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

Wolf-Fabian Hungerland

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## 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 and that the structure of demand is not easily approximated by using a single elasticity of substitution, which is often done in the literature. 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.

JEL classification: F12, F14, F61, N33, N74

Keywords: Product variety, elasticity of substitution, gains from trade, first globalisation

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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). The consumers' side is more sidelined, however, as indicated by Krugman's (1993) quote above. There are studies, also historical ones, that approximate consumer gains with measuring the availability of goods that were previously not imported or ceased to be imported. Approaches based on this extensive margin, however, are typically mute about the effect on actual consumption. 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.<sup>1</sup> 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. For this reason 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

<sup>1</sup> 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.

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 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 summarises the related 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 1492. They find that adding goods such as tea, coffee and sugar is worth 10 percent of the average income. [Costinot and Donaldson \(2016\)](#) use extremely 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. They do not focus on welfare but trade policy and They calculate sectoral elasticities of substitution with respect to tariffs and evaluate counterfactuals over British trade policy. Their findings suggest that the structure of demand as captured by these elasticities has highly significant explanatory power for Britain's country-specific tariff setup.

Other than that, however, the economic historiography of international trade has only started to explore very rich, disaggregated data ([Meissner, 2015](#)). These newer papers have moved the

extensive margin of international trade into focus, that is, entry and exit of goods or industries (see also [Hungerland, 2017](#), or Chapter ?? in this thesis). The extensive margin also includes the 'new goods margin', but all these papers explore the he extensive margin typically in terms of export growth and its decompositions. In this paper I consider the 'new goods' margin from an import perspective using the universe of available goods, observed in import records. This data includes colonial goods, but it also observes all other products imported, such as fabrics, meat or machines. 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 ( $\sigma$ ) 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, generally speaking, [Ruhl \(2008\)](#) observes an 'international elasticity puzzle', i.e. a substantial discrepancy between aggregate and microeconomic estimates of the trade elasticity, an elasticity closely related to the elasticity of substitution in many models. [Imbs and Mejean \(2017\)](#), for instance, show that elasticities already at the three-digit level vary greatly across countries. They attribute this to countries' patterns of production and the fact that given sector-level elasticity displays considerable cross-country heterogeneity. 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 seminal method of [Feenstra \(1994\)](#) are biased upwards (a circumstance also relevant to this paper, since I will use [Soderbery's \(2015\)](#) improved version of the Feenstra method).

All this also matters for historical applications and the longer run. There are indeed only very few historical assessments of this elasticity, and if so they focus on particular goods. [Irwin \(2000\)](#), for instance, estimates the elasticity of substitution of pig iron for the late nine-

teenth 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 easily 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) 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; Hungerland and Wolf, 2017b).

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. Due to the lack of estimated demand elasticities, many studies take adhoc elasticities to plug in their models. This holds particularly for historical applications. (Jacks *et al.*, 2011) estimate long-run trade costs from 1870 to 2000; but 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.<sup>2</sup> 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

<sup>2</sup> The term  $(\sigma - 1)$  corresponds to the Fréchet parameter  $\theta$  in the trade costs in Eaton and Kortum (2002). For his gravity application, Chaney (2008) estimates  $\gamma/\sigma-1$  where  $\gamma$  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.



this background, particularly the historical elasticities of substitution I provide may serve as benchmarks a bit closer to the truth than previously assumed elasticities.

### 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 to 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

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

The composite imported good is defined as

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

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  $K$ .<sup>3</sup>

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.<sup>4</sup> 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

<sup>3</sup> 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,  $\sigma_k$ , below.

<sup>4</sup> [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.

variety  $i$  of good  $k$  in period  $t$  at price  $p_{ikt}$ , so that

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

with the elasticity of substitution between varieties of the same good  $\sigma_k > 1 \quad \forall \quad k \in K$ ,<sup>5</sup> 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.<sup>6</sup> 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<sup>7</sup>

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

The expenditure function  $e(p_t, K_t)$  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*

<sup>5</sup> Note that with many goods the elasticity of demand is approximately equal to the good-specific constant elasticity of substitution  $\sigma_k$  Feenstra (2016). See also footnote 3.

<sup>6</sup> 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.

<sup>7</sup> Note that the functional form requires marginal costs to be fixed.

optimal for the prices and utility, i.e.  $c_{kt} = U_t \left( \frac{\partial e}{\partial p_{kt}} \right)$ , then

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

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

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

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  $b_k$ s, 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.<sup>8</sup>

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  $\sigma_k > 1$*

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

<sup>8</sup> 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  $\lambda_t(K)$  and  $\lambda_{t-1}(K)$  are constructed as the product variety formula

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

where  $r = t, t - 1$ .

The ratio  $\lambda_r(K) \leq 1$  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  $\lambda_k$ -ratio adjusts the price index to account for consumer valuation of these varieties. The *corrected*  $\lambda$ -ratio is the  $\lambda_k$ -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.<sup>9</sup>

The question, however, is by how much living costs fall. The answer depends on the size of this bias and the elasticity of substitution  $\sigma_k$ .<sup>10</sup> 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  $\sigma_k$  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 substi-

<sup>9</sup> Which means that the model only implicitly accounts for import constraints or frictions.

