well as the effects of changes in trade costs may be wrongly captured.

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1 Introduction

' [I]mports, not exports, are the purpose of trade.
That is, what a country gains from trade is the ability to import things it wants.'
— Krugman (1993, p. 24)

Globalisation is nothing new. Until the outbreak of World War I economies around the world found themselves in a process of integration that invites comparisons to today (e.g. Baldwin, 2016; Bordo, 2017). This integration process restarted after World War II and has led to the world economy we live in today. However, rising populism, both now and then, are—at least in part—fuelled by scepticism if not outright hostility to the international division of labour (Ferguson, 2016). Just witness the failed implementation of the Transatlantic Trade and Investment Partnership in which public protest played an essential role. This begs a classic question for trade economists as well as economic historians: What are the gains from all that integration in these two episodes of globalisation?

While there are numerous ways by which globalisation can cause welfare gains or losses, many are rather hard to capture. Recent studies emphasise job creation—or rather: destruction (e.g. Autor *et al.*, 2013). One of the more tractable ways of getting hold of the benefits of economic integration to consumers is the idea that the expanding variety of a good yields gains from trade because consumers value variety (Krugman, 1980). That is, in a monopolistically competitive world, consumers prefer to have some choice over different versions of the same good. In the following, I operationalise this idea using a standard assumption in the analysis of international trade: Every country makes things slightly different from those made by other countries (Armington, 1969). That is, suppliers differentiate within the products they produce. This is the starting point of this paper.

Based on the idea of national product differentiation and an international trade model with monopolistic competition, I provide an estimate of the gains from trade in two episodes of globalisation. I focus on Germany, a key player in both episodes. My estimates rely on very detailed data from the early twentieth and early twenty-first century that resemble the universe of Germany's imports, capturing quantities and prices as well as all import sources. With this data, I follow theory very closely and calculate a particular margin of the gains from trade: the consumption gains, as Arkolakis *et al.* (2012) call them.[1] I measure these gains by differentiating between how an exactly measured price index would move with and without changes in variety of a given set of imported goods. This is Feenstra's (1994) approach, which has been refined, among others, by Broda and Weinstein (2006). To perform such calculations, I need a measure of substitutability of goods between different source countries that indicates how elastic demand is for a given good, and on the aggregate level, how elastic import demand generally is. Therefore I estimate elasticities of substitution—a key parameter in many studies of international trade and international macroeconomics—for all goods at various levels of aggregation within the Standard International Trade Classification (SITC) for both episodes of globalisation, using Soderbery's (2015) limited information maximum likelihood (LIML) estimator.

My findings based on Germany's globalisation experience contribute to various branches of the literature. Estimates of good-specific elasticities of substitution suggest that there is substantial heterogeneity in terms of demand elasticity, over goods and their varieties—especially when compared over the long run. The median elasticity is 3.8 in the first globalisation, but only 2.5 in the second. To put this difference in perspective: In Krugman's (1980) model, which I will use to evaluate welfare, these elasticities translate to median mark-ups of 35 percent in the first globalisation but about 66 percent today. This suggests that demand was significantly more elastic in the first globalisation, and it shows that the structure of demand is not easily approximated by using one uniform elasticity of substitution. Both the time horizon as well as the set of trade partners matter. Based on these estimated elasticities, this article is the first that provides an estimate of the general consumer gains from growing import variety for the 'first globalisation'. The welfare calculations suggest that the gains from trade in the first globalisation are twice as much as today. Welfare turns out much lower—falling down to a fifth of the benchmark—when using non-contemporary, that is, inadequate elasticities. More strikingly, welfare gains turn out much lower—falling down to a fifth of the benchmark—when elasticities are used that do not actually originate in the data, say if modern-day elasticities are used in an historical application. This implies that simply taking one single elasticity can

[1] Note that new varieties can not only drive down consumer prices, but also raise productivity and promote innovation (as Goldberg *et al.* 2010 or Antràs *et al.* 2017 show), while disappearing products may cause the opposite.

easily be misleading in that gains from international trade as well as the effects of changes in trade costs may be underestimated.

This article proceeds as follows. Section 2 relates this study to previous literature. Section 3 lays out the theoretical foundation for the analysis. Section 4 describes the data. Section 5 presents the estimation strategy. Section 6 contains and discusses the results. Section 7 concludes.

2 Contributions

The number of papers that study the consumer gains from trade in modern globalisation is growing, initiated most notably by Broda and Weinstein (2006) for the United States; see Arkolakis *et al.* (2012) or Costinot and Rodríguez-Clare (2014) for surveys. The economic history literature, however, is almost mute on welfare gains from trade. Bernhofen and Brown (2005) use the unique case of Japan which was forcedly 'opened up' to trade in the mid nineteenth century. Within a comparative advantage framework they find gains from engaging in trade compared to autarky equal 8 to 9 percent of Japanese GDP. Hersh and Voth (2009) consider the entry of colonial goods to the English consumption basket since late fifteenth century. They find that adding goods such as tea, coffee and sugar is worth 10 percent of the average income. Costinot and Donaldson (2016) use detailed US agronomic data from 1880 to 1997 in a Ricardian framework to calculate price wedges for agricultural goods. They find long-run gains from US market integration that are similarly high as those of productivity gains over that period. De Bromhead *et al.*'s (2016) study of interwar Britain is the most related article to the present paper. Their focus, however, is trade policy not welfare. But their findings suggests a strong correlation between the elasticity of substitution and British trade policy during the Great Depression.

Other than that, however, the economic historiography of international trade has only started to explore very rich, disaggregated data (Meissner, 2015). These papers have moved the extensive margin of international trade into focus, that is, entry and exit of goods or industries. The extensive margin also includes the 'new goods margin', but all these papers explore the extensive margin typically in terms of export growth and its decompositions. In this paper I consider the ’new goods’ margin from a the import side using the universe of available goods, observed in import records. Against this background, the contribution of this paper is an estimate of how much consumers may have gained from the first globalisation hundred years ago.

This paper also contributes to the debate about the elasticity of substitution (σ) in both international trade and macroeconomics (Feenstra *et al.*, 2017; Redding and Weinstein, 2017). The elasticity of substitution determines the relative demand response to relative international prices which makes it key to understanding many features of the global economy. Feenstra *et al.* (2017, p. 1) summarise the status quo noting ’despite ever-expanding body of empirical study, there remains substantial uncertainty about the appropriate elasticity values to apply to different research and policy questions.’ Various empirical approaches to identify this elasticity exist, but the debate over the ’international elasticity puzzle’ Ruhl (2008) continues. Imbs and Mejean (2017), for instance, show that elasticities already at the three-digit level vary greatly across countries. In earlier work they argue that aggregate data ’constrain away’ microeconomic heterogeneity in trade elasticities (Imbs and Mejean, 2015). Bas *et al.* (2017) also argue that much more *micro* data is a key to the quantification of aggregate trade elasticities. Above that, Soderbery (2010, 2015) shows that estimates of the elasticity of substitution obtained with the widely used estimation procedure of Feenstra (1994) are biased upwards (a circumstance also relevant to this paper, since I will use Soderbery’s (2015) refined version of the Feenstra method).

All this matters also for historical applications and the longer run. There are only very few historical assessments of this elasticity, and if so they typically focus on particular goods only. Irwin (2000), for instance, estimates the elasticity of substitution of pig iron for the late nineteenth century. No study, however, exists that estimates these elasticities systematically for the first globalisation. I provide evidence that these elasticities vary substantially, not only across goods but also within the same product category across time, that is, in the long run.

Put differently, good-specific elasticities of substitution may not be very stable over the long run. Simply taking one single elasticity or a set of ahistorical elasticities can be misleading because gains from international trade as well as the effects of changes in trade costs may be wrongly captured. This, in turn, yields another novel insight. Using the distribution of elasticities based on German data, I show that import demand was much more elastic than it is today. This may be explained by increased specialisation within rather than across goods today (Schott, 2004; Hungerland and Wolf, 2017) and, more broadly, by a significantly more differentiated set of products. This observation directly contributes to the debate on the question of how different globalisation was then and now (Baldwin, 2016; Bordo, 2017).

The widely used gravity model also hinges on the elasticity of substitution as a parameter. In this model, the extent to which frictions to trade matter negatively correlates with sigma. That is, the more elastic demand for a good is, the less supplier-specific trade costs matter, assuming that there is more than one supplier and trade costs vary between them. Chaney's (2008) gravity model, for example, predicts that the elasticity of substitution steers the effect of trade costs. When goods are highly differentiated, that is, when they command rather low elasticities, the demand for such goods is relatively insensitive to changes in trade costs. However, due to the lack of estimated demand elasticities, many studies rely on adhoc elasticities taken from elsewhere. This holds particularly for historical applications. (Jacks *et al.*, 2011) estimate long-run trade costs from 1870 to 2000; their results vary by up to third of the benchmark when assuming different elasticities of substitution, along with substantial differences in estimated trade levels. Also in other gravity applications, sigma is at least part of a key parameter.[2] Anderson and van Wincoop (2004, p. 727) summarise the role of the elasticity of substitution for the interpretation of gravity models noting that '[t]here is confusion in the literature about whether one should use elasticities based on aggregate data or disaggregate data when interpreting estimation results based on aggregate data', and suggest that 'one should choose elasticities at a sufficiently disaggregated level at which firms truly compete.' Against this background, particularly the historical elasticities of substitution I estimates that may serve a benchmark a bit closer to the truth than previously assumed elasticities.

[2] The term $(\sigma - 1)$ corresponds to the Fréchet parameter θ in the trade costs in Eaton and Kortum (2002). For his gravity application, Chaney (2008) estimates $\gamma/\sigma-1$ where γ is the Pareto parameter. Felbermayr *et al.*'s (2018) use a Melitz-type model and explore the relation between trade and wage inequality. Their benchmark results rely on calibrations assuming $\sigma = 4$, but the effects they find change partially substantially if this parameter is set to different values.

3 Theory

This section lays out the monopolistic competition model of international trade by Broda and Weinstein (2006) from which the good-specific elasticity of substitution will be derived. The exposition includes parts of Feenstra (2016) and comes in a slightly different notation to adhere notation in other chapters of this thesis. Suppose D_t is a composite domestic good and M_t is a composite imported good with the elasticity of substitution $\kappa > 1$ between imports and domestic production. The upper level utility is then

$$U_t = \left(D_t^{\frac{1}{\kappa}} + M_t^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}. \tag{1}$$

The composite imported good is defined as

$$M_t = \left(\sum_{k \in K} M_{kt}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}, \tag{2}$$

where M_{kt} is the sub-utility coming from the consumption of imported good k in time t with the elasticity of substitution $\gamma > 1$ between all imported goods K.[3]

Imports of good k are differentiated across supplying countries $i \in I$ with I being the country space. That is, each trade partner of Germany exports a different variety of the good in question. This is Armington's (1969) assumption of national differentiation. It implies that the gains from trade measured in Section 6 are the gains from greater import variety of that good across source countries.[4] Against this background, $K_t \subset I$ is the subset of all varieties of k imported in t. Utility on the goods-level is captured with q_{ikt} denoting the consumption of variety i of good k in period t at price p_{ikt}, so that

$$M_{ikt} = \left(\sum_{k \in K_t} a_{ikt}^{\frac{1}{\sigma_k}} q_{ikt}^{\frac{\sigma_k-1}{\sigma_k}} \right)^{\frac{\sigma_k}{\sigma_k-1}}, \tag{3}$$

[3] The requirement of elasticities needing to be greater than one ensures that utility is concave over goods. That is, when $\sigma_k > 1$, welfare gains from having new varieties are finite, and thus measurable. In other words, the assumption is that all goods are substitutes to some degree. It also applies to the good-specific elasticities, σ_k, below.

[4] Benkovskis and Wörz (2014), for instance, relax this assumption, allowing the set of products and unobserved taste and quality parameter to vary. This, however, requires much more granular data than I have at hand.

with the elasticity of substitution between varieties of the same good $\sigma_k > 1 \quad \forall \quad k \in K$,[5] and $a_{ikt} > 0$ being taste parameters that may change over time, for instance due to the quality of a product. Demand per good may vary because the taste parameters can differ across goods. That is, good-specific utility is a non-symmetric CES function.[6] From equation 3 an exact price index can be derived for every single CES aggregate good k and all its varieties i. The price index is *exact* because it accounts for both new varieties and taste or quality changes in already imported goods.

To obtain one unit of utility in equation 3, the minimum expenditure is[7]

$$e\left(p_t, K_t\right) = \left(\sum_{k \in K_t} a_{ikt}^{\sigma_k} p_{ikt}^{(1-\sigma_k)}\right)^{\frac{1}{1-\sigma_k}}. \tag{4}$$

The expenditure function $e\left(p_t, K_t\right)$ captures living costs. It is the theoretical price index for the CES function – theoretical because we do not observe $a_{k,t}$.

The ratio of expenditure functions over time measures the change in utility. The first step is to consider only the case where there is no change in the set of goods consumed, i.e. there is no change in variety. Sato's (1976) and Vartia's (1976) works give the price index P^{SV} to measure the ratio of expenditures under that condition:

Theorem 1 (Sato 1976; Vartia 1976) *If the set of available goods is fixed at $K_{t-1} = K_t = K$, taste parameters are constant $a_{kt-1} = a_{kt}$, and observed consumption is assumed optimal for the prices and utility, i.e. $c_{kt} = U_t\left(\frac{\partial e}{\partial p_{kt}}\right)$, then*

$$\frac{e\left(p_t, K\right)}{e\left(p_{t-1}, K\right)} = P^{SV}\left(p_{t-1}, p_t, q_{t-1}, q_t, K\right) \equiv \prod_{k \in K}\left(\frac{p_{kt}}{p_{kt-1}}\right)^{w_k(K)} \tag{5}$$

[5] Note that with many goods the elasticity of demand is approximately equal to the good-specific constant elasticity of substitution σ_k Feenstra (2016). See also footnote 3.

[6] That means this model abstracts from potential implications of the Marshall's (1920) second law of demand: The longer the time allowed to adjust the quantity demanded for a commodity in response to a price change, the greater the price elasticity. Functional forms other than the Dixit-Stiglitz CES utility come with elasticities that can vary in time, and thus may offer more flexibility.

[7] Note that the functional form requires marginal costs to be fixed.

where the weights $w_k(K)$ *are constructed from the expenditure shares* $s_{kt}(K) \equiv \frac{p_{kt}q_{kt}}{\sum_{k\in K} p_{kt}q_{kt}}$ *as*

$$w_k(K) \equiv \frac{\left(\frac{s_{kt}(K)-s_{kt-1}(K)}{\ln s_{kt}(K)-\ln s_{kt-1}(K)}\right)}{\sum_{k\in K}\left(\frac{s_{kt}(K)-s_{kt-1}(K)}{\ln s_{kt}(K)-\ln s_{kt-1}(K)}\right)} \tag{6}$$

The price index P^{SV} is basically the ratio of expenditure functions. It is an 'exact' price index because it uses observed prices and quantities as a weighted geometric mean of the price ratios, with the weights of equation 6. The key implication of the theorem is that goods with high taste parameters b_k will also tend to have high weights. So even without knowing the true b_ks, the exact ratio of expenditures is obtainable. The numerator in equation 6 is the logarithmic mean of the shares $s_{kt}(K)$ and $s_{kt-1}(K)$, while the denominator makes the weights $w_k(K)$ sum to 1. The special formula for these weights in equation 6 is necessary to precisely measure the ratio of unit-expenditures in equation 5.[8]

The second step is to augment the price index P^{SV} with the change in variety. If variety changes, $e(p, K)$ captures the expenditure on the common set of goods only. Formally, $K \subseteq K_{t-1} \cap K_t \neq \emptyset$. That is, the sets of goods changes from one period to another, while some goods will be consumed in both periods, reflected in the last inequality. To correct the price index from equation 5 for the entry of new varieties or the ceasing imports of old ones, Feenstra's (1994) theorem comes into play.

Theorem 2 (Feenstra 1994) *Assuming that* $a_{kt-1} = a_t$ *for* $k \in K \subseteq K_{t-1} \cap K_t \neq \emptyset$, *and that observed quantities are optimal, then for* $\sigma_k > 1$

$$\frac{e\left(p_t, K_t\right)}{e\left(p_{t-1}, K_{t-1}\right)} = P^{SV}\left(p_{t-1}, p_t, q_{t-1}, q_t, K\right)\left(\frac{\lambda_t(K)}{\lambda_{t-1}(K)}\right)^{\frac{1}{\sigma_k-1}} \tag{7}$$

where $\lambda_t(K)$ *and* $\lambda_{t-1}(K)$ *are constructed as the product variety formula*

$$\lambda_r(K) = \left(\frac{\sum_{k\in K} p_{kr}q_{kr}}{\sum_{k\in K_r} p_{kr}q_{kr}}\right) = 1 - \left(\frac{\sum_{k\in K_r, k\notin K} p_{kr}q_{kr}}{\sum_{k\in K_r} p_{kr}q_{kr}}\right) \tag{8}$$

[8] Feenstra (2010) points out, however, that the weights are practically very similar to other intertemporal weights such as the Törnquist price index or simply s_{kt} or s_{kt-1}. See also Feenstra (2016, p. 127, footnote 12).

where $r = t, t-1$.

The ratio $\lambda_r(K) \leqslant 1$ is the expenditure on goods in the common set K relative to total expenditure in period r. When consumers spend more on new goods in period t than on disappearing goods from period $t-1$, then living costs fall by $\lambda_t(K)/\lambda_{t-1}(K) < 1$ through more variety. As varieties appear and disappear, the λ_k-ratio adjusts the price index to account for consumer valuation of these varieties. The *corrected* λ-ratio is the λ_k-ratio adjusted for consumer love of varieties of a given good by rising it to the power of $1/\sigma_k - 1$. Broda and Weinstein (2006) call this lambda ratio the 'aggregate import bias', and in the following I will do so too. The price index for the constant import basket K only requires to observe consumption. Hence, it does not depend on taste or quality parameters; their impact is captured in the realised consumption.[9]

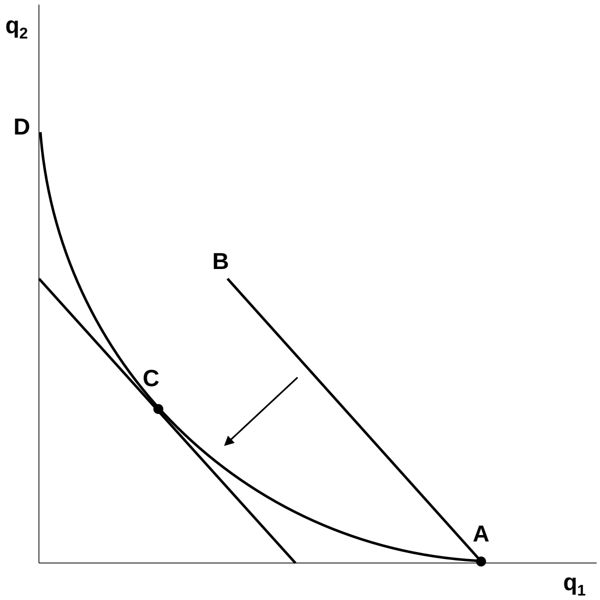
The question, however, is by how much living costs fall. The answer depends on the size of this bias and the elasticity of substitution σ_k.[10] This parameter governs the size of the effect of changing variety on welfare via Feenstra's (1994) bias term $(\lambda_t(K)/\lambda_{t-1}(K))^{\frac{1}{\sigma-1}}$ according to equation 7. It de- or inflates the exact but uncorrected import price index P_k^{SV} for good k. Figure 1 shows why σ_k is so important: Consider the consumption (q) of one vs. two goods. Consumers minimise their expenditure necessary to obtain utility on the indifference curve $\overline{AD}$. If only good 1 is available, then A on the budget line $\overline{AB}$ is chosen: All budget is spent on q_1. With good 2 available, consuming the bundle (q_1, q_2) at point C yields the same utility. The inward movement of the budget line reflects the above-mentioned reduction of living costs. How far the budget line—that is, living costs—drop(s) when a new good is introduced depends on the convexity of the indifference curve, or in other words: the elasticity of substitution. Note that in turn, if goods with low substitutability break away or become more expensive, the welfare losses are particularly big.[11]

[9] Which means that the model only implicitly accounts for import constraints or frictions.

[10] In standard comparative advantage models that use a continuum of goods, consumers are indifferent between varieties as long as price does not vary. That is, on the goods level, the elasticity of substitution between varieties is infinite in these models (Broda and Weinstein, 2006).

[11] To illuminate how σ_k works further, Appendix A presents scenarios of how the bias term corresponds to varying levels of substitutability between varieties of a good.

Figure 1
A New Good and the Elasticity of Substitution



Source: Feenstra (2016).

With all exact good-specific price indices that allow for both new varieties and taste or quality changes in already active trade relations, an exact import price index following Broda and Weinstein (2006) can be aggregated to that of one CES import good.

Theorem 3 (Broda and Weinstein 2006) *When* $a_{kt-1} = a_t$ *for* $k \in K \subseteq K_{t-1} \cap K_t \neq \varnothing$ *and* $\sigma_k > 1$*, then the exact aggregate import price index including variety change is*

$$\prod^M (p_t, p_{t-1}, q_t, q_{t-1}, K) = CIPI(K) \prod_{k \in K} \left(\frac{\lambda_{kt}}{\lambda_{kt-1}} \right)^{\frac{w_{kt}}{\sigma_k - 1}} \tag{9}$$

where

$$\prod_{k \in K} \left(P^{SV}(K_k)^{w_{kt}} \right) \tag{10}$$

is the aggregate conventional import price index (CIPI) and w_{kt} *are log-change ideal weights.*

This aggregate index improves prior work for three reasons (Broda and Weinstein, 2006). First, it allows for changes in quality or taste. Second, it allows for heterogeneity in goods-level demand responses due to different elasticities of substitution over goods. This eliminates the 'symmetry bias' arising from the assumption of perfectly interchangeable goods. Third, it is robust to the creation or destruction of goods. The measurement and inter-periodical comparison of this aggregate bias is the focus of the following sections. Eventually, the overall price index

$$\prod = \left(\frac{p_t^D}{p_{t-1}^D}\right)^{w_t^D} \left(\prod^M\right)^{w_t^M} \tag{11}$$

with log-change ideal weights w_t, will be used to obtain measure of welfare change due to changing variety.

4 Data

4.1 Sources

The empirical base for what follows is a combination of modern and historical data – data from two different episodes of globalisation. The first globalisation was characterised by industrialisation of the Western world and its offshoots and rapidly increasing cross-border integration driven by technology such as steam. Today's globalisation is rather underpinned by de-industrialisation, at least in many Western economies.[12] The exchange of goods (as well as services, money, people and ideas) has been fostered by technological progress such as the spread of the internet as well as by efforts to reduce political barriers to trade, mirrored in the foundation of the World Trade Organisation in 1995. The beginning of World War I marks the end of the first episode while the end of World War II is the start of the second globalisation.

For getting hold of the welfare gains from growing import variety, aggregate trade flows must be disaggregated down to the product level in a intertemporarily comparable way. But arranging the historical data so that it is comparable to modern trade statistics is not straightforward. The key problem is that historical product categories come in unstandardised. The classification of goods changed regularly. Luckily, historical German trade data is, comparatively, highly disaggregated. This allows re-classifying the historical trade data according to the Standard International Product Classification (SITC), revision 4. Chapter **??** shows how this was done for the historical German data underlying this paper. The result is the most detailed his-

[12] The terms first and second globalisation are very crude. Some authors such as Baldwin (2016) argue that today the world economy actually experiences its third globalisation. In relation to that the start and end of these periods vary from study to study.

torical dataset on Germany's foreign trade so far; it resembles the universe of the historical German trade data ahead of World War I, both in terms of product categories as well as trade partners. Chapter **??** presents more details of this data.[13]

Modern trade data comes from Eurostat (2017) in both quantities and values observed annually with all available trade partners at the SITC five-digit level. One problem the modern trade data brings with it is that some import sources as well as product categories in modern trade data are unreported – or rather: classified because triangulation would reveal sensitive information.[14]

Well aware of much finer disaggregations available for modern data, I do not use these in order to maintain comparability with the historical data. Of course, more granular trade data—say at the ten-digit or even firm level—enables other studies to find more precise measures of welfare. Such data is, however, often not available for periods before the year 2000. Using historical data basically prohibits further disaggregation. Yet even five-digit goods are far from perfect substitutes over Armington-varieties. It is thus important to stress that the present paper does not seek to revise previous estimates of the elasticity of substitution or calculations of the gains from variety that rest upon finer levels of disaggregation. The interest of this paper is the substitutability between products in two episodes of globalisation compared. And regarding data from the first globalisation, the data I use here is the best data available.[15]

The country dimension deserves a remark as well. The historical German trade data records 96 trade partners while the modern German trade statistics list 234 countries as (potential) import sources. Because I use the Armington-differentiation of goods to generate variety, it is important to rule out that differences in the comparative results are driven by differences in

[13] Handling historical data within the SITC framework was not perfect, of course. In some cases, an original product category was too broad to be assigned to an five-digit code. As explained in Chapter **??** in great detail, such categories therefore only received a higher order SITC code. For every SITC level the original product category did not fit, the items received a '+' to give them a five-digit code, if plausible. For instance, the original product category '*Nicht anderweitig genannte lebende Tiere*' (Kaiserliches Statistisches Amt, 1914), i.e. live animals not elsewhere specified received the SITC code 001++ ('live animals other than animals of division 03'). However, most original categories were indeed assignable to an SITC five-digit category, as the shares presented in table D10 in the appendix shows. Preparing the data in this way allows maintaining as much as possible of the informative hierarchy if the SITC system.

[14] Imports from classified sources amounts to some 3.5 percent of total imports, and it occurs in all SITC sections. On the implications of this for estimations, see footnote 33, footnote 19 and footnote 33.

[15] Bonigen and Soderbery (2010) use import data that differentiates between different brands of a single good (cars, in their case) and provide evidence that variety growth is likely to be underestimated with the type of trade data the present article uses.

the country space. I take care of these differences by estimating elasticities of substitution and calculating the lambda-ratios for the modern import data on both the country space of today as well as using the country space of 1913. Aggregating the country space of today to that of 1913 means that 234 countries are pooled to 96.

Such aggregation introduces some imprecision due to the fact that 1913-countries did not just fragment, but sometimes experienced border re-alignments. Moreover, Poland, today an important supplier of intermediates to German industry, is entirely excluded from the 1913-country space – and thus from the variety set. The reason is that Poland was divided in parts that belonged to Austria-Hungary, the German Empire and the Russian Empire. Above that, all potential effects of changing borders on economic activity—as highlighted, for instance, by Wolf *et al.* (2011)—have to be assumed away. The data prohibits all but to 'add up' modern polities. The biggest 'absorbers' of modern countries among the 1913-polities are the British West Indies (absorbing 18 modern polities), Rest of Polynesia (18), the Ottoman Empire (15), the Russian Empire (14), French Africa (10), British India (8), Austria-Hungary (7) and the Dutch West Indies (6).[16] Table D11 in the appendix lists the entire country space.

4.2 Descriptive Statistics

Germany's imports rose similarly in both episodes of globalisation, as figure 2 shows. Imports doubled or more in the periods 1885 to 1913 and 1995 to 2013. The baseline estimations in Section 5 rely on a subset of the data plotted in figure 2, starting in 1907 and 2007, respectively (indicated by the vertical lines in the graph). The data I analyse here starts in 1907 because before the quality of the unit values, with which I will proxy prices. In spring 1906, the German government implemented the Bülow tariff. The implementation of the tariff meant a significant change in how the statistical office recorded Germany's foreign trade. Most notably, from mid 1906 on the statistical office sought to actively maintain the variation in unit values in the actual shipments. Previously, the commission that set import unit values considered this practice as secondary, so that unit values from before 1907 are too artificial.[17]

[16] In a very few cases very small countries were simply included in the geographically dominating unit. For instance, Andorra was added to Spain or San Marino to Italy, respectively, in the 1913-country set.

[17] Note that historical trade data, especially imports, typically relies on estimated unit values set a by an official commission. In Germany, this practice was done until 1928. The commission of the statistical office

Figure 2
Imports, 1895-1913 and 1995-2013

Import values, deflated to 1913-marks and 2016-euros, respectively, then re-based to 100 in 1895 and 1995 respectively. Vertical lines mark time periods which are compared in Section 5. Source: Own calculations.

The end of estimation period is due to the beginning of World War I in 1914. Germany stopped reporting comparable import statistics from this year on throughout the war. For comparative reasons, I restrict the modern data to 2013 so that overall I look at variety changes over six years. This is also why the descriptives discussed in the following refer to this subset of the data.

The implication of using a sample of *only* six years, i.e. a rather small time span covered, is that we would not assume too much change in variety.[18] Nonetheless, the rise in Germany's imports in the two globalisation episodes has been accompanied by a rise in imported varieties. Table 1 gives an overview of the extent of this increase in both periods along the extensive margin. Recall that a good (k) is defined as a five-digit item and a variety of k, i_k, is defined as the import of k from a particular country i. Column (1) of table 1 reports the number of goods for which there was active trade while column (2) reports the total number varieties imported in a given year. In 1907 Germany imported 10,157 varieties of 907 goods

consisted of up to 140 experts that regularly consulted with industry representatives and customs authorities. Hoffmann (1965, p. 571-573) has still the most comprehensive discussion of this and concludes that after 1906, import prices are subject to meaningful cross-country variation. See also Chapters **??** and **??** for details.

[18]Section 6 takes the discussion of this further.

sourced from an average of 16.4 countries, while in 1913 there were 11,023 varieties of 902 goods sourced from an average of 17.9 countries. This yields variety growth of 8.5 percent.

A century later, the amount of imported varieties is, expectedly, much larger in absolute numbers. Germany imported 88,323 varieties of 2,940 goods from an average of 39.3 countries in 2007 and 92,332 varieties of 2,954 goods from an average of 40.9 countries in 2013. In relative terms, this increase is smaller; a bit more than 4 percent – and thus half of the variety growth in the first globalisation. The very small change in the number of goods compared to the change in the number in variety underscores the importance of differentiating between goods and their varieties. Using the country borders of 1913 means reducing the country-set by almost 60 percent. With this country set, the numbers turn out smaller, both in absolute and relative terms: The absolute number of varieties shrinks by roughly 30 percent compared to the 2013-country set, and within 1913-borders, modern Germany would have seen only 3 percent variety growth. However, the dramatic differences in the absolute numbers between the two episodes—even with 1913 borders—suggest that there are seven times more varieties today. This may reflect that, over the last century, structural change and reductions of trade costs have made it cheaper source products from a whole range of countries.

Columns (3) and (4) report the median and average number of countries exporting a good to Germany. These data support the substantial increase in the number of countries supplying a given good between periods—both numbers doubled over the last one hundred years, but only to a very small extent within the periods. When only considering the set of goods that were imported both at the start and end of each sample period ('common goods') versus those which were not, a more nuanced image emerges. Rows 3 to 6 of each panel in table 1 contain data on the set of common goods within each sample as well as on those goods that were newly imported or not imported any more at the end of the periods.

Table 1
Variety in German Imports in Two Globalisations

	Year	(1) Number of five-digit categories	(2) Number of varieties	(3) Median number of exporting countries	(4) Average number of exporting countries	(5) Share of total German imports
			First globalisation			
All 1907 goods	1907	907	10,157	13	16.4	100.0
All 1913 goods	1913	902	11,023	14	17.9	100.0
Common	1907	845	9,707	13	17.3	96.3
	1913		10,513	15	18.7	98.8
1907, not in 1913	1907	62	450	10	11.7	3.7
1913, not in 1907	1913	57	510	13	14.6	1.2
			Second globalisation			
All 2007 goods	2007	2,940	88,323 (67,986)	36 (27)	39.3 (28.1)	100.0
All 2013 goods	2013	2,954	92,332 (70,031)	38 (28)	40.9 (28.8)	100.0
Common	2007	2,912	88,196 (67,866)	36 (27)	39.5 (28.2)	97.1
	2013		91,940 (69,734)	38 (28)	41.0 (28.9)	93.9
2007, not in 2013	2007	28	127 (120)	7 (7)	6.7 (6.0)	2.9
2013, not in 2007	2013	42	392 (297)	26 (17)	23.0 (15.9)	6.1

Shares in column (5) in percent of total import value. Varieties are 'Armington', that is, varieties are country-good pairs. Parentheses indicate values for 1913-borders. Source: Own calculations.

Table 2
Major Sources of Variety, Ranked by the Number of Goods Supplied

Rank	1907-1913	2007-2013	2007-2013 with 1913-borders
1	France (5.2)	Netherlands (12.5)	Austria-Hungary (12.0)
2	UK and Ireland (9.3)	France (7.8)	Ottoman Empire (1.8)
3	Austria-Hungary (8.7)	Italy (5.5)	Russian Empire (4.2)
4	Netherlands (3.3)	Austria (4.3)	China (7.4)
5	Belgium (3.3)	Belgium (6.6)	Belgium (7.1)
6	Switzerland (2.1)	UK (4.8)	UK and Ireland (5.7)
7	United States (14.3)	United States (4.2)	Switzerland (4.0)
8	Russian Empire (15.2)	Switzerland (3.9)	British India (1.1)
9	Italy (2.9)	China (6.8)	Netherlands (12.5)
10	Denmark (1.8)	Spain (2.6)	Italy (5.5)
11	Sweden (1.9)	Poland (3.7)	France (7.8)
12	Norway (0.6)	Czech Republic (3.7)	United States (4.2)
13	Spain (1.5)	Denmark (1.4)	Spain (2.6)
14	Ottoman Empire (0.7)	Sweden (1.6)	Poland* (3.7)
15	British India (4.5)	Turkey (1.2)	Denmark (1.4)
16	Japan (0.4)	Japan (2.1)	Sweden (1.6)
17	Romania (1.1)	India (0.7)	Japan (2.1)
18	China (1.1)	Hungary (2.1)	Straits Settlements (0.8)
19	Dutch India (1.9)	Taiwan (0.6)	Korea (0.9)
20	Argentina (4.4)	South Korea (0.9)	Canada (0.4)

Import share in percent of total imports, pooled over period, in parentheses. Ranked according to the average number of five-digit goods imported by Germany from given country over respective period. * Poland was divided in parts that belonged to Austria-Hungary, German Empire and the Russian Empire. Source: Own calculations.

The number of varieties in the 'common' set of goods is fairly high. The ratio of new varieties to 'dying' varieties is 1.2 in the first globalisation, but 3.1 in the second (or 2.5. with 1913-borders). The vast majority of varieties was traded throughout the periods, but in relative terms the first globalisation saw a bigger increase in the number of new varieties, namely of 7 percent (versus a bit more than 1 percent in the second). Nonetheless, these new varieties command a bigger share of import value (6.1 percent) in the second globalisation than in the first (1.3 percent). For both episodes it holds that both new and disappearing goods were supplied by a smaller number of countries than the common goods.

Taken together, the data in table 1 suggest to expect two things when it comes to the gains from variety. First, we would not expect too much gains from variety in general because the short time periods simply limit the scope for great within-period changes. Second, net import expenditure on new goods is relatively small as share of total trade which also suggests that there are not too large gains from new varieties to be expected.

Table 2 breaks the data up by source country, ranked by the number of products exported to Germany and the shares of every country in total import value in parentheses. Unsurprisingly, the countries that export the most varieties to Germany tend to be large, high-income and geographically close economies. This is gravity at work. It also turns out that in one hundred years of globalisation there is not so much difference in the ranking of many countries. The biggest differences are that Russia and Argentina were relatively bigger sources of varieties then, while industrialising Asian import sources gained importance today. Another interesting nuance in the data presented in table 2 is that Austria-Hungary was one of the top two trade partners back then, but lost ground due to its disintegration after World War I: The mid panel—today's set of countries—of table 2 lists Austria, Czech Republic and Hungary separately, while the left- and right-hand panel—the set of countries in 1913—pools these and further polities under Austria-Hungary.