<sup>10</sup> In standard comparative advantage models using 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).

tution. Note that in turn, if goods with low substitutability break away or become more expensive, the welfare losses are particularly big.<sup>11</sup>

With all exact good-specific price indices that allow for both new varieties and taste or quality changes in existing varieties an aggregate exact import price index following [Broda and Weinstein \(2006\)](#) can be calculated to one CES aggregate import good.

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

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

where

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

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](#)).

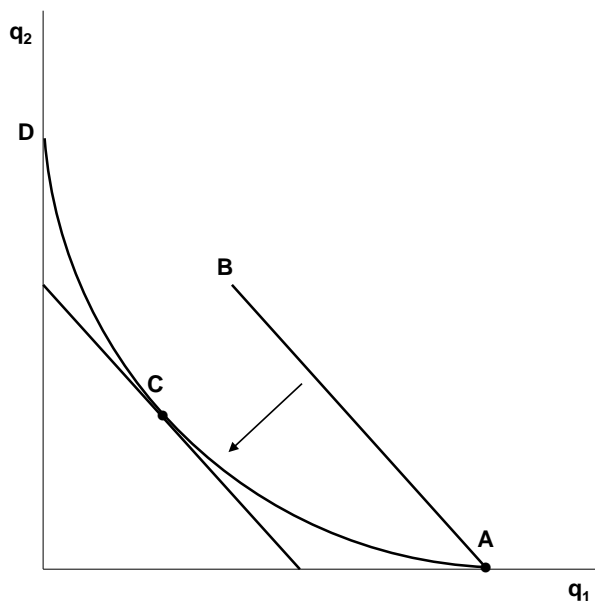
First, it allows for changes in quality or taste. Second, it allows for heterogeneity in goods-level demand responses due to different elasticities of substitution over goods. This eliminates the 'symmetry bias' arising from the assumption of perfectly interchangeable goods. Third, it is robust to the 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

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

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

<sup>11</sup> To illuminate how  $\sigma_k$  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 \(2016\)](#).

## 4 Data

### 4.1 Sources

The empirical base for what follows is a combination of modern and historical data – that is, data from two different episodes of globalisation. Broadly speaking, 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. The second globalisation – the one we find ourselves now in – is generally about de-industrialisation, at least in the Western economies.<sup>12</sup> 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, loosely speaking, the end of World War II is the start of the second globalisation.

<sup>12</sup> 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.

For getting hold of the welfare gains from growing import variety, aggregate trade flows must be disaggregated down to the product level in a intertemporally 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 a non-standardised form. National or multilateral efforts to generate harmonised international statistics were still in their infancy. The classification of goods changed regularly. That implies standardising product categories means aggregating, which in turn requires reasonably finely observed original data. 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). [Hungerland and Altmeppen \(2017\)](#) (or Chapter ?? in this thesis) do so for the historical German data and show that applying a modern classification such as the SITC to historical data yields a dataset ready to compare with modern trade data.<sup>13</sup> [Hungerland and Wolf \(2017a\)](#) (or Chapter ?? in this thesis) use their work and compile a dataset that 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.

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 but not the historical trade 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.<sup>14</sup>

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, much more granular trade data—say at the ten-digit or even firm level—enables other studies to find much more precise measures welfare. Such data is, however, often not available for periods before the year

<sup>13</sup> 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 [Hungerland and Altmeppen \(2017\)](#) 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.

<sup>14</sup> 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 [34](#), footnote [19](#) and footnote [34](#).

2000. Using historical data basically prohibits further disaggregation. Yet even when using the mostly five-digit data, as I do here, we learn something about the world because five-digit goods are far from perfect substitutes over Armington-varieties. Against this background, it is 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. This paper explores the substitutability between products in two comparable episodes of globalisation. And regarding data from the first globalisation, the data is the best data available.<sup>15</sup>

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. Given that 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 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 aggregating today's country space to that of 1913. Aggregating the country space of modern German statistics to that of 1913 means that the 234 countries are pooled down to 96 countries.

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. At this time, 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 flagged out, for instance, by [Wolf \*et al.\* \(2011\)](#)—have to be assumed away. The data prohibits, however, 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)

<sup>15</sup> Indeed, [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.



and the Dutch West Indies (6).<sup>16</sup> Table D11 in the appendix lists the entire country space, including historical counterparts.

## 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 reason for why I start only in 1907 and not before is the quality of unit values. In spring 1906, the government implemented the Bülow tariff. The implementation of the tariff came along with 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—which will proxy prices—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.<sup>17</sup>

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.

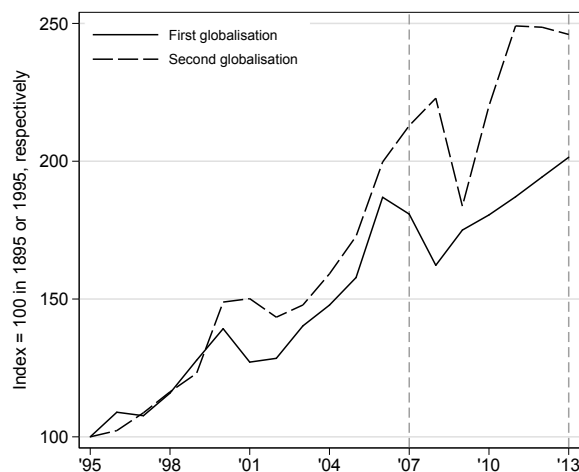
The implication of using a sample of *only* six years, i.e. a rather small time span covered, is that we would not assume too much change in variety.<sup>18</sup> Nonetheless, the rise in Germany's imports in the two globalisation episodes has been accompanied by a rise in imported varieties. Table 1 gives an overview of the extent of this increase in both periods along the extensive margin. Recall that a good ( $k$ ) is defined as SITC five-digit item and a variety of  $k$ ,  $i_k$ ,

<sup>16</sup> 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.

<sup>17</sup> 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 consisted of up to 140 experts that regularly consulted with industry representatives. (Hoffmann, 1965, p. 571-573) is most in-depth discussion of this. He suggests that after 1906, import prices are subject to meaningful cross-country variation. See also Hungerland and Wolf (2017a) or Chapter ?? in this thesis.

<sup>18</sup>Section 6 takes the discussion of this further.

FIGURE 2  
IMPORTS, 1895-1913 AND 1995-2013



Vertical lines mark time periods which are compared in Section 5. Import values, deflated to 1913-marks and 2016-euros, respectively, then re-based to 100 in 1895 and 1995 respectively. Source: Own calculations based on data as exposed in Section 4.1.

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 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, namely 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 number, expectedly, turn out smaller, both in absolute terms as well as in relations: 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

TABLE 1  
VARIETY IN GERMAN IMPORTS IN TWO GLOBALISATIONS

|                      | Year | (1)<br>Number of<br>SITC<br>five-digit<br>categories | (2)<br>Number<br>of<br>varieties | (3)<br>Median<br>number of<br>exporting<br>countries | (4)<br>Average<br>number of<br>exporting<br>countries | (5)<br>Share of<br>total<br>German<br>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<br>(67,986)               | 36<br>(27)   | 39.3<br>(28.1)  | 100.0   |
| All 2013 goods       | 2013 | 2,954  | 92,332<br>(70,031)               | 38<br>(28)   | 40.9<br>(28.8)  | 100.0   |
| Common               | 2007 | 2,912  | 88,196<br>(67,866)               | 36<br>(27)   | 39.5<br>(28.2)  | 97.1  |
|                      | 2013 |  | 91,940<br>(69,734)               | 38<br>(28)   | 41.0<br>(28.9)  | 93.9  |
| 2007, not in 2013    | 2007 | 28   | 127<br>(120)                     | 7<br>(7)   | 6.7<br>(6.0)  | 2.9   |
| 2013, not in 2007    | 2013 | 42   | 392<br>(297)                     | 26<br>(17)   | 23.0<br>(15.9)  | 6.1   |

Varieties are 'Armington', that is, varieties are country-good pairs. Parentheses indicate values for 1913-borders. Shares in percent of total import value. Source: Own calculations based on data as exposed in Section 4.1.

numbers between the two episodes—even with 1913 borders—indicate 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. It stands out that the number of varieties in the 'common' set of goods. 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. Somewhat surprisingly, however, it turns out that the in one hundred years of globalisation there is not so much difference in the ranking of some 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 today Austria-Hungary was one of the top two trade partners back then, but lost ground – very probably due to territorial reasons. among others: 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 more economic territories under Austria-Hungary.

More generally, using modern trade data with the set of 1913-countries shows this 'empire disintegration' effect. The three Eastern empires and China would supply the broadest range of

TABLE 2  
MAJOR SOURCES OF VARIETY, RANKED BY THE NUMBER OF GOODS SUPPLIED

| Rank | 1907-1913             | 2007-2013            | 2007-2013 with<br>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)                   |

\* Note that Poland was divided in parts that belonged to Austria-Hungary, German Empire and the Russian Empire. Ranked according to the average number of SITC five-digit goods imported by Germany from given country over respective period. Import share in percent of total imports, pooled over period, in parentheses. Ranking based on the number of goods imported from source country in given year. Source: Own calculations based on data as exposed in Section 4.1.

products. This is for different reasons. Former members of the double-monarchy are industrialised economies supplying Germany with intermediates. Former members of the Russian Empire supply much more energy than anything else, that is, primarily oil and gas. 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.<sup>19</sup>

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. More generally, the table 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.

<sup>19</sup> 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 import 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 34 and footnote 34.

TABLE 3  
COUNTRIES' CONTRIBUTION TO VARIETY GROWTH AND IMPORT SHARES

| Rank | 1907-1913      |              |              | 2007-2013 |              |              | 2007-2013, with 1913-borders |              |              |
|------|----------------|--------------|--------------|-----------|--------------|--------------|------------------------------|--------------|--------------|
|      | Supplier       | Contribution | Import share | Supplier  | Contribution | Import share | Supplier                     | Contribution | 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        |

\* 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. Contributions are recorded in percent and measure country  $i$ 's share in total variety growth  $((N_{iKt} - N_{iKt-1})/N_{Kt-1})$ , where  $N$  is the number of varieties and total variety growth is  $((N_{Kt} - N_{Kt-1})/N_{Kt-1})$ , 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 these shares do not sum to 100 due to the fact that only the top ten variety contributors are shown. Own calculations based on data as exposed in Section 4.1.