More generally, using modern trade data with the set of 1913-countries shows this 'empire disintegration' effect. The three Eastern empires—Russia, Austria-Hungary and Turkey—as well as China would supply the broadest range of products. This is for different reasons. Most former members of the double-monarchy are industrialised economies today supplying Germany with intermediates. Former members of the Russian Empire supply more energy than anything else. This also holds, by and large, for the Ottoman Empire. These observations point towards the fact that empires fell apart along the lines of economic specialisation.

Such findings support Schulze and Wolf (2009) and Wolf *et al.* (2011), who argue that national borders affect trade at the same time as trade affects borders. Note, however, that the value-based import shares of the 1913-countries do not perfectly correspond to the variety on offer. Most strikingly, the Ottoman Empire stands out. It would rank second with respect to the product range on offer, but the value of imports from this country would be much smaller, namely a mere 1.8 percent of all imports. The large product range combined with small import values is explained mostly by Israel: Then a part of the Ottoman empire, now an exporter of high-tech goods to Germany – but Israeli imports make up only a small share of total German imports.[19]

[19] This surprisingly small value share is in part also be due to the classification of the country space of the modern data, since it is very likely that among the 15 countries which constitute this artificial polity some are classified. More precisely, I find that one classified polity alone commands some 4.5 percent of Germany's im-

The importance of these countries for the growth in varieties available in Germany is, however, relatively less important, as table 3 shows. The table reports the contributions to variety growth, measured by the ratio of the net change in varieties between the start and end of each period under study from a given country to the change in varieties imported by Germany as a whole. It also reports the average share of imports from that a given country, weighted by log change ideal weights, but on the country level. While Germany's sources of new varieties were spread much more around the world in the first globalisation, the table shows that Eastern Europe is key in the creation of new varieties for Germany today.

port value, and another 2.1 percent. The same logic holds for the constructed import share of the Russian Empire in today's imports. See also footnote 14, footnote 33 and footnote 33.

Table 3
Countries' Contribution to Variety Growth and Import Shares

	1907-1913			2007-2013			2007-2013, with 1913-borders		
Rank	Supplier	C'bution	Import share	Supplier	C'bution	Import share	Supplier	C'bution	Import share
1	Romania	0.58	1.14	Romania	0.28	0.76	Romania	0.36	0.75
2	Sweden	0.48	2.00	Poland	0.20	3.68	Poland*	0.27	3.68
3	Ottoman Empire	0.47	0.63	Slovakia	0.20	1.29	Serbia	0.25	0.11
4	China	0.44	1.06	Serbia	0.19	0.11	Mexico	0.24	0.42
5	Spain	0.41	1.69	Lithuania	0.19	0.18	Bulgaria	0.24	0.23
6	Argentina	0.41	4.75	Mexico	0.19	0.42	British India	0.20	1.01
7	Norway	0.37	0.53	Bulgaria	0.18	0.23	French India	0.19	0.38
8	Finland	0.33	0.33	Latvia	0.17	0.07	Portugal	0.18	0.55
9	Japan	0.32	0.38	India	0.15	0.62	Ottoman Empire	0.15	1.84
10	Brasil	0.31	2.24	Vietnam	0.15	0.38	Russian Empire	0.15	4.15
	Total	8.53	14.73	Total	4.54	7.74	Total	3.01	13.11

Contributions are recorded in percent and measure country i's share in total variety growth $\left({(N_{iKt}-N_{iKt-1})}/{N_{Kt-1}}\right)$, where N is the number of varieties and total variety growth is $\left({(N_{Kt}-N_{Kt-1})}/{N_{Kt-1}}\right)$, from 1907 to 1913 and 2007 to 2013, respectively. Import shares are recorded in percent and equivalent to country-specific log ideal weights. These weights w_i are constructed from the expenditure shares $s_{it} \equiv {V_{it}}/{\sum V_{it}}$ where V_{it} is the total import value if country i in t so that $w_i \equiv \left(\frac{s_{it}-s_{it-1}}{\ln s_{it}-\ln s_{it-1}}\right)/\sum\left(\frac{s_{it}-s_{it-1}}{\ln s_{it}-\ln s_{it-1}}\right)$, see Section 3 for details, especially equation 6. * Note that Poland was divided in parts that belonged to Austria-Hungary, German Empire and the Russian Empire. Supplying countries are ranked according to size of contribution to variety growth. The shares reported do not sum to 100 because only the top ten variety contributors are shown. Source: Own calculations.

More generally, table 3 is dominated by rather small trade partners, when judging by their shares in total German imports (except Argentina then and Poland now). Moreover, the last row shows that Germany spent double the amount on new varieties from only the top ten sources in the first globalisation than in the second. This suggests that the dynamics in variety changes were bigger hundred years ago. Using 1913-borders for today does not change that. However, the former Asian colonies as well as the Ottoman and the Russian Empire equivalents turn out, expectedly, more important. It is also interesting to note that China is absent from the top ten variety generators today, and also that Romania was Germany's biggest contributor to variety in both globalisation episodes.

5 Estimating the Elasticities of Substitution

Equation 3 applies to the imports of varieties i of a single good $k \in K_t$ from the set of source countries I. To arrive at a measure of welfare due to changes in variety, Feenstra's (1994) λ-ratios (equation 8) must be calculated with a good-specific elasticity of substitution (σ_k) across countries. That is, each σ_k must be estimated separately. But without observing shifters in demand and supply multiple quantity-price relations make it hard to pin down the elasticities of demand and supply. Having more than one good complicates this because it is hard to find exogenous, i.e. instrumental variables that apply to all good-specific demand and supply equations.

This is why Feenstra (1994) developed an estimator that helps overcoming this problem. His generalised methods of moments (GMM) estimator uses the panel nature of the trade data, i.e. it exploits both variation over time and in the cross-section between trade partners of Germany. Previewing what is derived below more extensively, the estimator uses variety-, that is country fixed effects as instruments to identify the desired elasticities. The following describes the formal derivation of the estimation procedure based on Broda and Weinstein (2006) and Feenstra (2016).

Differentiating the expenditure function (equation 5) yields the share of expenditure on each variety i of good k

$$s_{ikt} = b_{ikt} \left(\frac{p_{ikt}}{q(p_t, K_t)} \right)^{1-\sigma_k}. \tag{12}$$

Using unit values instead of expenditure shares is problematic, especially in historical trade data, because unit values were often commission-set prices. Moreover, unit values in trade data are always prone to measurement error due to issues in recording or within-category heterogeneity. Using import shares rather than quantities makes handling measurement errors in unit values easier. Kemp (1962) argues that this adjustment controls for the error in quantities being correlated with unit values.

Taking natural logs and taking the difference over time, demand can be re-written as

$$\Delta \ln s_{ikt} = \phi_{kt} - (\sigma_k - 1)\Delta \ln p_{i,k,t} + \varepsilon_{ikt} \tag{13}$$

where $\phi_t \equiv (\sigma_k - 1)\Delta \ln q(p_t, K_t)$ is a fixed effect and $\epsilon_{ikt} \equiv \Delta \ln b_{ikt} \equiv \Delta \ln I_{ikt}$ is an error capturing shocks in tastes or a change in the number of products.

Supply varies in the amount of exports of each variety i of a good k, and is assumed to be

$$\Delta \ln p_{ikt} = \beta \Delta \ln q_{ikt} + \psi_{ikt} \tag{14}$$

where ψ_{ikt} is a random supply error.

Combining the above demand and supply equations eliminates quantity from supply so that a reduced form supply curve, or a price equation emerges:

$$\Delta p_{ikt} = \Psi_{kt} + \frac{\rho_k \varepsilon_{ikt}}{\sigma_k - 1} + \delta_{ikt} \tag{15}$$

with the parameters

$$\Psi_{kt} = \frac{\beta(\phi_t + \Delta \ln E_t)}{1 + \beta_k \sigma_k}$$

and

$$\rho_k = \frac{\beta_k(\sigma_k - 1)}{1 + \beta \sigma_k},$$

with $0 < \rho_k < 0$, total expenditure as $E_t = \sum_{i \in I_t} p_{ikt} \times q_{ikt}$, and the error term

$$\delta_{ikt} = \frac{\psi_{ikt}}{1 + \beta_k \sigma_k}.$$

There is, as noted above, a simultaneous equations problem. The demand error ε_{kt} in equation 13 is correlated with the price in the reduced supply curve (equation 15). That is, if demand moves outwards (e.g. if variety grows), the demand error grows and raises the price along the supply curve.[20] This rules out using OLS. Using instruments that are correlated with the expenditure share and price but uncorrelated with the errors in these equations would be an alternative – theoretically. Finding suitable IVs for all trade partners is hopeless.

Feenstra (1994) argues that the simultaneous equations problem can be overcome by exploiting the panel nature of the dataset. This requires assuming $E(\varepsilon_{ikt}\delta_{ikt}) = 0$, that is, that the unobserved disturbances ε_{ikt} with $k = 1, ..., I$ and δ_{jt} with $j = 1, ..., I$ are independent with zero mean and variances $\upsilon_{\varepsilon i}$ and $\upsilon_{\delta i}$, respectively. In other words: Demand and supply elasticities are constant and demand and supply errors uncorrelated at the variety level for all countries $i, j = 1, ..., I$ when good-time specific effects are controlled for.

To implement this assumption, Feenstra (1994) suggests to write the demand and supply equations 13 and 15 so that good-specific unobservable are eliminated. To do so, a reference variety c must be chosen to which the demand and supply equations have to be differenced against (first differences are denoted by Δ).[21] That is,

$$\begin{aligned} \widetilde{\varepsilon}_{ikt} &= \varepsilon_{ikt} - \varepsilon_{ckt} \\ &= (\Delta \ln s_{ikt} - \Delta \ln s_{ikt}) + (\sigma_k - 1)(\Delta \ln p_{ikt} - \Delta \ln p_{ckt}), \end{aligned} \tag{16}$$

and

$$\begin{aligned} \widetilde{\delta}_{ikt} &= \delta_{ikt} - \delta_{ict} \\ &= (\Delta \ln p_{ikt} - \Delta \ln p_{ckt}) - \left(\frac{\rho_k \widetilde{\varepsilon}_{ikt}}{\sigma_k - 1}\right) \\ &= (\rho_k - 1)(\Delta \ln p_{ikt} - \Delta \ln p_{ckt}) - \left(\frac{\rho_k}{\sigma_k - 1}\right)(\Delta \ln s_{ikt} - \Delta \ln s_{ckt}). \end{aligned} \tag{17}$$

[20] Standard gravity estimations of the elasticity of substitution assume good-specific supply curves implicitly to be horizontal, which bypasses simultaneity bias. This is a special case of equation 15 (Broda and Weinstein, 2006, equation 15). However, that means that one single elasticity is used across all goods and their varieties. Section 6.3 entertains this assumption and discusses the welfare implications.

[21] Note that choosing a reference variety means choosing a reference country for every good under the Armington assumption. Feenstra (1994) suggests that k should be selected on the criterion that it is sold every year and, when there are more than one candidates, the 'dominant' source country – Japan in his case. In the present application, using Soderbery's (2015) estimator, the reference variety is chosen automatically for every good separately based on the intensity of trade within every product category.

Feenstra (1994) shows that equations 16 and 17 can be multiplied and divided by $(1-\rho_k)(\sigma_k-1)$ in order to obtain one estimable equation. This yields

$$Y_{ikt} = \theta_{1,k} X_{1,it} + \theta_{2,k} X_{2,it} + u_{ikt}, \tag{18}$$

where

$$Y_{ikt} = (\Delta \ln p_{ikt} - \Delta \ln p_{ckt})^2, \tag{19a}$$

$$X_{1,ikt} = (\Delta \ln s_{ikt} - \Delta \ln s_{ckt})^2, \tag{19b}$$

$$X_{2,it} = (\Delta \ln p_{ikt} - \Delta \ln p_{ckt})(\Delta \ln s_{ikt} - \Delta \ln s_{ckt}), \tag{19c}$$

where the coeffcients are non-linear functions of σ_k and ρ_k

$$\theta_{1,k} = \frac{\rho_k}{(\sigma_k - 1)^2 (1 - \rho_k)}, \tag{19d}$$

$$\theta_{2,k} = \frac{2\rho_k - 1}{(\sigma_k - 1)(1 - \rho_k)} \tag{19e}$$

and the error is

$$u_{ikt} = \frac{\widetilde{\varepsilon}_{ikt} \widetilde{\delta}_{ikt}}{(\sigma_k - 1)(1 - \rho_k)}. \tag{19f}$$

The estimation equation is then the average of each of the variables 19a to 19f over time. That is,

$$\bar{Y}_{ikt} = \theta_{1,k} \bar{X}_{1,ikt} + \theta_{2,k} \bar{X}_{2,ikt} + \bar{u}_{ikt} \tag{20}$$

This is Feenstra's (1994) estimating equation. The variables are second moments of the data, i.e. the variances and covariances of the log differences of the varieties' prices and import shares. The error term in equation 20, u_{ikt}, is the cross-moment of the errors in the supply and demand curves, which are uncorrelated by the assumption made above. With $T \to \infty$, the error should vanish in its probability limit. Therefore running OLS on equation 21 is a consistent GMM estimator for $\theta_{1,k}$ and $\theta_{2,k}$ when $\bar{X}_{1,ikt}$ and $\bar{X}_{2,ikt}$ are not co-linear. To ensure this, the relative variance of the errors in supply and demand must be different. Put differently, some heteroskedasticity in the error terms for supply and demand across countries is necessary, so that

$$\frac{\upsilon_{\varepsilon ik}^2 + \upsilon_{\varepsilon ck}^2}{\upsilon_{\varepsilon jk}^2 + \upsilon_{\varepsilon ck}^2} \neq \frac{\upsilon_{\delta ik}^2 + \upsilon_{\delta ck}^2}{\upsilon_{\delta j,k}^2 + \upsilon_{\delta ck}^2}, \tag{21}$$

where i and j denote different varieties of good k and c is the reference variety. This requirement is realistic because supply errors vary with country-specific shocks while demand errors vary with taste or quality shocks. The nature of shocks, which causes heteroskedasticity in the errors of variety-specific, that is, country-specific errors of demand and supply is unlikely to be the same. This procedure is called identification through heteroskedasticity (Rigobon, 2003). Feenstra (2010, Appendix 2.1) demonstrates that using variety-, that is, country fixed effects in a country-product-time panel for equation 18 has an IV interpretation: Regressing $X_{1,ikt}$ and $X_{2,it}$ on variety fixed effects predicts the averages $\bar{X}_{1,ikt}$ and $\bar{X}_{2,ikt}$. That is, estimating equation 20 can be interpreted as the second stage of an IV estimation.

Fulfilling equation 21 is sufficient to ensure that OLS estimates of $\theta_{1,k}$ and $\theta_{2,k}$ in equation 20 are consistent. But efficient estimates require WLS. After a preliminary OLS estimation of equation 20, the inverse of the variance of the predicted errors in equation 18 is used to reweight the regression. This yields efficient estimates of the parameters in equation 20. Feenstra (1994) shows that the efficient estimates of $\widehat{\theta}_{1,k}$ and $\widehat{\theta}_{2,k}$ allow solving for the import demand and export supply elasticities $\hat{\sigma_k}$ and $\hat{\rho_k}$ – under a crucial condition: If $\widehat{\theta}_{1,k} > 0$, then

$$\text{(a)} \quad \text{if } \widehat{\theta}_{2,k} > 0, \text{ then } \hat{\rho_k} = \frac{1}{2} + \left(\frac{1}{4} - \frac{1}{4 + \left(\widehat{\theta}_{2,k}^2 / \widehat{\theta}_{1,k} \right)} \right)^{\frac{1}{2}}$$

$$\text{(b)} \quad \text{if } \widehat{\theta}_{2,k} < 0, \text{ then } \hat{\rho_k} = \frac{1}{2} - \left(\frac{1}{4} - \frac{1}{4 + \left(\widehat{\theta}_{2,k}^2 / \widehat{\theta}_{1,k} \right)} \right)^{\frac{1}{2}}$$

and in both cases

$$\hat{\sigma_k} = 1 + \left(\frac{2\hat{\rho_k} - 1}{1 - \hat{\rho_k}} \right) \frac{1}{\widehat{\theta_2}} > 1.$$

As $\hat{\theta_2} \to 0$, then $\hat{\rho} \to \frac{1}{2}$ and $\hat{\sigma} \to 1 + \widehat{\theta_1}^{\frac{1}{2}}$

There is, however, a problem when $\widehat{\theta}_{1,k} < 0$. When this is the case, estimates of σ_k and ρ_k lie outside the ranges $\hat{\sigma_k} > 1$ and $0 \leqslant \hat{\rho_k} < 1$. That is, infeasible elasticity estimates emerge. Broda and Weinstein (2006) use a grid search procedure to determine real, feasible estimates of the parameters of interest when this is the case.