## 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)  $\lambda$ -ratios (equation 8) must be calculated with a good-specific elasticity of substitution ( $\sigma_k$ ) across countries. That is, each  $\sigma_k$  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  $k$

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

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.<sup>20</sup>

<sup>20</sup> See also footnote 23.



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

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

where  $\phi_t \equiv (\sigma_k - 1)\Delta \ln q(p_t, K_t)$  is a fixed effect and  $\varepsilon_{ikt} \equiv \Delta \ln b_{ikt} \equiv \Delta \ln I_{ikt}$  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

$$\Delta \ln p_{ikt} = \beta \Delta \ln q_{ikt} + \psi_{ikt} \quad (14)$$

where  $\psi_{ikt}$  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:

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

with the parameters

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

and

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

with  $0 < \rho_k < 1$ , total expenditure as  $E_t = \sum_{i \in I_t} p_{ikt} q_{ikt}$  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  $\varepsilon_{kt}$  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.<sup>21</sup> This rules out using OLS. Using instruments that are correlated with the ex-

<sup>21</sup> 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,

penditure share and price but uncorrelated with the errors in these equations would be an alternative – theoretically. As noted above, finding suitable IVs is hopeless for all trade partners.

Feenstra (1994) argues that the simultaneous equations bias can be avoided by exploiting the panel nature of the dataset. This requires assuming  $E(\varepsilon_{i,k,t}\delta_{ikt}) = 0$ , that is, that the unobserved disturbances  $\varepsilon_{ikt}$  with  $k = 1, \dots, I$  and  $\delta_{jt}$  with  $j = 1, \dots, I$  are independent with zero mean and variances  $v_{\varepsilon_i}$  and  $v_{\delta_i}$ , respectively. In other words: Demand and supply elasticities are constant and demand and supply errors uncorrelated at the variety level for all countries  $i, j = 1, \dots, I$  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  $\Delta$ ).<sup>22</sup> That is,

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

and

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

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

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

2006, equation 15). However, means that one single elasticity is used across all goods and their varieties. Section 6.3 entertains this assumption and discusses the welfare implications.

<sup>22</sup> 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.

where

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

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

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

where the coefficients are non-linear functions of  $\sigma_k$  and  $\rho_k$

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

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

and the error is

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

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

That is,

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

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  $T \rightarrow \infty$ , 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

$$\frac{v_{\varepsilon ik}^2 + v_{\varepsilon ck}^2}{v_{\varepsilon jk}^2 + v_{\varepsilon ck}^2} \neq \frac{v_{\delta ik}^2 + v_{\delta ck}^2}{v_{\delta jk}^2 + v_{\delta ck}^2}, \quad (21)$$

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. This means that after a preliminary OLS estimation of equation 20, the inverse of the variance of the predicted errors in equation 18 is used to re-weight the regression. This yields efficient estimates of the parameters in equation 20. Feenstra (1994) shows that the efficient estimates of  $\hat{\theta}_{1,k}$  and  $\hat{\theta}_{2,k}$  allow solving for the import demand and export supply elasticities  $\hat{\sigma}_k$  and  $\hat{\rho}_k$  – under a crucial condition: If  $\hat{\theta}_{1,k} > 0$ , then

$$\begin{aligned} \text{(a) if } \hat{\theta}_{2,k} > 0, \text{ then } \hat{\rho}_k &= \frac{1}{2} + \left( \frac{1}{4} - \frac{1}{4 + \left( \frac{\hat{\theta}_{2,k}^2}{\hat{\theta}_{1,k}} \right)} \right)^{\frac{1}{2}} \\ \text{(b) if } \hat{\theta}_{2,k} < 0, \text{ then } \hat{\rho}_k &= \frac{1}{2} - \left( \frac{1}{4} - \frac{1}{4 + \left( \frac{\hat{\theta}_{2,k}^2}{\hat{\theta}_{1,k}} \right)} \right)^{\frac{1}{2}} \end{aligned}$$

and in both cases

$$\hat{\sigma}_k = 1 + \left( \frac{2\hat{\rho}_k - 1}{1 - \hat{\rho}_k} \right) \frac{1}{\hat{\theta}_2} > 1.$$

As  $\hat{\theta}_2 \rightarrow 0$ , then  $\hat{\rho} \rightarrow \frac{1}{2}$  and  $\hat{\sigma} \rightarrow 1 + \hat{\theta}_1^{-\frac{1}{2}}$

There is, however, a problem when  $\hat{\theta}_{1,k} < 0$ . When this is the case, estimates of  $\sigma_k$  and  $\rho_k$  lie outside the ranges  $\hat{\sigma}_k > 1$  and  $0 \leq \hat{\rho}_k < 1$ . 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.<sup>23</sup>

To avoid bias and to handle estimations that yield  $\hat{\theta}_{1,k} < 0$ , [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 nonlinear LIML routine to the feasible regions. This is why I use [Soderbery's \(2015\)](#) estimation routine here, good by good.<sup>24</sup>

## 6 Results

The procedure follows [Broda and Weinstein \(2006\)](#). First, I calculate the  $\lambda_k$ -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,  $\sigma_k$ , by estimating equation 20 over its Armington-varieties. Third, I combine my estimates of  $\sigma_k$  with the  $\lambda_k$ -ratio per good. This yields an estimate of how much the exact corrected price index ( $P^{SV} (\lambda_t(K)/\lambda_{t-1}(K))^{1/\sigma_k-1}$ , 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).