Next to this problem, Soderbery (2010, 2015) shows that the Feenstra estimator is only consistent when there the time dimension is sufficiently large. With low T significant biases and infeasible elasticities can emerge; outliers receive too large weights.[22] To avoid bias and to handle estimations that yield $\widehat{\theta}_{1,k} < 0$, Soderbery (2015) develops a 'hybrid' or 'unified' estimator which combines limited information maximum likelihood (LIML) with a constrained nonlinear LIML routine to address small sample bias and correct grid search inefficiencies, respectively. Combining Leamer (1981) and Feenstra (1994), this approach relies on estimating bounds on the set of potential true estimates of supply or demand. Soderbery (2015) finds that the elasticities of substitution are overestimated when the above problems remain unaddressed. He argues that it is necessary to weight each country's hyperbolic relation between import and supply elasticities. Infeasible estimates are constrained with a non-linear LIML routine to the feasible regions. This is why I use Soderbery's (2015) estimation routine here, good by good.[23]

6 Results

The procedure follows Broda and Weinstein (2006). First, I calculate the λ_k-ratio for each good k as in equation 8. This quantifies how much variety within a give five-digit category changed. This gives the crucial parameter that tells how easily the German economy was willing to change suppliers of a good. Second, I obtain the elasticity of substitution, σ_k, by estimating equation 20 over its Armington-varieties. Third, I combine my estimates of σ_k with the λ_k-ratio per good. This yields an estimate of how much the exact corrected price index ($P^{SV}\left(\lambda_t(K)/\lambda_{t-1}(K)\right)^{1/\sigma_k - 1}$, equation 7) for good k changed due changing variety. Fourth, I aggregate the good-specific price movements weighted by log change ideal weights (equation 6).

[22] As noted above, unit values may introduce additional imprecision due to measurement error. Feenstra (1994) proves that this error can be controlled for by adding a constant in the estimating equation such that $Y_{ikt} = \theta_{0,k}X_{0,kt} + \theta_1 X_{1,ikt} + \theta_2 X_{2,ikt} + u_{ikt}$ where $\theta_{0,k}X_{0,ikt}$ is a vector of ones. See also Feenstra (2010, p. 25-27). Alternatively, Broda and Weinstein (2006) suggest allowing the measurement error to depend inversely proportionally on each variety's quantity sold and the number of periods. But due to better performance, Soderbery (2015) uses Feenstra's (1994) correction in his LIML estimator.

[23] Galstyan (2017) argues that applying the LIML estimator on too small panels may produce inconsistent results. Nonetheless, he concludes that the estimator is still more robust than any other available method given the data at hand.

This yields an corrected aggregate exact import price index which allows—together with aggregate import shares and GDP data—calculating welfare changes using equation 9.

6.1 Variety Growth

Let us start with variety growth. The λ_k-ratios measure variety growth more precisely than the count data— or: the extensive margin—in table 1, since they take the consumers' budget decision into account by using expenditure shares as weights. Recall that the more λ_k-ratio $<$ 1, the more expenditure is devoted to new varieties. [24]

Table 4 reports descriptive statistics for the λ_k-ratios of all goods used in the calculation of the aggregate price index.[25] The data indicate that the impact of new varieties was, expectedly, rather small, given that we look only at seven year-periods. More precisely, the median λ_k-ratio indicates that variety grew by roughly 1 percent in both periods. The outcome does not change when using the 1913 country space for the modern data, as the numbers reported in parentheses indicate. This is in line with the lambda-ratio of 0.99 by Mohler and Seitz (2012), who perform very similar calculations for Germany from 1999 to 2008. They find a lambda-ratio of very close to one also for other big EU economies. It is also not very far from Broda *et al.*'s (2017) calculation of a lambda-ratio for Germany of 0.95 from 1994 to 2003. Using counts to determine variety growth suggests stronger variety growth in both periods: 8.3 percent more variety (growth rate of 9 percent) during the seven years ahead of World War I and 4.3 percent more from 2007 to 2013 (growth rate 4.5 percent).

The results highlight the importance of using λ_k-ratios—more a measure of the intensive margin—rather than relying only on counts to measure variety growth. [26] When correctly accounting for the fact that new varieties often have smaller market shares the appropriate magnitudes of variety growth are substantially smaller. The observed variety growth is, however, still 'raw'.

[24] To moderate the effect of outliers I winsorise the λ_k-ratios at the 5th and 95th percentile. Bo and Jacks (2012), who apply Broda and Weinstein's (2006) method to Canadian data, classify λ_k-ratios as outliers when they are below 0.8 or greater than 1.07.

[25] The λ_k-ratio is undefined when there are no common varieties of the five-digit category between $t-1$ and t, i.e. $K_k = \varnothing$. This explains why the number of λ_k-ratios is smaller than the actually five-digit categories at hand: In some cases I had to aggregate the ratios to higher SITC levels.

[26] Depending on what it is compared to, the λ_k-ratio is also considered as part of the extensive margin (see for example Amiti and Freund, 2010).

Table 4
Descriptive Statistics of the Lambda-Ratios

Period	Statistic	λ_k-ratio	Implied by count
1907-1913	5th percentile	0.749	0.917
	Median	0.999	
	95th percentile	1.120	
	N	673	
2007-2013	5th percentile	0.861 (0.903)	0.957 (0.970)
	Median	0.999 (0.999)	
	95th percentile	1.182 (1.154)	
	N	2558	

λ_k-ratios according to equation 8 with import values in respective years. Implied count = $^{N_{it-1}}/_{N_{it}}$ with N being the number of varieties in t as in column (4) in table 1. Results based on 1913-borders in parentheses. Source: Own calculations.

The 1 percent variety growth does not directly imply an increase in consumer welfare because the extent to which varieties are substitutes for each other needs to be taken into account. As noted above, it is the elasticity of substitution which governs this effect.

6.2 Elasticities of Substitution

I now turn to the estimation of the elasticities of substitution based on equation 20. The estimations were conducted at various levels of aggregation of good k.[27] Given the thousands of elasticities I estimate, I refrain from reporting all results in detail but present summarising observations.[28]

The first result is that the elasticities are very differently distributed in the two episodes of globalisation. Figure 3 plots the distributions of the elasticities at the five-digit level. It shows that import demand in the first globalisation is much more skewed to the right than that of

[27] The historical data recorded trade flows not only in tons but in part also in pieces or barrels etc. Estimations were performed separately for unit-specific trade flows per good. The estimated elasticities are trade-weighted averages over different units of the same good.

[28] I provide all estimated elasticities at the three-digit level in table D12 in the Appendix. Broda *et al.* (2017) note that it is unlikely that all of the estimated variety effects are reasonable since they are derived from tens of thousands individual estimates. Like Broda and Weinstein (2006), who truncate their estimated elasticities at $1.05 < \sigma_k < 131.5$, I truncate the estimated sigmas at 1.05 and 100 except when reporting the descriptive statistics.

the second globalisation.[29] In other words, import demand was much more elastic than it is today.[30]

That Germany's import demand is less elastic than today may be explained by increased specialisation within rather than across goods today (Schott, 2004; Hungerland and Wolf, 2017) and, more broadly, by a significantly more differentiated set of products. Witness that there was active trade in roughly 900 SITC five-digit items during 1907-1913, but around 2950 in 2007-2013 (see table 1. This suggest that the sorting of skill-intensive industries to high-wage nations and labour-intensive industries to low wage nations is much more advanced today (Baldwin, 2016). International value chains dominate much of the world economy in the present globalisation, but were almost absent in the globalisation ahead of World War I. So when we are looking at international trade in the first globalisation, we are looking at trade primarily in final goods.

In contrast, today the production of a final good often involves the assembly of multiple previously imported intermediates. Ossa (2015) finds that demand for the average intermediate is rather elastic, but some industries run on so specific imported varieties that make the entire industry heavily dependent on certain imports, which mirrors in small sigmas, i.e. a rather inelastic import demand. He concludes that while imports in the average industry do not matter too much, imports in some industries are critical to the functioning of the economy. Put differently, these elasticities are also a measure of how vulnerable an economy is in terms of its suppliers. Below I will take a closer look on selected industries, but the bottom line is: Using single elasticities to capture an economy's position in the world economy may easily be misleading.

Table 5 reports more detailed descriptive statistics that confirm this impression. The median elasticity is 3.8 in the first globalisation, but only 2.5 in the second. As indicated above, using

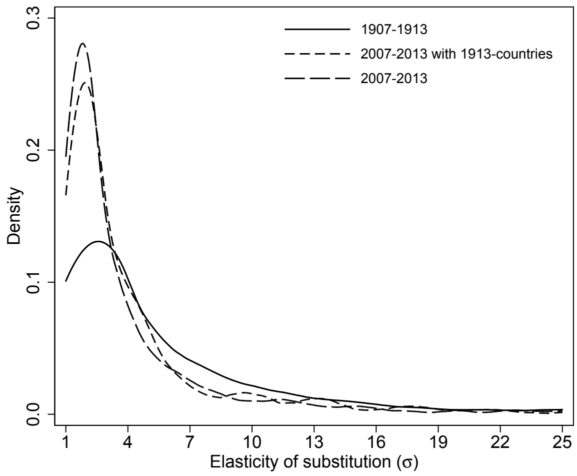
[29] As in other studies estimating the elasticity of substitution using the Feenstra-Broda and Weinstein-Soderbery-method, the distribution of elasticities is highly skewed towards the right so that the means are much larger than the medians (see, for example, Bo and Jacks 2012, Mohler and Seitz 2012 or Ossa 2015). This makes the median elasticity more expressive, and this is why I refer to the median sigma when speaking of sigma, if not stated differently.

[30] I also use a subset of the data where the observations come from one volume that covers the years 1908 to 1913 only. Because the data from this volume does not require a harmonisation of product categories, I can run the estimations on the 'true' product level that is much more granular than data classified according to the SITC. Figure D6 in the appendix plots the distribution of elasticities based on this subset and compares them with those estimated on the five-digit level. The difference is negligible.

the 1913-country does not change that too much yielding a median elasticity of 2.7. That is, roughly speaking, the elasticity in the early twentieth century is 40 percent smaller than today. To put this difference in perspective: In the Krugman model, which I will use below to evaluate welfare, these elasticities translate to median mark-ups of 35 percent in the first globalisation but about 66 percent today (59 percent using 1913-countries). One potential explanation for this could be that although the differences between Western economies and the rest of the world was larger than today, back then the differences between developed economies were actually not as large as today.

The estimated elasticities are similar but smaller than earlier estimates. In their more than a decade old survey on trade costs, Anderson and van Wincoop (2004) find that sigma typically ranges from 5 to 10, based on partially very different identification approaches. For their assessment of trade costs from 1870 to 2000, Jacks *et al.* (2011) set the aggregate elasticity of substitution to 8, but they also use 6 and 10 in additional estimations. For their estimations of trade costs between 1870 and 1913 only, Jacks *et al.* (2010) take an aggregate sigma of 11 and check for robustness with a sigma equal to 5, noting that this level is 'unrealistically distant'. Irwin (2000) estimates the elasticity of substitution for pig iron for the late nineteenth century and finds values of about 2.5 to 3.0 in the short run but reckons that the elasticity is '6 to 7 in the long run'. I obtain a sigma of 1.21 for the SITC category 671 ('pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys').

Figure 3
Distribution of Elasticities of Substitution



Based on estimations using equation 20 and five-digit items in SITC, revision 4. The display but not the shape of the density is truncated at $\sigma_k = 25$ for exposition. Consider table D11 in Appendix D11 for a conversion list of today's countries to 1913-countries. Source: Own calculations.

Table 5
Descriptive Statistics on the Elasticities of Substitution

Period	N	Mean	Median	5th percentile	95th percentile
1907-1913	727	80.13 (26.40)	3.81 (0.10)	1.23	67.56
2007-2013 with 1913-borders	829	18.21 (4.77)	2.69 (0.12)	1.20	39.12
2007-2013	1,347	79.95 (22.42)	2.47 (0.07)	1.14	43.83

Based on estimations using equation 20 and five-digit items in SITC, revision 4. Standard errors in parentheses. The total number of elasticities estimated at the five-digit level is smaller than the total number of SITC categories available within each period. This is due to the fact that Germany imported some goods only from a small number of countries, while the estimation procedure requires at least three countries per category to identify the desired parameters. Consider table D11 in Appendix D11 for a conversion list of today's countries to 1913-countries. Source: Own calculations.

The elasticities obtained using the Feenstra-Broda and Weinstein-method are more directly comparable. Broda *et al.* (2017) find median sigma of 3.9 for Germany and 3.4 across the world for 1994 to 2003. Mohler and Seitz (2012) estimate a median sigma of 4.67 for Germany from 1997 to 2007. Broda and Weinstein (2006) report a median sigma of 2.8 for 1979 to 1990 and of 2.5 for 1991 to 2001 for the United States. Once again, all these estimations tend to yield higher elasticities, implying more elastic demand. However, as noted above, there is reason to believe that small sample bias has led to over-estimated elasticities (Soderbery, 2010, 2015). Soderbery (2015) re-estimates US elasticities from 1993 to 2007 and finds a median elasticity of 1.9 at the eight-digit level of the Harmonised System (HS). That is, the Soderbery-correction of the Feenstra-Broda and Weinstein-method yields a 35 percent lower median demand elasticity. The HS eight-digit level elasticities are not directly comparable to those of the SITC. The higher granularity means that elasticities should be higher than those estimated at the five-digit level due to greater substitutability between varieties within more narrowly defined categories. This implies that US elasticities based on the Soderbery-method should be even more left-leaning (also see figure D7 in the Appendix where the elasticity distributions are compared with those of Broda and Weinstein 2006 as well as Soderbery 2015). The differences in medians are economically quite important because these are often the values that researchers use for their models when only one uniform elasticity is required.

Using 1913-borders over the source countries, however, does not change the distribution of the elasticities too much. Recall that doing so reduces the number of maximum varieties per good because the number of countries is more than halved. The distribution based on 1913-countries is skewed only mildly more to the right than when using the actual countries reported in modern trade data. This is rather striking given the strength of the Armington assumption in the present identification setup. Thinking in Armington terms means thinking in 'country boxes' while the analysis of modern international trade increasingly withdraws from traditional national borders as a unit of analysis. This suggests that the Armington assumption generates sufficient variation in variety also with a smaller set of countries.[31]

[31] Lashkaripour and Lugovskyy (2017) propose that products and ideas are less differentiated intranationally than internationally.

Table 6
Elasticities of Substitution and the Rauch-Classification

Good type	1907-1913	2007-2013
Homogeneous	5.30	2.82
	(0.57)	(0.23)
Reference-priced	3.88	2.90
	(0.35)	(0.15)
Differentiated	3.77	2.45
	(0.15)	(0.04)

Based on estimations using equation 20 and five-digit items in SITC, revision 4. Standard errors in parentheses. Note that Rauch's (1999) classification—of which here the liberal, updated version is used—is based in SITC revision 2 which causes some unavoidable, but minor imprecision due to the fact that some items were re-classified between the two revisions. Source: Own calculations based on Rauch (1999, 2007).

As already noted, we would generally expect that there is more product differentiation today than there was a century ago. One reason is that today there are more industrialised economies, and more industrialised economies produce more differentiated products. To this adds the professionalisation of marketing and branding which we would expect to lower substitutability due to product segmentation – which in turn is just another word for differentiation. Another reason is simply technical: The much higher number of countries today gives rise to vastly larger number of potential Armington-variety within a given CES good. In the spirit of Rauch (1999), we would expect that substitutability corresponds to product differentiation. Consumers switch more easily between two varieties of beer than between two varieties of microscopes. That is, we would expect that the elasticity of substitution is lower between goods that are highly differentiated. In turn, goods that are primarily traded on organised exchanges should have higher elasticities since they are more homogeneous.

Table 6 shows the median elasticity differentiated by product differentiation according to Rauch's (1999) classification, based on the four-digit level. For the first globalisation, homogeneous goods command a much higher elasticity than reference-priced or heterogeneous goods, albeit the latter two good types do not differ too much. Similarly, but less pronounced this also holds for the second globalisation – with generally lower elasticities. This, once again, confirms that across sectors, import demand is less elastic than it was a century ago.

Let us consider some exemplary cases of the estimated elasticities. Table 7 shows the elasticities of substitution for the ten largest three-digit positions in Germany's imports in each of the periods. The first impression of table 7 is that Germany's import structure in the first globalisation was indeed very different from that of today. Cotton and wool, hides and skins, grains as well as textile yarn were the top imports then, while today mineral sources of energy dominate. The elasticities of substitution turn out, however, as we would expect: In the first globalisation, relatively homogeneous goods such as cotton of 9.6. Import demand of textile yarns, on the other hand, was much more inelastic with an elasticity of 1.6. This probably corresponds to vast quality differences due to different stages of industrialisation of Germany's trade partners. Demand for coal and live animals was so high that I truncated the elasticity to 100,[32] suggesting that the origin of these goods does not seem to have mattered at all. Import demand for barley, unexpectedly, turns out very inelastic. This may be due to differences in the tariff scheme: While wheat tariffs fell in the twenty years ahead of World War I, barley tariffs rose. This naturally limits the scope of import variety.

[32] Following Broda and Weinstein (2006), see also footnote 28.

Table 7
Elasticities of Substitution for Major Three-digit Sectors

Average import share	SITC three-digit	Description	σ_k
		1907 to 1913	
6.4	263	Cotton	9.6
5.3	268	Wool and other animal hair (including wool tops)	3.1
4.3	041	Wheat (including spelt) and meslin, unmilled	19.2
4.1	211	Hides and skins (except furskins), raw	2.4
3.8	043	Barley, unmilled	1.5
3.1	081	Feeding stuff for animals [...]	3.1
2.9	651	Textile yarn	1.6
2.8	321	Coal, whether or not pulverized [...]	100.0*
2.8	682	Copper	9.8
2.7	001	Live animals	100.0*
		2007 to 2013 (with elasticities for 1913-borders in parentheses)	
5.9	333	Petroleum oils [...], crude	13.4 (9.1)
3.8	781	Motor cars and other motor vehicles [...]	1.7 (1.6)
3.4	343	Natural gas, whether or not liquefied	1.7 (1.2)
2.8	784	Parts and accessories of the motor vehicles [...]	4.2 (1.5)
2.6	334	Petroleum oils [...], (other than crude)	9.1 (2.8)
2.5	542	Medicaments (including veterinary medicaments)	2.0 (5.4)
2.4	792	Aircraft and associated equipment; spacecraft [...]	1.1 (1.1)
2.3	764	Telecommunications equipment [...]	13.5 (3.3)
2.2	776	Thermionic valves or tubes [...]	1.8 (1.1)
1.8	752	Automatic data-processing machines [...]	3.2 (3.1)

Based on estimations using equation 20 and three-digit items in SITC, revision 4. Import shares reported in percent of total imports at three-digit level based on import values pooled over respective seven-year periods. Parentheses indicate values for 1913-borders. * Truncated; see text. ** Taken from two-digit level; see footnote 33. Item descriptions were shortened for exposition. Source: Own calculations.

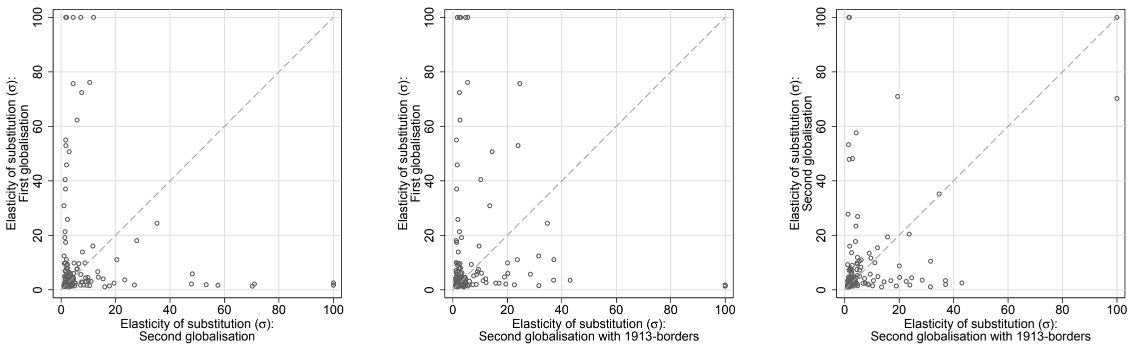
Figure 4

Differences in Elasticities of Substitution in Two Globalisations

(a) First vs. Second Globalisation

(b) First vs. Second Globalisation with 1913-borders

(c) Second Globalisation: Today's Borders vs. 1913-borders



Based on estimations using equation 20 and three-digit items in SITC, revision 4. 'First globalisation' refers to estimations based on the period 1907 to 1913 and 'second globalisation' to the period 2007 to 2013. Only items considered with active trade in both globalisation periods. That is, 63 percent of imports in the first globalisation but only 16 percent in the second are covered. Note that all $\sigma_k > 100$ have been truncated to 100. Source: Own calculations.

The estimates of the elasticities of substitution in the second globalisation also look plausible. Demand for carriers of mineral energy, i.e. gas and crude oil, is very elastic: Witness the sigmas of 13.4 for crude oil or the 9.1 for non-crude oil. Gas demand, on the other hand, turns out much less elastic. This is unlikely due to the homogeneous nature of this good, but rather due to Germany particular import structure. Germany imports gas basically only from Russia and Norway.[33] Demand for cars or parts of it as well as very specialised imports of aircraft equipment are, on the other hand, very inelastic. This reflects the fact that these industries rely on very specialised imports from rather few countries that make them, and that, once imports from these suppliers break away, substantial welfare losses may occur to the German economy.

[33] To be precise, the German import statistics report only two import sources for gas, both of which are classified. This is, however, quite plausible: Witness the political debate about Germany's foreign policy stance in the Crimea conflict, where Russian gas supply to Germany was at the heart of the German domestic debate (see for example Deutsche Welle, 2014). The fact that some import sources are classified means that in the panel, the number of varieties may be artificially higher. In one year, where a source is not classified, imports from a given source may count as variety of this source but if in another year classification applies, the data looks like that this variety comes from another country. This yields another 'variety', coming along with additional country-fixed effects and the problem that intertemporal changes are not entirely precisely measured because trade in t may not be associated correctly to trade in $t-1$. Since there is nothing to be done about this problem, the estimation simply treats unclassified countries, which are at least differentiated by numbers and not pooled, as part of the country set.

Recent literature such as Imbs and Mejean (2017) suggests to expect substantial variation in the elasticities depending on which 'version' of Germany we look: The German economy in the early twentieth century, the German economy today or the German economy today but with trade partners within the borders of 1913. This is visible in the estimation results. When considering the estimations based on 1913-borders, some demand elasticities turn out to be lower because of the reduced country space, that is, less varieties to chose from. Moreover, we would expect that despite some similarities with regard to substitutability, there may be visible differences in substitutability due to different underlying economic structures between countries, say the United States.

Figure 4 plots the estimated elasticities at the three-digit level in three pairs against each other. Because comparisons are only possible where elasticities are available, I restrict the graphs to items with active trade. That is we are looking at 63 percent of import value for the first globalisation and merely 16 percent in the second. Also note that these elasticities are not trade-weighted as Section 3 has highlighted, the actual effect of this parameter interacts with the amount of new or disappearing variety.

Baring this in mind, the changes in sector specific-elasticities between the different periods are striking nonetheless. While some demand became more elastic, other sectors must have gone through growing differentiation. As the discussion of the examples above suggests, the set of borders matters for good-specific elasticities too – despite the relative similarity between the distributions of elasticities for 2007-2013 based on different borders. The elasticity for cotton (SITC 263), for example, lowered from 9.6 (as reported above) to 6.5 in the second globalisation. The elasticity of demand for 'meat of bovine animals, fresh, chilled or frozen' (SITC 011) fell from 75.1 to 24.5. Other elasticities turn out similar between the two globalisation episodes. 'ores and concentrates of precious metals (other than of gold)' (SITC 289) has an elasticity of 1.4 in the first globalisation, and 1.05 (truncated) in the second. Aluminium (SITC 684) saw its demand becoming more elastic with an elasticity of 11.1 in the first globalisation, but one of 20.0 in the second. Taken together the results suggest that using an 'inadequate', i.e. ahistorical elasticities which have not been obtained from the data that they should help explain, noise is likely to be the result.[34] The bottom line is that good-specific elasticities of substitution ideally also require the adequate country set on which they are estimated, especially if only one importer is considered. Generalisations from one economy to another may turn out misleading. And the elasticity of substitution seems to be much less stable, the more 'micro' the data gets.

6.3 Import Prices and Welfare

The following evaluates the price effects of changes in varieties. To do so, the estimated elasticities of substitution as well as the calculated λ_k-ratios are plugged into equation 9. This yields the end-point-ratio, which is the corrected import price index divided by the conventional import price index $CIPI(K)$ from equation 10:

$$\frac{\Pi^M}{CIPI(K)} = \prod_k \left(\frac{\lambda_{kt}}{\lambda_{kt-1}} \right)^{\frac{w_{kt}}{\sigma_k - 1}} \tag{22}$$

The end-point-ratio captures the extent to which new varieties affected the conventional import price index. When comparing the start years 1907 and 2007 to 1913 and 2013, respectively,[35] the ratio is 0.994 for 1907 to 1913 and 0.998 for 2007 to 2013. That is, new varieties—even if only mildly—reduced the price level. This finding suggests that the conventional import price index is biased upwards in both periods if new varieties were omitted. The comparison of the two ratios suggests that the German import structure was already quite 'saturated' ahead of World War I. Most imports were sourced from known suppliers. Since we are only considering the German case, generalisations remain a task for future research.

Variety growth—the inverse of the end-point ratio—let the variety-adjusted unit price for imports fall 0.6 percent faster than the unadjusted price between 1907 and 1913 or about 0.1 percentage points per year. The impact of variety growth was much smaller hundred years later. Between 2007 and 2013, the growth of varieties made the exact price index fell about 0.2 percent faster than the unadjusted index over this time period or about 0.02 percentage

[34] Figure C.2 in the Appendix plots the estimated elasticities by Broda and Weinstein (2006) at the three-digit level—which makes them comparable to the findings above—for the two periods they study, 1979 to 1989 and 1990 to 2001. The plots exhibit similarly strong differences in the elasticities.

[35] Note that such calculations do not incorporate intra-periodical changes as only start and end years are compared.

points per year. Given that we look only at six years of change, these results are plausible. Broda and Weinstein (2006) find an end-point ratio of 0.917 and an average ratio of 0.8 percentage points per year for the ten years up to 2001 in the United States. These more visible reductions in the price index are likely due to more years being covered. Looking at EU members from 1998 to 2008, Mohler and Seitz (2012) conclude that for most EU countries the import price index was biased upwards due to the omission of newly imported varieties, but their end-point ratio for Germany is 1.001, suggesting an downward bias of 0.12 percent over the ten years they consider. If we assume that import prices fell by the amounts mentioned about on average per year over the entire periods 1895 to 1913 and 1995 to 2013 (as displayed in figure 2), growth of varieties cumulatively reduced the exact price relative to conventionally measured import price index by about 4.9 percent in the first and by about 1.5 percent in the second globalisation.[36]

The final step is to translate the import-price reducing effects of variety growth into welfare effects. To do so, I assume—in line with other applications of Feenstra's (1994) method—an economy as in Krugman (1980).[37] In this model, the inverse of equation 22, log-ideally weighted by the share of imports to GDP, yield the gains from variety:

$$\left[\prod_{k}\left(\frac{\lambda_{kt}}{\lambda_{kt-1}}\right)^{\frac{w_{kt}}{\sigma_k-1}}\right]^{-w_t^M+1} \tag{23}$$

with w_t^M being log-ideal import shares of GDP.

Table 8 reports the welfare changes due to changes in import variety. Column (1) shows the period-specific welfare estimates based on the good-specific estimated elasticities as exposed

[36] These growth rates are calculated as follows: Change in entire period = (1 + Average annual change)^T, with $T = 19$ being the number of years in each period, i.e. 1895-1913 and 1995-2013, respectively. Note that the financial crisis after the Lehman collapse is not covered in this calculations. During the financial crisis, import prices fell must faster implying that the back-of-the-envelope calculations here represent a lower bound.

[37] This assumption is not only helpful for comparative reasons—Broda and Weinstein (2006) apply it, too—but also because of its good tractability. Moreover, in that model a country may gain from trade even though there are no price changes of existing goods. But the use of this model comes at a cost. I implicitly assume that the number of domestically produced varieties remains unaffected. In other words, domestically produced goods cannot be substituted by imported goods. That is, changing variety of imported goods does not the variety of domestically produced goods. This may be at odds with both theoretical and empirical findings based on heterogonous firms models. In Melitz (2003), more productive firms from abroad crowd out less productive domestic firms by decreasing domestically produced variety. Arkolakis *et al.* (2008) suggest that the total number of varieties consumed in a country may even decrease despite lower trade costs invite to more trade. However, Feenstra (2010) shows that even in such classes of models, the gains from imported variety and losses from domestically produced varieties can cancel each other out.

above. From 1907 to 1913, the welfare gain due to growing variety amounts to 0.2 percent of GDP to access the wider set of varieties available in 1913 rather than the set available in 1907. A century later it is only half of that, that is, 0.1 percent. Put differently, despite a much smaller set of goods and their varieties, Germany enjoyed twice as much welfare gains from newly imported varieties than it does today. This result is even more striking when considering that the level of protection ahead of World War I was much higher than it is today. This may reflect the fact that today many 'low hanging fruits' in terms of variety have been harvested, which resonates with Bordo's (2017) argument that the world economy's pace of integration is slowing down or pausing, but not reversing. Beyond that, it is worthwhile to note that in both episodes of globalisation, these gains are primarily due to new varieties from Eastern Europe as well as Asia, as table 3 shows. This corresponds with prior findings on how the German economy is integrated in the world economy: Already in the first globalisation, Germany profited from the integration of Western and Eastern Europe.

The welfare results seem small at first sight, but because we are looking at estimates of the 'incremental' gains from import variety (Feenstra, 2010), these numbers are plausible. The results are consistent with previous findings based on similar research designs. Mohler and Seitz (2012) find no 'sizable gains from newly imported varieties' for Germany and other large European economies: They arrive at gains from variety between 0.2 and 0.75 percent of GDP for EU members from 1998 to 2008. For Germany, they actually report welfare losses of -0.03 percent, possibly due to the break-away of some rare but important varieties that command relatively inelastic demand. Broda and Weinstein (2006), looking at the US, find welfare gains of 1.8 percent of GDP over 1979 to 1988 and 2.6 percent from 1990 to 2001. Note, however, that the import shares are traditionally much smaller in the US than in Germany: Broda and Weinstein used 6.7 percent from 1972 to 1988 and 10.3 percent from 1990 to 2001. In contrast, Germany had a log-ideal import share of 18.8 percent in 1907-1913 already, and a whopping 31.1 in 2007-2013 (Mohler and Seitz use a log-ideal import share of 0.26 for 1998-2008). This suggests that the potential for more integration in the global economy—and perhaps also the gains from more trade-induced variety growth—are smaller for Germany than for the US. Above that, recall that there are other margins of the gains from trade that remain unexplored here. This implies that these results are, if anything, a lower bound of the welfare gains

Table 8
Welfare Results

	(1) σ_k	(2) σ_{median}	(3) $\sigma^{\text{other period}}_{\text{median}}$	(4) $\sigma^{\text{other period}}_{k}$	(5) $\sigma = 5$	(6) $\sigma = 8$	(7) $\sigma = 10$
1907-1913	0.20	0.08	0.15	0.04	0.03	0.02	0.01
2007-2013	0.11	0.04	0.02	0.02	0.02	0.01	0.01

Percent of GDP consumers would give up to access the import basket of the period end rather than that of the beginning of the period, depending on the choice of the elasticity of substitution. Calculated using equation 23. Source: Own calculations.

from trade. Much product differentiation happens on much finer levels of aggregation,[38] which is something that cannot be explored with the historical data I have at hand. Considering intermediate goods, Ossa (2015) shows that accounting for cross-industry variation in elasticities of substitution magnifies the gains from trade because sectoral dependencies loom large.

The reason why Section 6.2 extensively discussed the good-specific elasticities of substitution is that it greatly matters for welfare analysis. Table 8 also reports welfare calculations based on different elasticities of substitution. Column (2) reports the welfare when the period-specific median elasticity, i.e. 3.81 for 1907 to 1913 and 2.47 for 2007 to 2013 is used. The welfare gains would more than halve in both episodes in comparison to the benchmark results on welfare in column (1) Column (3) gives the welfare results when the median elasticities of the respective other period is used. For the 1907-1913 period, welfare is lower by a quarter. For the 2007-2013 period, welfare falls to fifth. Column (4) takes the good-specific elasticities from the respective other period.[39] Welfare turns out to be a fifth of the benchmark results for both episodes. Columns (5) to (7) use various uniform elasticities traditionally used in the literature.[40] Welfare would turn out even lower. The bottom line of these alternative welfare estimates is that when using ad-hoc elasticities or already the set of good-specific elasticities from elsewhere, the analysis of welfare is flawed – in the present case welfare would be severely underestimated given already low welfare results in the benchmark.

[38] See also footnote 15.
[39] When no elasticity was readily available from the set of estimates, I took the sectoral median from a higher level of aggregation.
[40] Recall that an elasticity of 8 is technically already very high (see Appendix A), so that this case is the case with the highest degree of homogeneity from the viewpoint of a CES consumer. When the elasticity of substitution goes to infinity, trade converges to that in a homogeneous goods model.

The data invites to compare the gains from import variety also over the long run. To do so, however, some strong restrictions need to be made. I inflate the import values from 1907 to 1913 to 2016-euros using purchasing power parities by Deutsche Bundesbank (2017). The crudeness of this procedure may introduce measurement errors. I then take mean imports over the periods 1907-1913 and 2007-2013 and aggregate all to the one-digit level. This means that variety changes are observed within different varieties of 'food or live animals' (SITC 0) or 'machinery and transport equipment' (SITC 7). I use the estimated elasticities for today estimated using 1913-borders, and pool Germany's import data according to 1913-borders as above. I then arrive at a welfare gain due to newly imported varieties 38 percent of 2013-GDP over one century. This number is large but crude, and as indicated above, it is very likely to be a lower bound to this margin of welfare. If, for example, a sigma of 8 is used, as in other historical applications, welfare gains amount to a mere 7.7 percent of GDP. All this highlights once again that it is important to try get as close as possible to the real demand strucutre of the economy we observe.

7 Conclusion

This paper compared the gains from international trade through changes in product variety in two episodes of globalisation, using Germany's globalisation experience, and focusing on the consumption side of the economy. The key idea in answering this question is that expanding variety of a good may yield gains from trade because consumers value variety (Krugman, 1980). Here, this variety is generated via Armington's (1969) assumption that every country makes things slightly different from those made by other countries. I measure these gains by differentiating between how an exactly measured domestic price index would move with and without changes in variety of a given set of imported goods.

What are the gains from trade today compared to those in the globalisation hundred years ago? To answer this question I rely on Krugman's (1980) idea that consumers value growing import variety, and very granular German product-level data from the first globalisation (ahead of World War I), and today. First, I derive structural estimates of the elasticity of substitution at the product-level for both globalisation episodes. I find substantial heterogeneity in terms of how elastic demand over goods and their varieties is, especially when compared over the long run. The median elasticity is 3.8 in the first globalisation, but only 2.5 in the second. This suggests that demand was more elastic in the first globalisation. Second, I use these estimated elasticities and calculate the consumer gains from growing import variety ahead of World War I and for today. The welfare calculations suggest that the gains from trade in the first globalisation are twice as much as today. Welfare turns out much lower—falling down to a fifth of the benchmark—when using non-contemporary, that is, inadequate elasticities. Simply taking one single elasticity or a set of ahistorical elasticities can be easily misleading because gains from international trade as well as the effects of changes in trade costs may be wrongly captured.