<sup>23</sup> 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.

<sup>24</sup> [Galstyan \(2017\)](#) argues that applying the LIML estimator on small panels may produce inconsistent results. Nonetheless, 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  $\lambda_k$ -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 smaller  $\lambda_k$ -ratio  $< 1$ , the more expenditure is devoted to new varieties.<sup>25</sup>

Table 4 reports descriptive statistics for the  $\lambda_k$ -ratios of all goods used in the calculation of the aggregate price index.<sup>26</sup> 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  $\lambda_k$ -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 very much 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. Indeed 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 \(2006\)](#) 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).

This table highlights the importance of using  $\lambda_k$ -ratios—more a measure of the intensive margin—rather than relying on counts to measure variety growth.<sup>27</sup> 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’.

<sup>25</sup> To moderate the effect of outliers I winsorise the  $\lambda_k$ -ratios at the 5th and 95th percentile. [Bo and Jacks \(2012\)](#), who apply [Broda and Weinstein’s \(2006\)](#) method to Canadian data, classify  $\lambda_k$ -ratios as outliers when they are below 0.8 or greater than 1.07.

<sup>26</sup> The  $\lambda_k$ -ratio is undefined when there are no common varieties of the five-digit category between  $t - 1$  and  $t$ , i.e.  $K_k = \emptyset$ . This explains why the number of  $\lambda_k$ -ratios is smaller than the actually five-digit categories at hand: In some cases I had to aggregate the ratios to higher SITC levels.

<sup>27</sup> Depending on what it is compared to, the  $\lambda_k$ -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       | $\lambda_k$ -ratio | Implied by<br>count |
|-----------|-----------------|--------------------|---------------------|
| 1907-1913 | 5th percentile  | 0.749              |                     |
|           | Median          | 0.999              | 0.917               |
|           | 95th percentile | 1.120              |                     |
|           | N               | 673                |                     |
| 2007-2013 | 5th percentile  | 0.861<br>(0.903)   | 0.957<br>(0.970)    |
|           | Median          | 0.999<br>(0.999)   |                     |
|           | 95th percentile | 1.182<br>(1.154)   |                     |
|           | N               | 2558               |                     |
|           |                 |                    |                     |

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.  $\lambda_k$ -ratios calculated according to equation 8 with import values in respective years. Source: Own calculations based on data as exposed in Section 4.1.

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 The Elasticities of Substitution

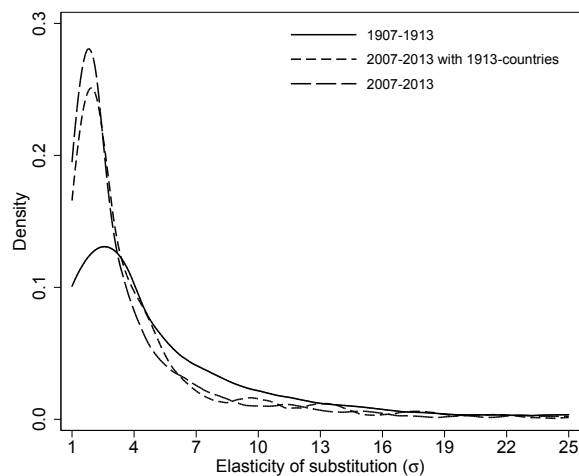
I now turn to the estimation of the elasticities of substitution based on equation 20. The estimations were conducted at various levels of aggregation of good  $k$ .<sup>28</sup> Given the thousands of elasticities I estimate, I refrain from reporting all results in detail but present summarising observations.<sup>29</sup>

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

<sup>28</sup> 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.

<sup>29</sup> I provide all estimated elasticities at the three-digit level in table D12 in the appendix, as well in an online appendix on my [sites.google.com/site/wolffabianhungerland/home](https://sites.google.com/site/wolffabianhungerland/home), however. Broda *et al.* (2006) 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.

FIGURE 3  
DISTRIBUTION OF ELASTICITIES OF SUBSTITUTION



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 based on data as exposed in Section 4.1.

that import demand in the first globalisation is much more skewed to the right than that of the second globalisation.<sup>30</sup> In other words, import demand was much more elastic than it is today.<sup>31</sup>

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, 2017b) 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

<sup>30</sup> As in other studies estimating the elasticity of substitution using the methods by 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.

<sup>31</sup> 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.



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 basically run on very specific imported varieties making the entire industry heavily dependent on certain imports, i.e.: generating a rather inelastic import demand. He finds 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 focus on selected industries in more detail, 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 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).

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. \(2010\)](#) even assume 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').