To obtain a measure of the gains from trade, I estimate good-specific elasticities of substitution, a key parameter in many studies of international trade and international macroeconomics. This elasticity varies substantially in the degree of aggregation, the country space as well as over time. The structure of demand is not easily approximated by using one uniform elasticity of substitution, both the time horizon as well as the set of trade partners matter. I find that the median elasticity is lower today than hundred years ago, which points towards increasing specialisation within, rather than between goods over time (see Schott 2004). This resonates well with the findings of (Hungerland and Wolf, 2017) who argue that such within-sector specialisation is in parts already visible in the first globalisation. More generally it suggests that demand was more elastic back then. Based on these estimated elasticities I calculate the gains from trade looking at seven years in two episodes of globalisation. I find gains from new variety amounting to 0.2 percent of GDP in the first but only half of that in the second globalisation. These numbers appear small but are reasonable given the small period under study. More strikingly, welfare turn out much lower—falling down to a fifth of the benchmark—when inadequate elasticities are used.

There are various avenues for future research, especially with focus on the long run development of international trade. Exploring of the role of frictions to trade may now, with adequate contemporary substitution elasticities at hand, be conducted closer to the actual experience of contemporary economies. Once a homogenised cross-country panel of disaggregated import data from the first to the second globalisation is available, research will be able to explore a popular conjecture in the literature, namely that price elasticity of demand is greater in the long run: The more time passes, the stronger the substitution away from higher priced varieties. Moreover, this paper was forced to ignore firm-level variation in terms of productivity, which is the focus of most recent research in international trade. Working with historical data unfortunately does normally not allow observing a representative set of real microeconomic units, that is firms. Therefore this paper to relied on the 'symmetry assumption', i.e. all firms are assumed identical. Ossa's (2015) findings, however, suggest that integrating historical input-output data with trade data may yield higher gains from trade due to the dependency of certain industries on certain goods. What is more, changes in domestic variety are not captured by this model, although Arkolakis *et al.* (2008) argue that this may be the case.[41]

Against this background, the present paper contributed corroborating evidence and some new points of departure. The bottom line is: Disaggregated historical data has the potential to revise some views economists take when looking at long-run developments in international trade.

[41] See, however, also footnote 37.

Amiti, M. and Freund, C. (2010). The Anatomy of China's Export Growth. In R. C. Feenstra and S.-J. Wei (Eds.), *China's Growing Role in World Trade*, Chicago, IL: University of Chicago Press. 35 – 56.

Anderson, J. E. and van Wincoop, E. (2004). Trade Costs. *Journal of Economic Literature*, *42*(3), 691–751.

Antràs, P., Fort, T. C., and Tintelnot, F. (2017). The Margins of Global Sourcing: Theory and Evidence from U.S. Firms. *American Economic Review*, *107*(9), 2514–2564.

Arkolakis, C., Costinot, A., and Rodríguez-Clare, A. (2012). New Trade Models, Same Old Gains? *American Economic Review*, *102*(1), 94–130.

Arkolakis, C., Demidova, S., Klenow, P. J., and Rodríguez-Clare, A. (2008). Endogenous Variety and the Gains from Trade. *American Economic Review*, *98*(2), 444–450.

Armington, P. (1969). A Theory of Demand for Products Distinguished by Place of Production. *International Monetary Fund Staff Papers*, *16*, 159–178.

Autor, D. H., Dorn, D., and Hanson, G. H. (2013). The China Syndrome: Local Labor Market Effects of Import Competition in the United States. *American Economic Review*, *103*(6), 2121–2168.

Baldwin, R. E. (2016). *The Great Convergence Information Technology and the New Globalization.* Cambridge, MA: Belknap Press of Harvard Universiy Press.

Bas, M., Mayer, T., and Thoenig, M. (2017). From Micro to Macro: Demand, Supply, and Heterogeneity in the Trade Elasticity. *Journal of International Economics*, *108*(3), 1–19.

Benkovskis, K. and Wörz, J. (2014). How Does Taste and Quality Impact on Import Prices? *Review of World Economics*, *150*(4), 665–691.

Bernhofen, D. and Brown, J. (2005). An Empirical Assessment of the Comparative Advantage Gains from Trade: Evidence from Japan. *American Economic Review*, *95*(1), 208–225.

Bo, C. and Jacks, D. S. (2012). Trade, Variety, and Immigration. *Economics Letters*, *117*(1), 243–246.

Bonigen, B. A. and Soderbery, A. (2010). Measuring the Benefits of Foreign Product Variety with an Accurate Variety Set. *Journal of International Economics*, *82*(2), 168–180.

Bordo, M. D. (2017). The Second Era of Globalization is Not Yet Over: An Historical Perspective. *National Bureau of Economic Research Working Paper Series*, Working Paper Nr. 23786.

Broda, C., Greenfield, J., and Weinstein, D. (2017). From Groundnuts to Globalization: A Structural Estimate of Trade and Growth. *Research in Economics*, *71*(4), 759–783.

Broda, C. and Weinstein, D. (2006). Globalization and the Gains From Variety. *Quarterly Journal of Economics*, *121*(2), 541–585.

Chaney, T. (2008). Distorted Gravity: The Intensive and Extensive Margins of International Trade. *American Economic Review*, *98*(4), 1707–1721.

Costinot, A. and Donaldson, D. (2016). How Large Are the Gains from Economic Integration? Theory and Evidence from U.S. Agriculture, 1880-1997. *National Bureau of Economic Research Working Paper Series*, Working Paper Nr. 22946.

Costinot, A. and Rodríguez-Clare, A. (2014). Trade Theory with Numbers: Quantifying the Consequences of Globalization. In G. Gopinath, E. Helpman, and K. Rogoff (Eds.), *Handbook of International Economics*, Amsterdam: Elsevier, chap. 4. 4th ed., 197–261.

De Bromhead, A., Fernihough, A., Lampe, M., and O'Rourke, K. H. (2016). When Britain Turned Inward: Protection and the Shift Towards Empire in Interwar Britain. *National Bureau of Economic Research Working Paper Series*, Working Paper Nr. 23164.

Deutsche Bundesbank (2017). Kaufkraftvergleiche historischer Geldbeträge. URL `https://www.bundesbank.de/Redaktion/DE/Standardartikel/Statistiken/kaufkraftvergleiche{%}5C{_}{_}historischer{%}5C{_}geldbetraege.html`.

Deutsche Welle (2014). Germany's Russian Energy Dilemma. URL `http://www.dw.com/en/germanys-russian-energy-dilemma/a-17529685`.

Eaton, J. and Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, *70*(5), 1741–1779.

Eurostat (2017). EU Trade Since 1988 By SITC (DS-018995). URL `http://epp.eurostat.ec.europa.eu/newxtweb/`.

Feenstra, R. C. (1994). New Product Varieties and the Measurement of International Prices. *American Economic Review*, *84*(1), 157–177.

Feenstra, R. C. (2010). *Product Variety and the Gains from International Trade*. Cambridge, MA: MIT Press.

Feenstra, R. C. (2016). *Advanced International Trade: Theory and Evidence*. Princeton, NJ: Princeton University Press, 2nd ed.

Feenstra, R. C., Luck, P., Obstfeld, M., and Russ, K. N. (2017). In Search of the Armington Elasticity. *Review of Economics and Statistics*, forthcoming.

Felbermayr, G., Impullitti, G., and Prat, J. (2018). Firm Dynamics and Residual Inequality in Open Economies. *Journal of the European Economic Association*, forthcoming.

Ferguson, N. (2016). Populism as a Backlash against Globalization: Historical Perspectives. *Horizons*, *4*(8), 12–21.

Galstyan, V. (2017). LIML Estimation of Import Demand and Export Supply Elasticities. *Applied Economics*, *15*(8), 1–9.

Goldberg, P., Khandelwal, A., Pavcnik, N., and Topalova, P. (2010). Imported Intermediate Inputs and Domestic Product Growth: Evidence from India. *Quarterly Journal of Economics*, *125*(4), 1727–1767.

Hersh, J. and Voth, H.-J. (2009). Sweet Diversity: Colonial Goods and the Welfare Gains from Trade after 1492. *Universitat Pompeu Fabra*, mimeo.

Hoffmann, W. G. (1965). *Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*. Berlin: Springer.

Hungerland, W.-F. and Wolf, N. (2017). Globalisation Then and Now: New Evidence From Germany. *Institute of Economic History, School of Business and Economics, Humboldt-University of Berlin*, mimeo.

Imbs, J. and Mejean, I. (2015). Elasticity Optimism. *American Economic Journal: Macroeconomics*, *7*(3), 43–83.

Imbs, J. and Mejean, I. (2017). Trade Elasticities. *Review of International Economics*, *25*(2), 383–402.

Irwin, D. A. (2000). Could the United States Iron Industry Have Survived Free Trade after the Civil War? *Explorations in Economic History*, *37*(3), 278–299.

Jacks, D. S., Meissner, C. M., and Novy, D. (2010). Trade Costs in the First Wave of Globalization. *Explorations in Economic History*, *47*(2), 127–141.

Jacks, D. S., Meissner, C. M., and Novy, D. (2011). Trade Booms, Trade Busts, and Trade Costs. *Journal of International Economics*, *83*(2), 185–201.

Kaiserliches Statistisches Amt (1914). *Statistik des Deutschen Reichs - Der Verkehr mit den einzelnen Ländern im Jahre 1913 unter Vergleichung mit den vier Vorjahren. Abschnitt A: Europäischen Staaten*, vol. 271A (NF). Berlin: Puttkammer and Mühlbrecht.

Kemp, M. C. (1962). Errors of Measurement and Bias in Estimates of Import Demand Parameters. *Economic Record*, *38*(83), 369–372.

Krugman, P. (1980). Scale Economies, Product Differentiation, and the Pattern of Trade. *American Economic Review*, *70*(5), 950–959.

Krugman, P. (1993). What Do Undergrads Need to Know About Trade? *American Economic Review, Papers and Proceedings*, *83*(2), 23–26.

Lashkaripour, A. and Lugovskyy, V. (2017). National Differentiation and Industry-Wide Scale Effects. *Centre for Aboriginal Economic Policy Research, Australian National University*, Working Paper Nr. 2017–004.

Leamer, E. E. (1981). Is it a Demand Curve, or is it a Supply Curve? Partial Identification through Inequality Constraints. *Review of Economics and Statistics*, *63*(3), 319–327.

Marshall, A. (1920). *Principles of Economics*. London: Macmillan and Co., 8th ed.

Meissner, C. M. (2015). New Perspectives on the First Wave of Globalization. *National Bureau of Economic Research Report*, Nr. 1: Research Summary. URL `http://www.nber.org/reporter/2015number1/meissner.html`.

Melitz, M. J. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*, *71*(6), 1695–1725.

Mohler, L. and Seitz, M. (2012). The Gains from Variety in the European Union. *Review of World Economics*, *148*(3), 475–500.

Ossa, R. (2015). Why Trade Matters After All. *Journal of International Economics*, *97*, 266–277.

Rauch, J. E. (1999). Networks Versus Markets in International Trade. *Journal of International Economics*, *48*(1), 7–35.

Rauch, J. E. (2007). Classification of SITC Rev. 2 Commodities into Organized Exchange, Reference-priced, and Differentiated. URL `http://econweb.ucsd.edu/{~}jrauch/rauch{_}classification.html`.

Redding, S. J. and Weinstein, D. E. (2017). Aggregating from Micro to Macro Patterns of Trade. *National Bureau of Economic Research Working Paper Series*, Working Paper Nr. 24051.

Rigobon, R. (2003). Identification Through Heteroskedasticity. *Review of Economics and Statistics*, *85*(4), 777–792.

Ruhl, K. J. (2008). The International Elasticity Puzzle. *Department of Economics, Pennsylvania State University*, mimeo. URL `http://kimjruhl.com/s/ElasticityMarch08.pdf`.

Sato, K. (1976). The Ideal Log-Change Index Number. *Review of Economics and Statistics*, *58*(2), 223–228.

Schott, P. (2004). Across-product versus Within-product Specialization in International Trade. *Quarterly Journal of Economics*, *119*(2), 647–78.

Schulze, M.-S. and Wolf, N. (2009). On the Origins of Border Effects: Insights from the Habsburg Empire. *Journal of Economic Geography*, *9*(1), 117–136.

Soderbery, A. (2010). Investigating the Asymptotic Properties of Elasticity of Substitution Estimates. *Economics Letters*, *190*(2), 57–62.

Soderbery, A. (2015). Estimating Import Supply and Demand Elasticities: Analysis and Implications. *Journal of International Economics*, *96*(1), 1–17.

Vartia, Y. (1976). Ideal Log-Change Index Numbers. *Scandinavian Journal of Statistics*, *3*(3), 121–126.

Wolf, N., Schulze, M.-S., and Heinemeyer, H.-C. (2011). On the Economic Consequences of the Peace: Trade and Borders After Versailles. *Journal of Economic History*, *4*(2011), 915–949.

Appendix

A On the Workings of Sigma

To illuminate how σ_k works further, the following presents four scenarios of how the bias term corresponds to varying levels of substitutability between varieties of a good. Table D9 outlines the scenarios and figure D5 shows how Feenstra's (1994) bias term reacts to varying levels of substitution elasticities. In all scenarios 10 percent of import expenditure is spent on new goods in $t-1$ (column 1 in table D9) and the exact but uncorrected import price index P^{SV} set to unity in both periods in all scenarios for simplicity.

TABLE D9
LAMBDA AND CHANGING VARIETY – FOUR SCENARIOS

			(1)		(2)	(3)	(4)	(5)
				$\Delta imports$	0%	0%	50%	50%
				$\Delta variety$	50%	–50%	50%	–50%
Imports. . .			$t-1$		t_A	t_B	t_C	t_D
...in total	$\sum_{k\in K_r} pq$	*in \$*	1.00		1.00	1.00	1.50	1.50
...of new varieties	$\sum_{k\notin K,k\in K_r} pq$	*in \$*	0.10		0.15	0.05	0.15	0.05
		in %	10%		15%	5%	10%	3%
...of common goods	$\sum_{k\in K,k\notin K_r} pq$	*in \$*	0.90		0.85	0.95	1.35	1.45
		in %	90%		85%	95%	90%	97%
Period-specific lambda	$\lambda_r(K)$		90%		85%	95%	90%	97%
Lambda ratio	$\frac{\lambda_t(K)}{\lambda_{t-1}(K)}$		*NA*		0.94	1.06	1.00	1.07

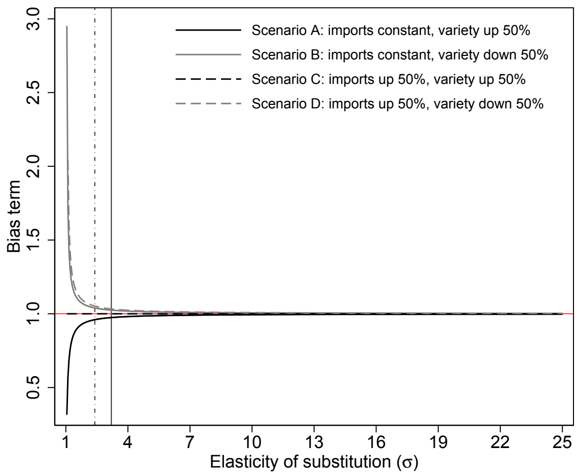
For periods $r=t,t-1$. Source. Own example.

In scenario A (column 2 in table D9), total imports do not change over time but expenditure on new varieties *grows* by 50 percent. Figure D5 shows that when demand is elastic and new varieties are close substitutes, i.e. $\sigma\to\infty$, the bias in the price index due to new goods disappears. Importing new but easily substitutable varieties does not change the price index—and thus welfare—much. In contrast, if demand is rather inelastic and new varieties are not easily substitutable, i.e. $\sigma\to 1$, the bias in the price index grows and can yield substantial reductions in the price level and thus improvements in welfare. All else equal, the product-level price index falls by 44 percent if a variety with $\sigma=1.1$ is newly imported, but falls only by 6 percent if $\sigma=2$. If $\sigma=10$, the price index deflates by only 0.6 percent.

In scenario B (column 2 in table D9), total imports remain constant too but expenditure on new varieties *falls* by 50 percent. As in the first scenario, the more new varieties are close substitutes, the less the the bias in the price index due to new goods matters. But when if inelastic demand, i.e. not easily substitutable varieties, and shrinking imports come together, the disappearing imports become very costly. Figure D5 shows that, all else equal, the product-level price index rises by 71 percent if a variety with $\sigma=1.05$ stops being imported, but rises only by 6 percent if $\sigma=2$. If $\sigma=10$, the price index inflates by only 0.6 percent.

Figure D5

Variety Bias and the Elasticity of Substitution – Four Scenarios



For $P^{SV} = 1$ in both periods. The vertical lines represent the median elasticity for Germany for the first (bold line) and second (dashed line) globalisation as estimated in Section 6. The y-axis displays $({}^{\lambda_t(K)}/_{\lambda_{t-1}(K)})^{\frac{1}{\sigma_k - 1}}$ as in Feenstra (1994) with λ_r corresponding to scenarios outlined in table D9.

Intertemporal variation in the total value of imports may sharpen or mitigate the power of σ_k below.[42] This is why scenario C (column 4 in table D9), expenditure on new varieties *grows* by 50 percent but total imports also grow by 50 percent. As artificial this case is, it shows nevertheless that levels matter – substitution effects are fully muted by growing total trade. All else equal, there are no net welfare changes. In scenario D (column 5 in table D9) expenditure on new varieties falls by 50 percent, while total imports grow by 50 percent. This case shows that although much less of total trade is spent on new varieties, the absolute rise in imports nevertheless bears out welfare improvements through more consumption.

[42] Any welfare change due to imports is subject to the value of imports in total economic activity too. That is, all the dynamics discussed in the following are subject to a constant, reasonably big import share.

B Data Appendix

B.1 Goods

TABLE D10
PURITY OF HISTORICAL SITC ITEMS

Number of pluses	Number of five-digit categories	Share	Cumulative share
0	573	58.6	58.6
1	245	25.1	83.7
2	102	10.4	94.1
3	42	4.3	98.4
4	16	1.7	100.0

Shares in percent. Source: Chapter **??**.

B.2 Country Conversion List

Note that these polities differ slightly from that in table **??** since the subset of the historical data used in Chapter **??** is smaller and the most recent. This subset comes with a much finer country space than data from years preceding the Bülow tariff in 1906.