TABLE 5  
DESCRIPTIVE STATISTICS ON THE ELASTICITIES OF SUBSTITUTION

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

Standard errors in parentheses. SITC five-digit items based on revision 4 (United Nations, 2006). Note that 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 based on data as exposed in Section 4.1.

The elasticities obtained using the Feenstra-Broda and Weinstein-method are more directly comparable. Broda *et al.* (2006) 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 already, there is reason to believe that small sample bias has led to over-estimated elasticities (Soderbery, 2010, 2015). Indeed, 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. Note that 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)). These differences in medians are economically quite important because these are often the values that researchers use to plug in 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. It suggests that the Armington assumption indeed generates sufficient variation in variety.<sup>32</sup>

TABLE 6  
ELASTICITIES OF SUBSTITUTION AND THE [RAUCH](#)-CLASSIFICATION

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

Median elasticities for SITC four-digit items based on revision 4 ([United Nations, 2006](#)). 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 (see [Hungerland and Altmeyden, 2017](#), for a discussion of this) or [Rauch \(2007\)](#). Source: Own calculations based on data as exposed in Section 4.1 and [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 mi-

<sup>32</sup> [Lashkaripour and Lugovsky \(2017\)](#) show that products and ideas are less differentiated intra-nationally

croscopes. 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.

TABLE 7  
ELASTICITIES OF SUBSTITUTION FOR MAJOR THREE-DIGIT SECTORS

| Average import share  | SITC three-digit | Description   | $\sigma_k$ |
|---|------------------|---|------------|
| 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<br>(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)  |

\* Truncated; see text. \*\* Taken from two-digit level; see footnote 34. Import shares reported in percent of total imports based on import values pooled over respective seven-year periods. Parentheses indicate values for 1913-borders. Three-digit items based on revision 4 (United Nations, 2006). Note that item descriptions were shortened for exposition. Source: Own calculations based on data as exposed in Section 4.1.

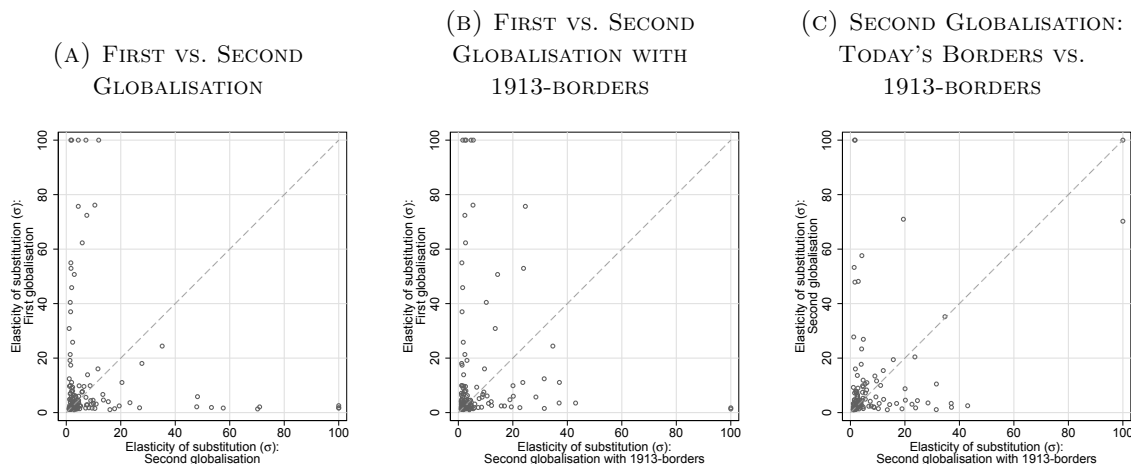
Let us consider some exemplary cases of the estimated elasticities. Table 7 shows the elasticities of substitution for the ten largest three-digit positions in Germany's imports in each of the periods. The first striking message of table 7 is that Germany's import structure in the first globalisation 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 vary, however, quite nicely with what 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 corresponds to vast quality differences due to different stages of industrialisation of Germany's trade partners in a time when textile yarn was one of the key goods in international trade. Demand for coal and live animals was so high that I truncated the elasticity to 100,<sup>33</sup> 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.

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.<sup>34</sup> 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.

<sup>33</sup> Following Broda and Weinstein (2006), see also footnote 29.

<sup>34</sup> 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 numbered, as part of the country set.

FIGURE 4  
DIFFERENCES IN ELASTICITIES OF SUBSTITUTION BETWEEN TWO EPISODES OF  
GLOBALISATION



'First globalisation' refers to estimations based on the period 1907 to 1913 and 'second globalisation' to the period 2007 to 2013. Items at three-digit level based on revision 4 (United Nations, 2006). 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 based on data as exposed in Section 4.1.