Table D11
Trade Partners of Germany in Today's and 1913-borders

Country as in Eurostat (2017)	Country as in German 1913 statistics
Afghanistan	Asien, Rest (nicht weiter spezifiziert) [2]
Albania	Türkei [15]
Algeria	Algerien
Amerikanisch-Samoa (ab 2001)	Samoa-Inseln [2]
Amerikanische Jungferninseln	Dänisch Westindien
Amerikanische Überseeinseln, kleinere (ab 2001)	Ozeanien, Rest [18]
Andorra	Spanien [4]
Angola	Portugiesisch Westafrika [4]
Anguilla	Britisch Westindien [18]
Antigua und Barbuda	Britisch Westindien [18]
Argentina	Argentinien [2]
Armenia	Türkei [15]
Aruba	Niederländisch Westindien [6]
Australia	Australien [2]
Austria	Österreich-Ungarn [7]
Azerbaijan	Russland [14]
Belgium (and Luxemburg -> 1998)	Belgien [2]
Benin (Dahomey -> 1976)	Französisch Westafrika [10]
Bosnia and Herzegovina	Österreich-Ungarn [7]
Burkina Faso (Upper Volta -> 1985)	Französisch Westafrika [10]
Bahamas	Britisch Westindien [18]
Bahrein	Aden, Bahrein, Kameran, Kuria-Muria und Perim [2]
Bangladesh	Britisch Indien [8]
Barbados	Britisch Westindien [18]
Belarus	Russland [14]
Belize	Britisch Westindien [18]
Bermuda	Britisch Westindien [18]
Besetzte palästinensische Gebiete (ab 1995)	Türkei [15]
Bhutan	Britisch Indien [8]
Bolivia	Bolivien
Bonaire, St. Eustatius und Saba (ab 2013)	Niederländisch Westindien [6]
Botswana	Britisch Südafrika [6]
Brazil	Brasilien
Britisches Territorium im Indischen Ozean	Britisch Indien [8]
British Virgin Islands	Ozeanien, Rest [18]
Brunei Darussalam	Asien, Rest (nicht weiter spezifiziert) [2]
Bulgaria	Bulgarien
Burundi	Britisch Ostafrika [6]
Cosos (Keeling) Islands	Australien [2]
Cambodia	Britisch Indien [8]
Cameroon	Deutsch Westafrika [2]
Canada	Kanada
Cape Verde	Britisch Westindien [18]

Continued on next page

Table D11 – *Continued from previous page*

Country as in Eurostat (2017)	Country as in German 1913 statistics
Central African Republic	Belgisch Kongo [3]
Ceuta (ab 1999)	Spanien [4]
Chad	Französisch Westafrika [10]
Chile	Chile
China	China [4]
Colombia	Kolumbien
Congo	Belgisch Kongo [3]
Cook Islands	Ozeanien, Rest [18]
Costa Rica	Costa Rica
Croatia	Österreich-Ungarn [7]
Cuba	Kuba und Puerto Rico
Curaçao (ab 2013)	Niederländisch Westindien [6]
Cyprus	Gibraltar, Malta und Zypern [3]
Czech Republic	Österreich-Ungarn [7]
Denmark	Dänemark
Djibouti	Afrika, Rest (nicht weiter spezifiziert) [2]
Dominica	Britisch Westindien [18]
Dominican Republic	Dominikanische Republik
Ecuador	Ecuador
Egypt	Ägypten [3]
El Salvador	El Salvador
Equitorial Guinea	Französisch Westafrika [10]
Eritrea	Italienisch Afrika
Estonia	Russland [14]
Ethiopia	Abessinien
Falkland Islands	Argentinien [2]
Fiji	Ozeanien, Rest [18]
Finland	Finnland
France	Frankreich
Französisch-Polynesien	Französisch Australien[2]
Französische Südgebiete (ab 2001)	Französisch Australien[2]
Guinea-Bissau	Portugiesisch Westafrika [4]
Gabon	Französisch Westafrika [10]
Gambia	Britisch Westafrika [5]
Georgia	Russland [14]
Ghana	Britisch Westafrika [5]
Gibraltar	Gibraltar, Malta und Zypern [3]
Great Britain	Großbritannien und Irland [2]
Greece	Griechenland
Grenada	Britisch Westindien [18]
Guam (ab 2001)	Ozeanien, Rest [18]
Guatemala	Guatemala
Guinea	Französisch Westafrika [10]
Guyana	Britisch Westindien [18]
Haiti	Haiti
Heiliger Stuhl (Vatikanstadt)	Italien [3]
Honduras	Honduras
Hong Kong	Hong-Kong
Hungary	Österreich-Ungarn [7]
India	Britisch Indien [8]
Indonesia	Niederländisch Indien
Iran	Persien
Iraq	Türkei [15]
Irland	Großbritannien und Irland [2]
Israel	Türkei [15]

Continued on next page

Table D11 – *Continued from previous page*

Country as in Eurostat (2017)	Country as in German 1913 statistics
Italy	Italien [3]
Ivory Coast	Britisch Westafrika [5]
Jamaica	Britisch Westindien [18]
Japan	Japan
Jordan	Türkei [15]
Kyrgyz Republic	Russland [14]
Kaimaninseln	Britisch Westindien [18]
Kazakhistan	Russland [14]
Kenya	Britisch Ostafrika [6]
Kiribati	Britisch Westindien [18]
Komoren	Afrika, Rest (nicht weiter spezifiziert) [2]
Kongo, Demokratische Republik	Belgisch Kongo [3]
Korea, Demokratische Volksrepublik	Korea [2]
Kosovo (ab 06/2005)	Türkei [15]
Kuwait	Türkei [15]
Laos	Britisch Indien [8]
Latvia	Russland [14]
Lebanon	Türkei [15]
Lesotho	Britisch Südafrika [6]
Liberia	Liberia
Libya	Libyen
Liechtenstein (ab 1995)	Schweiz [2]
Lithuania	Russland [14]
Luxembourg	Belgien [2]
Mauritania (incl. Spanish Sahara from 1977)	Französisch Westafrika [10]
Micronesia, Federated States of	Ozeanien, Rest [18]
Macao	Portugiesisch Indien
Macedonia	Türkei [15]
Madagascar	Madagaskar
Malawi	Britisch Ostafrika [6]
Malaysia	Straits Settlements [2]
Maldives	Ceylon und die Malediven [4]
Mali	Französisch Westafrika [10]
Malta	Gibraltar, Malta und Zypern [3]
Marshall Islands	Ozeanien, Rest [18]
Mauritius	Ceylon und die Malediven [4]
Mayotte (bis 2013)	Französisch Indien [2]
Melilla (ab 1999)	Spanien [4]
Mexico	Mexiko
Moldova	Russland [14]
Mongolia	China [4]
Montenegro (ab 01/2006)	Montenegro
Montserrat	Britisch Westindien [18]
Morocco	Marokko
Mozambique	Portugiesisch Ostafrika
Myanmar	Britisch Indien [8]
Northern Mariana Islands	Ozeanien, Rest [18]
Namibia	Deutsch Südwestafrika
Nauru	Ozeanien, Rest [18]
Nepal	China [4]
Netherlands	Niederlande
Netherlands Antilles	Niederländisch Westindien [6]
New Caledonia	Französisch Westindien [2]
New Zealand	Neuseeland [2]
Nicaragua	Nicaragua

Continued on next page

Table D11 – *Continued from previous page*

Country as in Eurostat (2017)	Country as in German 1913 statistics
Nicht ermittelt (1)	CLASSIFIED (1)
Nicht ermittelt (2)	CLASSIFIED (2)
Nicht ermittelt (3)	CLASSIFIED (3)
Nicht ermittelt (4)	CLASSIFIED (4)
Nicht ermittelt (5)	CLASSIFIED (5)
Nicht ermittelt (6)	CLASSIFIED (6)
Niger	Französisch Westafrika [10]
Nigeria	Britisch Westafrika [5]
Niue	Ozeanien, Rest [18]
Norway	Norwegen
Oman	Britisch Ostafrika [6]
Palau	Ozeanien, Rest [18]
Pakistan	Britisch Indien [8]
Panama	Panama
Papua New Guinea	Kaiser-Wilhelms-Land und Deutsch Neu-Guinea
Paraguay	Paraguay
Peru	Peru
Philippines	Philippinen
Pitcairn	Ozeanien, Rest [18]
Poland	(Polen = excluded)
Portugal	Portugal
Qatar	Türkei [15]
Romania	Rumänien
Russia	Russland [14]
Rwanda	Deutsch Ostafrika [2]
Saint Helena	Britisch Westindien [18]
Samoa	Samoa-Inseln[2]
San Marino	Italien [3]
Sao Tome und Principe	Portugiesisch Westafrika [4]
Saudi Arabia	Türkei [15]
Senegal	Französisch Westafrika [10]
Serbien	Serbien
Seychilles	Ceylon und die Malediven [4]
Sierra Leone	Britisch Westafrika [5]
Singapore	Straits Settlements [2]
Slovakia	Österreich-Ungarn [7]
Slovenia	Österreich-Ungarn [7]
Soloman Islands	Ozeanien, Rest [18]
Somalia	Britisch Ostafrika [6]
South Africa	Britisch Südafrika [6]
South Korea	Korea [2]
Spain	Spanien [4]
Sri Lanka	Ceylon und die Malediven [4]
St. Barthélemy (ab 2013)	Französisch Westindien [2]
St. Kitts and Nevis	Britisch Westindien [18]
St. Lucia	Britisch Westindien [18]
St. Martin (niederländischer Teil) (ab 2013)	Niederländisch Westindien [6]
St. Vincent and the Grenadines	Britisch Westindien [18]
Sudan	Ägypten [3]
Suriname	Niederländisch Westindien [6]
Swaziland	Britisch Südafrika [6]
Sweden	Schweden
Switzerland	Schweiz [2]
Syria	Türkei [15]

Continued on next page

Table D11 – *Continued from previous page*

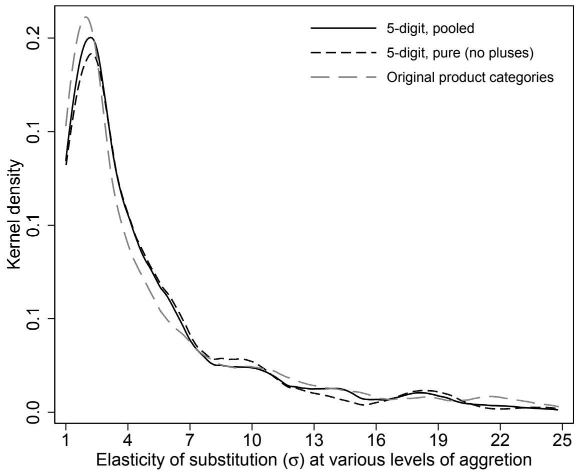
Country as in Eurostat (2017)	Country as in German 1913 statistics
Südsudan (ab 2013)	Ägypten [3]
TOKELAU	Neuseeland [2]
Taiwan	China [4]
Tajikistan	Russland [14]
Tanzania	Deutsch Ostafrika [2]
Thailand	Siam
Timor-Leste (ab 2001)	Ozeanien, Rest [18]
Togo	Deutsch Westafrika [2]
Tonga	Ozeanien, Rest [18]
Trinidad and Tobago	Portugiesisch Westafrika [4]
Tunisia	Tunesien
Turkey	Türkei [15]
Turkmenistan	Russland [14]
Tuvalu	Ozeanien, Rest [18]
Uganda	Britisch Ostafrika [6]
Ukraine	Russland [14]
United Arab Emirates	Türkei [15]
United States	Vereinigte Staaten von Amerika
Uruguay	Uruguay
Uzbekistan	Russland [14]
Vanatu	Ozeanien, Rest [18]
Venezuela	Venezuela
Vietnam	Französisch Indien [2]
Wallis and Futuna	Ozeanien, Rest [18]
Yemen	Aden, Bahrein, Kameran, Kuria-Muria und Perim [2]
Zambia	Britisch Südafrika [6]
Zimbabwe	Britisch Südafrika [6]

Countries in parentheses do not appear in the historical trade statistics. Numbers in brackets indicate the number of modern-day countries absorbed by 1913-country. Source: See Section 4.1.

C More on the Estimated Elasticities of Substitution

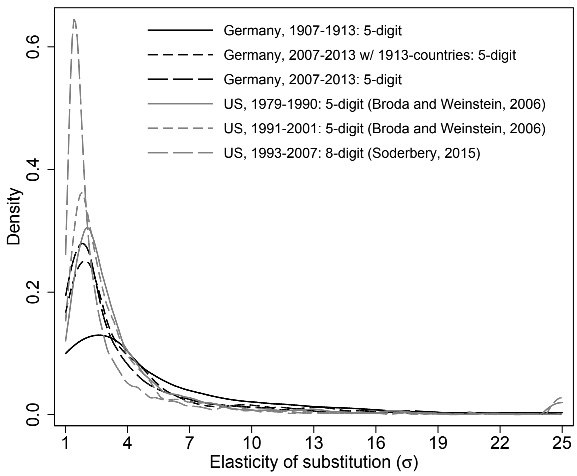
C.1 Additional Distributions of Elasticities of Substitution

Figure D6
Distribution of Elasticities of Substitution Compared (A)



The display but not the shape of the density is truncated at $\sigma_k = 25$ for exposition. Source: Own calculations.

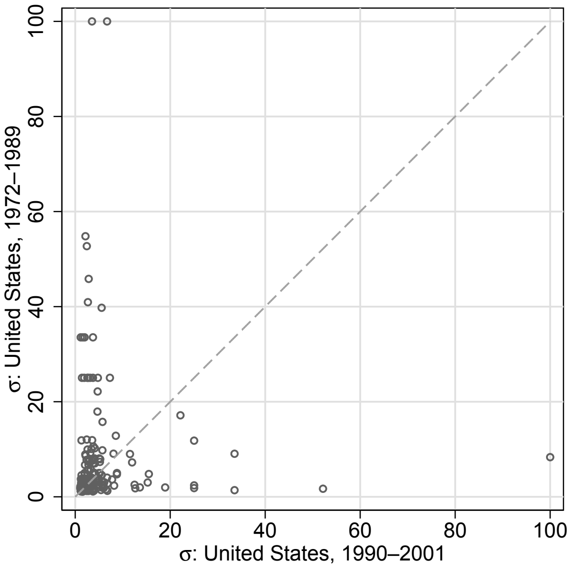
Figure D7
Distribution of Elasticities of Substitution Compared (B)



The display but not the shape of the density is truncated at $\sigma_k = 25$ for exposition. Note that the elasticities for Germany are estimated based on SITC revision 4, US elasticities for 1979 to 1990 are based on SITC revision 2, US elasticities for 1991 to 2001 are based on SITC revision 3 and US elasticities for 1993 to 2007 are based on the Harmonised System at the eight-digit level. While different revisions of the SITC still allow comparisons between them, the latter set of estimated elasticities is not comparable right away: The higher granularity means that elasticities should be higher than those estimated at the five-digit level due to greater substitutability between varieties within more narrowly defined categories. This implies that US elasticities based on the Soderbery-method should be even more left-leaning. Consider table D11 in Appendix D11 for a conversion list of today's countries to 1913-countries. Source: Elasticities for Germany from own calculations; US elasticities come from Broda and Weinstein (2006) and Soderbery (2015).

C.2 Elasticities of Substitution of Broda and Weinstein

Figure D8
Estimated Elasticities by Broda and Weinstein Compared



Items at three-digit level based on revision 2 and 3. This difference causes some unavoidable, but minor imprecision due to the fact that some items were re-classified between the two revisions (see Chapter **??**, for a discussion of this). Only items considered with active trade in both periods. Note that all $\sigma_k > 100$ have been truncated to 100. Source: Broda and Weinstein (2006).