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. More generally, 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. Nonetheless, the changes in sector specific-elasticities between the different periods are striking. While some demand became more elastic, other sectors must have gone through growing differentiation. As the discussion

of the examples above already 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. Of course, many elasticities did not move too much. ‘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. That means, in turn, that using an ‘inadequate’, that is ahistorical elasticity which has not been obtained from the data that it should help explain, noise will be the result.<sup>35</sup> 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 all but 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  $\lambda_k$ -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  $CIP I(K)$  from equation 10:

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

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,<sup>36</sup> the ratio is 0.994 for 1907 to 1913 and 0.998 for 2007 to 2013. That is, new varieties—

<sup>35</sup> Figure C.2 in the appendix plots comparable estimated elasticities—i.e. in the three-digit level—by Broda and Weinstein (2006) for the two periods they study: 1979 to 1989 and 1990 to 2001. The plots show the same huge differences in the elasticities.

<sup>36</sup> Note that such calculations do not incorporate intra-periodical changes as only start and end years are compared.

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. Somewhat surprisingly, 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 – however: Given that we look at the difference over one century, the impression remains that this feature of globalisation is relatively stable over the longer run.

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 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 may reflect that more years were 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 look at. 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.<sup>37</sup>

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

<sup>37</sup> These growth rates are calculated as follows:  $\text{Change in entire period} = (1 + \text{Average annual change})^{19}$ , with 19 being the number of years in each period. 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.



economy as in [Krugman \(1980\)](#).<sup>38</sup> Under this assumption, the inverse of equation 22, log-ideally weighted by the share of imports to GDP, yield the gains from variety:

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

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 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 experienced 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 Eastern Europe with Europe's core economies.

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. Indeed, the results are consistent with previous findings based on similar research designs. [Mohler and](#)

<sup>38</sup> 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 heterogenous 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.

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 due to the break-away of some apparently important varieties commanding relatively inelastic demand. Broda and Weinstein (2006), looking at the US, find welfare gains of 1.8 percent over 1979 to 1988 and 2.6 percent from 1990 to 2001. Note, however, that the log-ideal import shares are traditionally much smaller in the US than in Germany: Broda and Weinstein used 6.7 percent for 1972–1988 and 10.3 percent for 1990–2001. 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 is smaller for Germany, along with the potential gains from changes in variety. 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 from trade. Much product differentiation happens on much finer levels of aggregation,<sup>39</sup> which is something that cannot be explored in the present setup. 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.<sup>40</sup> 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 litera-

<sup>39</sup> See also footnote 15.

<sup>40</sup> When no elasticity was readily available from the set of estimates, I took the sectoral medians from a higher level of aggregation.

TABLE 8  
WELFARE RESULTS

|           | (1)        | (2)                      | (3)  | (4)                              | (5)          | (6)          | (7)           |
|-----------|------------|--------------------------|--|----------------------------------|--------------|--------------|---------------|
|           | $\sigma_k$ | $\sigma_{\text{median}}$ | $\sigma_{\text{median}}^{\text{other period}}$ | $\sigma_k^{\text{other period}}$ | $\sigma = 5$ | $\sigma = 8$ | $\sigma = 10$ |
| 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 based on data as exposed in Section 4.1.

ture.<sup>41</sup> 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.

The data invites to compare the gains from import variety also over the long run. To do so, however, some rather 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 the first measurement errors. I then take mean imports over the periods 1907-1913 and 2007-2013 and aggregate all to the SITC 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 I also pool Germany's import data according to 1913-borders. 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 structure of the economy we observe.

<sup>41</sup> 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.

## 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 the 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.

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 (see Schott 2004). This resonates well with the findings of (Hungerland and Wolf, 2017b) 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 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. (be-

cause 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 margin that more recent research in international trade puts into the limelight. Working with historical data unfortunately does not observe real microeconomic units, that is firms. This forced this paper to rely on the 'symmetry assumption', in that all firms are 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.<sup>42</sup> In broader words: The production side of the economy remains to be explored more.

Against this background, the present paper contributed, if anything, 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.

<sup>42</sup> See, however, also footnote [38](#).

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## Appendix

## A On the Workings of Sigma

To illuminate how  $\sigma_k$  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            | $\sum_{k \in K_r} pq$                   | <i>in \$</i>                | 1.00        | 1.00             | 1.00        | 1.50        | 1.50        |      |
| ...of new varieties    | $\sum_{k \notin K, k \in K_r} pq$       | <i>in \$</i><br><i>in %</i> | 0.10<br>10% | 0.15<br>15%      | 0.05<br>5%  | 0.15<br>10% | 0.05<br>3%  |      |
| ...of common goods     | $\sum_{k \in K, k \notin K_r} pq$       | <i>in \$</i><br><i>in %</i> | 0.90<br>90% | 0.85<br>85%      | 0.95<br>95% | 1.35<br>90% | 1.45<br>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.

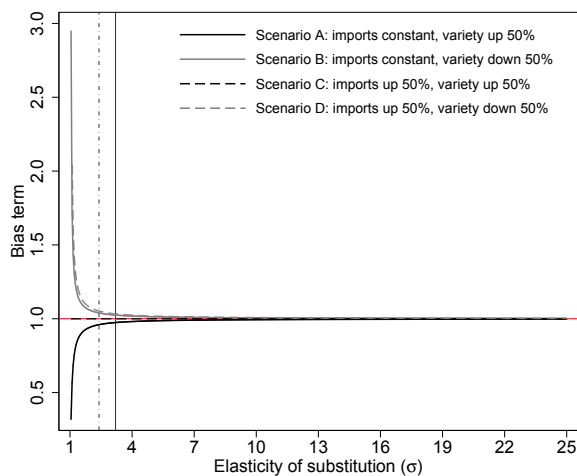
In scenario A (column 2 in table D9), total imports do not change over time but expenditure on new varieties *grows* by 50 percent. Figure D5 shows that when demand is elastic and new varieties are close substitutes, i.e.  $\sigma \rightarrow \infty$ , the bias in the price index due to new goods disappears. 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.  $\sigma \rightarrow 1$ , 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.

Diese  
Tabelle  
muss  
nochmal  
überarbeitet  
werden.

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  $\lambda_r$  corresponding to scenarios outlined in table D9.

Intertemporal variation in the total value of imports may sharpen or mitigate the power of  $\sigma_k$  below.<sup>43</sup> 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.

<sup>43</sup> 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<br>of<br>pluses | Number of<br>five-digit<br>categories | Share | Cumulative<br>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: Own calculations based on [Hungerland and Altmepfen \(2017\)](#).

## 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]                             |
| Azerbaidjan                                     | 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]                            |
| Cocos (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                                  |
| Equatorial 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]                     |
| Kazakhstan                                  | 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                                    |

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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]                                 |

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Table D11 – *Continued from previous page*

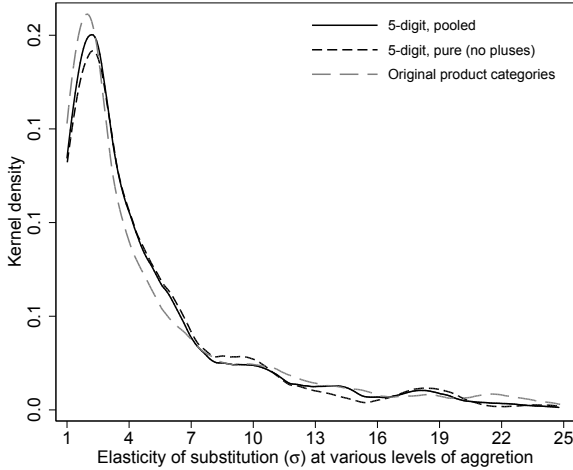
| Country as in Eurostat (2017) | Country as in German 1913 statistics              |
|-------------------------------|---|
| Südsudan (ab 2013)            | Ägypten [3]                                       |
| TOKELAU                       | Neuseeland [2]                                    |
| Taiwan                        | 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, Kameron, 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

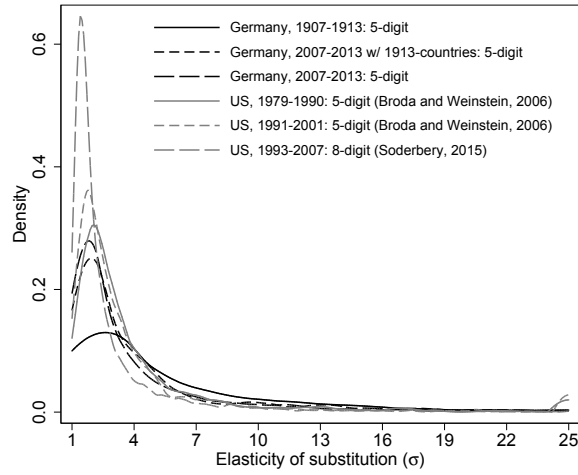
## C.1 Additional Distributions of Elasticities of Substitution

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 based on data as exposed in Section 4.1.

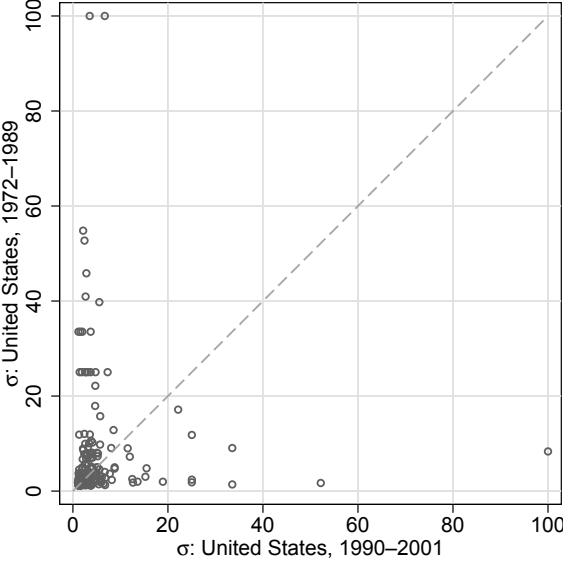
FIGURE D7  
 DISTRIBUTION OF ELASTICITIES OF SUBSTITUTION COMPARED (B)



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 come from own calculations based on data as exposed in [Section 4.1](#); 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 [Hungerland and Altmepfen 2017](#), 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | First glob. | 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | First glob. | 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                                    | $\sigma_k$  |                                  |
|------|--|-------------|----------------------------------|
|      |  | 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 ([United Nations, 2006](#)). Source: Based on data as exposed in Section 4.1 and estimations as described in Section 5.

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