C.3 Estimated Elasticities of Substitution Per Three-Digit Sector

Table D12
Elasticities of Substitution at the Three-digit level

Item	Description	σ_k First glob.	Second glob. (with 1913-borders)
0++	NO DESCRIPTION	1.8	
001	Live animals other than animals of divis [...]	100.0*	(19.1)
011	NO DESCRIPTION	75.7	4.4 (24.6)
012	Other meat and edible meat offal, fresh, [...]	2.7	1.3 (2.2)
016	Meat and edible meat offal, salted, in b [...]		7.4 (2.5)
017	Meat and edible meat offal, prepared or [...]	1.7	1.1*
022	NO DESCRIPTION		1.4 (6.1)
023	Butter and other fats and oils derived f [...]		3.2 (3.6)
024	Cheese and curd	2.1	71.0 (19.4)
025	Eggs, birds', and egg yolks, fresh, drie [...]	13.4	3.7
034	NO DESCRIPTION		7.6 (1.1*)
035	Fish, dried, salted or in brine; smoked [...]	2.5	100.0* (1.7)
036	Crustaceans, molluscs and aquatic invert [...]	100.0*	2.1
037	Fish, crustaceans, molluscs and other aq [...]	1.7	100.0* (1.5)
041	Wheat (including spelt) and meslin, unmi [...]	19.2	1.4 (3.2)
042	Rice	4.0	15.4 (12.1)
043	Barley, unmilled	1.5	(1.7)
044	Maize (not including sweet corn), unmill [...]	100.0*	13.1
045	Cereals, unmilled (other than wheat, ric [...]	1.8	26.9 (4.7)
046	Meal and flour of wheat and flour of mes [...]	2.8	7.4 (4.4)
047	Other cereal meals and flours	3.9	1.5 (4.7)
048	Cereal preparations and preparations of [...]	1.9	53.3 (1.4)
054	NO DESCRIPTION	4.6	13.6 (2.5)
056	Vegetables, roots and tubers, prepared o [...]	1.1	1.3
057	Fruit and nuts (not including oil nuts), [...]	16.1	11.6 (9.6)
058	Fruit, preserved, and fruit preparations [...]	2.4	3.4 (16.9)
059	Fruit juices (including grape must) and [...]		1.2 (2.0)
061	NO DESCRIPTION	2.3	2.8 (2.7)
062	Sugar confectionery	5.1	2.4 (7.6)
071	NO DESCRIPTION	2.3	(9.2)
072	Cocoa		1.7 (4.5)
073	Chocolate and other food preparations co [...]	5.7	1.9 (8.7)
074	Tea and maté	2.0	2.1 (8.5)
075	Spices	2.1	4.0
081	Feeding stuff for animals (not including [...]		5.0 (10.2)
091	Margarine and shortening	1.1	16.0 (1.8)
098	Edible products and preparations, n.e.s.	3.6	4.6 (1.4)
099	NO DESCRIPTION		12.7 (42.7)
111	NO DESCRIPTION		1.3
112	Alcoholic beverages	6.1	3.4 (10.5)
121	NO DESCRIPTION	1.4	4.9 (5.5)
122	Tobacco, manufactured (whether or not co [...]	1.6	1.6 (1.7)
199	NO DESCRIPTION		23.6 (2.7)
21+	NO DESCRIPTION	18.2	
211	Hides and skins (except furskins), raw	2.4	4.0 (4.0)
212	Furskins, raw (including heads, tails, p [...]	1.2	1.7
222	NO DESCRIPTION		2.2 (1.5)
223	Oil-seeds and oleaginous fruits, whole o [...]	5.6	7.2 (1.5)

Continued on next page

Table D12 – *Continued from previous page*

Item	Description	σ_k First glob.	Second glob. (with 1913-borders)
231	NO DESCRIPTION	100.0*	7.2 (5.5)
232	Synthetic rubber; reclaimed rubber; wast [...]		8.0 (15.5)
244	NO DESCRIPTION	7.5	5.7 (9.4)
245	Fuel wood (excluding wood waste) and woo [...]	11.1	1.9 (37.1)
246	Wood in chips or particles and wood wast [...]	4.5	9.8 (4.5)
247	Wood in the rough, whether or not stripp [...]	1.4	17.7 (4.0)
248	Wood, simply worked, and railway sleeper [...]	7.8	1.9 (2.2)
251	NO DESCRIPTION	1.7	7.1 (2.2)
261	NO DESCRIPTION	6.9	2.0
263	Cotton	9.6	6.5 (2.6)
264	Jute and other textile bast fibres, n.e. [...]		2.1 (5.2)
265	Vegetable textile fibres (other than cot [...]	2.6	2.1 (4.7)
266	Synthetic fibres suitable for spinning		1.4 (1.2)
267	Other man-made fibres suitable for spinn [...]		13.7 (2.2)
268	Wool and other animal hair (including wo [...]	3.1	2.0 (2.2)
269	Worn clothing and other worn textile art [...]		10.2 (2.0)
272	NO DESCRIPTION	1.8	3.1 (22.6)
273	Stone, sand and gravel	9.3	2.3 (6.7)
274	Sulphur and unroasted iron pyrites	2.0	(2.2)
277	Natural abrasives, n.e.s. (including ind [...]	1.7	100.0* (100.0*)
278	Other crude minerals	1.3	1.9 (3.9)
281	Iron ore and concentrates	13.9	7.8 (1.9)
282	Ferrous waste and scrap; remelting scrap [...]	9.9	1.5 (1.2)
283	Copper ores and concentrates; copper mat [...]		10.1 (10.1)
284	Nickel ores and concentrates; nickel mat [...]		3.3 (2.9)
285	Aluminium ores and concentrates (includi [...]	4.5	4.5 (4.0)
287	Ores and concentrates of base metals, n. [...]	1.7	1.4 (1.4)
288	Non-ferrous base metal waste and scrap, [...]	2.9	7.8 (2.1)
289	Ores and concentrates of precious metals [...]	1.4	1.1* (1.1)
291	Crude animal materials, n.e.s	24.4	35.2 (34.7)
292	Crude vegetable materials, n.e.s.	4.9	1.2 (1.3)
299	NO DESCRIPTION		(100.0*)
321	Coal, whether or not pulverized, but not [...]	100.0*	4.4 (2.8)
322	Briquettes, lignite and peat	2.3	
325	Coke and semi-coke (including char) of c [...]	3.3	2.4 (1.9)
333	NO DESCRIPTION	6.7	13.4 (9.1)
334	Petroleum oils and oils obtained from bi [...]	4.4	9.1 (2.8)
335	Residual petroleum products, n.e.s., and [...]		3.4
342	NO DESCRIPTION		3.6 (3.6)
343	Natural gas, whether or not liquefied		1.7 (1.2)
344	Petroleum gases and other gaseous hydroc [...]		6.0
399	NO DESCRIPTION		54.4 (100.0*)
411	NO DESCRIPTION	18.1	(1.8)
42+	NO DESCRIPTION	1.7	
421	NO DESCRIPTION	3.6	23.4 (4.1)
422	Fixed vegetable fats and oils, crude, re [...]	5.2	7.1
431	NO DESCRIPTION	100.0*	11.9 (4.7)
499	NO DESCRIPTION		(10.8)
511	NO DESCRIPTION	8.0	2.3 (2.8)
512	Alcohols, phenols, phenol-alcohols, and [...]		3.7 (4.7)
513	Carboxylic acids and their anhydrides, h [...]	35.5	
514	Nitrogen-function compounds		1.1* (1.9)
515	Organo-inorganic compounds, heterocyclic [...]		2.7

Continued on next page

Table D12 – *Continued from previous page*

Item	Description	σ_k First glob.	Second glob. (with 1913-borders)
516	Other organic chemicals	2.6	2.3 (1.7)
522	NO DESCRIPTION	2.2	(1.6)
523	Salts and peroxysalts, of inorganic acid [...]		1.3 (1.5)
524	Other inorganic chemicals; organic and i [...]		1.1 (1.2)
525	Radioactive and associated materials		5.0
531	NO DESCRIPTION	62.3	5.9 (2.6)
532	Dyeing and tanning extracts, and synthet [...]		14.8
533	Pigments, paints, varnishes and related [...]	4.1	3.3 (3.1)
54+	NO DESCRIPTION	1.7	
541	NO DESCRIPTION	1.7	3.6
542	Medicaments (including veterinary medica [...]	9.0	2.0 (5.4)
551	NO DESCRIPTION	31.6	1.7
553	Perfumery, cosmetic or toilet preparatio [...]	3.9	(6.8)
554	Soap, cleansing and polishing preparatio [...]		3.2 (2.1)
562	NO DESCRIPTION	2.4	5.3 (4.6)
571	NO DESCRIPTION		3.4 (5.3)
572	Polymers of styrene, in primary forms		2.4 (9.2)
573	Polymers of vinyl chloride or of other h [...]		4.2 (2.1)
574	Polyacetals, other polyethers and epoxid [...]		2.4 (8.6)
575	Other plastics, in primary forms		1.4 (1.5)
579	Waste, parings and scrap, of plastics		2.7 (1.1)
581	NO DESCRIPTION		2.4 (1.4)
582	Plates, sheets, film, foil and strip, of [...]	76.1	10.5 (5.4)
583	Monofilament of which any cross-sectiona [...]		(8.7)
591	NO DESCRIPTION		2.1 (1.8)
592	Starches, inulin and wheat gluten; album [...]		4.1 (6.7)
593	Explosives and pyrotechnic products		1.5 (1.4)
597	Prepared additives for mineral oils and [...]	41.0	(2.1)
598	Miscellaneous chemical products, n.e.s.	8.7	2.8
599	Residual products of the chemical or all [...]		1.7 (33.4)
600	NO DESCRIPTION		1.1* (2.2)
611	NO DESCRIPTION	2.0	3.1 (3.6)
612	Manufactures of leather or of compositio [...]	6.0	4.6 (20.2)
613	Furskins, tanned or dressed (including h [...]		1.9 (2.3)
621	NO DESCRIPTION	4.7	1.4 (18.9)
625	Rubber tyres, interchangeable tyre tread [...]	2.5	19.4 (15.7)
629	Articles of rubber, n.e.s.	50.7	2.9 (14.4)
633	NO DESCRIPTION	1.9	(4.0)
634	Veneers, plywood, particle board, and ot [...]	1.7	57.6 (4.2)
635	Wood manufactures, n.e.s.	1.6	(7.3)
641	NO DESCRIPTION	2.0	4.4 (2.3)
642	Paper and paperboard, cut to size or sha [...]	2.6	4.9 (12.2)
651	Textile yarn	1.6	(1.1)
652	Cotton fabrics, woven (not including nar [...]	9.7	1.2 (2.0)
653	Fabrics, woven, of man-made textile mate [...]		2.1 (1.6)
654	Other textile fabrics, woven	1.2	1.6 (1.6)
655	Knitted or crocheted fabrics (including [...]	17.4	1.6 (1.4)
656	Tulles, lace, embroidery, ribbons, trimm [...]	1.4	1.8
657	Special yarns, special textile fabrics a [...]	2.1	1.2 (1.1*)
658	Made-up articles, wholly or chiefly of t [...]	1.4	4.1 (1.7)
659	Floor coverings, etc.	1.9	3.3 (3.1)
661	NO DESCRIPTION	1.2	3.5
662	Clay construction materials and refracto [...]	12.4	1.1 (31.5)

Continued on next page

Table D12 – *Continued from previous page*

Item	Description	σ_k First glob.	σ_k Second glob. (with 1913-borders)
663	Mineral manufactures, n.e.s.	1.5	1.3 (1.5)
664	Glass		1.8 (1.7)
665	Glassware	52.9	1.7 (23.9)
666	Pottery	2.3	1.4 (1.7)
667	Pearls and precious or semiprecious ston [...]	2.1	3.3 (1.4)
671	NO DESCRIPTION	1.2	1.4 (1.3)
672	Ingots and other primary forms, of iron [...]	4.0	4.5 (3.3)
673	Flat-rolled products of iron or non-allo [...]	1.1	8.2
674	Flat-rolled products of iron or non-allo [...]	2.8	1.9 (1.8)
675	Flat-rolled products of alloy steel		3.5 (28.5)
676	Iron and steel bars, rods, angles, shape [...]	1.3	70.2 (100.0*)
677	Rails or railway track construction mate [...]	6.2	2.5 (3.3)
678	Wire of iron or steel	9.9	8.8 (20.1)
679	Tubes, pipes and hollow profiles, and tu [...]		2.2 (6.8)
681	NO DESCRIPTION	1.2	1.5 (1.7)
682	Copper	9.8	4.7 (1.5)
683	Nickel	1.1	(9.5)
684	Aluminium	11.1	20.4 (23.7)
685	Lead	1.9	2.7 (2.8)
686	Zinc	2.6	1.9 (1.3)
687	Tin	3.1	11.0 (6.0)
689	Miscellaneous non-ferrous base metals em [...]		1.9
691	NO DESCRIPTION	1.8	8.3 (5.9)
692	Metal containers for storage or transpor [...]	1.5	10.5 (31.6)
693	Wire products (excluding insulated elect [...]	1.3	(32.0)
694	Nails, screws, nuts, bolts, rivets and t [...]	1.4	3.6 (2.9)
695	Tools for use in the hand or in machines	3.0	9.2 (1.1)
696	Cutlery	1.1	5.6
697	Household equipment of base metal, n.e.s [...]	2.5	1.9
699	Manufactures of base metal, n.e.s.	3.4	10.0 (11.1)
7++	NO DESCRIPTION	9.0	
700	NO DESCRIPTION		2.1 (7.6)
711	NO DESCRIPTION	1.5	2.2 (2.2)
712	Steam turbines and other vapour turbines [...]	37.0	1.6 (1.4)
713	Internal combustion piston engines and p [...]	2.8	3.5 (3.7)
714	Engines and motors, non-electric (other [...]	4.3	2.0 (1.1)
716	Rotating electric plant and parts thereo [...]	1.3	1.2 (1.1*)
718	Power-generating machinery and parts the [...]	3.1	(1.1*)
721	NO DESCRIPTION		(3.0)
722	Tractors (other than those of headings 7 [...]		7.5 (15.3)
723	Civil engineering and contractors' plant [...]		1.4 (1.4)
724	Textile and leather machinery and parts [...]	5.9	48.2 (2.9)
725	Paper mill and pulp mill machinery, pape [...]	21.3	1.4 (2.4)
726	Printing and bookbinding machinery and p [...]	2.1	47.9 (1.6)
727	Food-processing machines (excluding dome [...]	3.8	4.4 (2.1)
728	Other machinery and equipment specialize [...]	72.4	7.5 (2.4)
731	NO DESCRIPTION		3.1 (13.5)
733	Machine tools for working metal, sintere [...]	6.9	1.4 (1.8)
735	Parts, n.e.s., and accessories suitable [...]		3.2 (2.4)
737	Metalworking machinery (other than machi [...]		3.1 (2.1)
741	NO DESCRIPTION		18.3
742	Pumps for liquids, whether or not fitted [...]	1.4	1.6 (1.5)
743	Pumps (other than pumps for liquids), ai [...]	30.9	1.1* (13.5)

Continued on next page

Table D12 – *Continued from previous page*

Item	Description	σ_k First glob.	σ_k Second glob. (with 1913-borders)
744	Mechanical handling equipment and parts [...]	1.7	9.5 (4.7)
745	Non-electrical machinery, tools and mech [...]	2.5	1.4
746	Ball- or roller bearings		(4.1)
748	Transmission shafts (including camshafts [...]		2.1
749	Non-electric parts and accessories of ma [...]	1.9	4.2 (7.3)
751	NO DESCRIPTION	100.0*	1.7 (2.4)
752	Automatic data-processing machines and u [...]		3.2 (3.1)
759	Parts and accessories (other than covers [...]		1.6 (1.7)
761	NO DESCRIPTION		1.4 (1.3)
762	Reception apparatus for radio-broadcasti [...]		(1.7)
763	Sound recording or reproducing apparatus [...]		5.4 (6.6)
764	Telecommunications equipment, n.e.s., an [...]		13.5
771	NO DESCRIPTION	1.3	(6.1)
772	Electrical apparatus for switching or pr [...]		1.4 (2.1)
773	Equipment for distributing electricity, [...]	3.5	2.5 (43.0)
774	Electrodiagnostic apparatus for medical, [...]		3.1 (1.2)
775	Household-type electrical and non-electr [...]		100.0* (49.7)
776	Thermionic, cold cathode or photo-cathod [...]		1.8 (1.1)
778	Electrical machinery and apparatus, n.e. [...]	4.6	1.9 (1.2)
781	NO DESCRIPTION	21.7	1.7
782	Motor vehicles for the transport of good [...]	5.6	(5.6)
783	Road motor vehicles, n.e.s.		1.4 (1.1*)
784	Parts and accessories of the motor vehic [...]	1.2	4.2 (1.5)
785	Motor cycles (including mopeds) and cycl [...]	5.2	(1.6)
786	Trailers and semi-trailers; other vehicl [...]		2.6 (2.1)
791	NO DESCRIPTION	1.3	3.5 (2.0)
792	Aircraft and associated equipment; space [...]		1.1 (1.1)
793	Ships, boats (including hovercraft) and [...]	40.5	1.5 (10.3)
799	NO DESCRIPTION		100.0* (100.0*)
800	NO DESCRIPTION		4.9 (4.0)
811	NO DESCRIPTION		4.4 (4.4)
812	Sanitary, plumbing and heating fixtures [...]		4.0 (6.1)
821	NO DESCRIPTION		4.1 (13.8)
831	NO DESCRIPTION		3.9 (3.6)
841	NO DESCRIPTION	25.8	2.3 (1.8)
842	Women's or girls' coats, capes, jackets, [...]	1.3	(1.1*)
843	Men's or boys' coats, capes, jackets, su [...]	100.0*	25.3
844	Women's or girls' coats, capes, jackets, [...]		1.6
845	Articles of apparel, of textile fabrics, [...]	5.7	3.5 (28.5)
846	Clothing accessories, of textile fabrics [...]	55.0	1.7 (1.3)
848	Articles of apparel and clothing accesso [...]	2.2	3.0 (1.5)
851	NO DESCRIPTION	1.9	(9.9)
871	NO DESCRIPTION	7.1	1.6 (1.1)
872	Instruments and appliances, n.e.s., for [...]	1.4	1.8 (2.6)
873	Meters and counters, n.e.s.	6.4	2.8 (1.2)
874	Measuring, checking, analysing and contr [...]		4.9
881	NO DESCRIPTION		1.9 (2.2)
882	Photographic and cinematographic supplie [...]		2.9 (1.6)
883	Cinematographic film, exposed and develo [...]		10.8 (1.5)
884	Optical goods, n.e.s.	18.0	27.8 (1.2)
885	Watches and clocks	3.8	3.4 (1.1)
891	NO DESCRIPTION	1.1*	2.9 (4.0)
892	Printed matter	45.9	2.0 (1.6)

Continued on next page

Table D12 – *Continued from previous page*

Item	Description	σ_k First glob.	Second glob. (with 1913-borders)
893	Articles, n.e.s., of plastics	3.5	3.4 (37.0)
894	Baby carriages, toys, games and sporting [...]	11.8	(5.1)
895	Office and stationery supplies, n.e.s.		(1.2)
896	Works of art, collectors' pieces and ant [...]	100.0*	2.0 (1.6)
897	Jewellery, goldsmiths' and silversmiths' [...]		1.7 (1.7)
898	Musical instruments and parts and access [...]	7.8	5.9 (2.4)
899	Miscellaneous manufactured articles, n.e [...]	2.3	32.4
931	NO DESCRIPTION		2.1 (2.2)
941	NO DESCRIPTION		1.2
961	NO DESCRIPTION	4.4	(100.0*)
971	NO DESCRIPTION	1.8	1.1 (1.1)
972	NO DESCRIPTION		20.5 (1.1*)
999	NO DESCRIPTION		1.9 (1.8)

* Truncated; see text. SITC items based on revision 4. Based on data as exposed in Section 4.1 and estimations as described in Section 5.