On the Sensitivity of Estimated Elasticities of Substitution

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Abstract

In recent contributions elasticities of substitution estimated from disaggregated trade data are used to address different questions in trade and macroeconomics. The estimates of the elasticities differ somehow from paper to paper. This paper evaluates the sensitivity of these estimates towards various changes in the estimation specification using the methodology set up by Feenstra (1994). To assess the plausibility of the estimates at an aggregate level, central properties for the estimated elasticities are proposed. It is shown that these properties hold using some estimators and some specifications. Additionally, estimates of individual elasticities are analyzed. Again, using appropriate estimators and estimation specifications, the elasticities are estimated quite robustly. Some elasticities however react very sensitively to different specifications even if their standard errors suggest otherwise. Consequently, some general tests for misspecification are applied. Finally, the results are used to give some suggestions that applied researchers might find useful to estimate elasticities of substitution for their work.

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1 Introduction

It can be argued that the elasticity of substitution is one of the most important parameters in international economics. It is used in many studies of international macroeconomics and international trade to address a large variety of questions. In the trade section for example, elasticities of substitution are used to measure costs that result from trade barriers.[1] In international real business cycle models, the elasticities are used to model the negative correlation between terms of trade and the trade balance.[2] In other studies, these parameters determine the importance of exchange rates for monetary policy.[3] Many more applications could be named here; the message does not change: This parameter is in the center of many contributions in international economics.

In the literature, some discussions about the estimation and the magnitude of estimated elasticities take place. In many papers[4] the large differences between elasticities estimated from aggregate data and the ones estimated from disaggregated data are discussed. Aggregate elasticities that are mostly used in international macroeconomics are typically much lower than their disaggregate counterparts that are predominantly used in international trade contributions. In my paper I leave this question open and concentrate on elasticities estimated from disaggregated trade data.[5]

Such elasticities have been estimated by different authors using different approaches to address different questions in the past. Examples are Feenstra (1994), Hanson (1998), Blonigen and Wilson (1999), Romalis (2007) and others. I concentrate on the approach of Feenstra (1994) which has recently triggered some important contributions in international trade: A first paper by Broda and Weinstein (2006), henceforth BW2006, extends the estimation technique developed by Feenstra (1994) and estimates elasticities of substitution for many imported goods from official import statistics. The resulting elasticities allow the authors to quantify the gains from imported variety for the US between 1972 to 2001 by calculating an import price index that corrects for the growth in varieties. They find that in the past 20 years, the gains from variety account for 2.6 percent of the U.S. GDP.

In another paper, Broda et al. (2006), henceforth BGW2006, use estimated elasticities of substitution for the imports of 73 countries to structurally estimate the share of total factor productivity growth that is due to the growth of newly imported varieties. They estimate that 12 percent of the productivity growth is due to these new varieties. In another recent contribution by Gaulier and Méjean

[1] See Anderson and van Wincoop (2004) for an extensive study and a literature review.
[2] As in Backus et al. (1994) and others.
[3] As in the model of Galì and Monacelli (2005).
[4] See for example Ruhl (2003) and Imbs and Méjean (2009)
[5] Disaggregated data can also be used to estimate one overall aggregate elasticity. However, in this contribution I consider only the estimation of disaggregate elasticities, for example for different product categories or different industries.

(2006), henceforth GM2006, the estimated elasticities are again used to correct the aggregate import price index. They find that the fairly high cross-country differences in the price index bias lead to differences in relative prices on the world markets. This suggests changes in the real exchange rates as they are perceived today.

In the working paper version of his seminal contribution[6], Chaney (2006) also uses the estimates of the elasticities of substitution calculated by BW2006 to evaluate whether higher elasticities magnify the impact of trade barriers on trade flows. He finds the results of the predictions of the Krugman models are distorted because these models do not account for the heterogenity of firms.

Comparing the existing estimates of elasticities of substitution in the literature, it is striking that the results are somewht different although similar data sets are used: Mean and median elasticities vary considerably in the existing work. However, neither of the existing papers discusses the sensitivity of these estimates. In this paper, this is done by varying the estimation specification in different ways. First, the used *estimator* is varied and the results are compared. Secondly, there are some decisions a researcher has to make before the estimation. For example, the aggregation level and the definition of product categories have to be chosen. The elasticities are also estimated under these different specifications.

It is then evaluated whether some *central aggregate properties* of these elasticities hold under different specifications. It can be shown that these properties hold if the elasticities are estimated in a certain, consistent way using an appropriate estimator. Furthermore, I analyse the behaviour of *individual, disaggregated* elasticities under the different specifications. It is shown that many elasticities are robust in the sense that they do not change much economically. However, some of the elasticities react very sensitively to a change of specification. In most of the cases, this is accompanied by very low standard errors that suggest an accuracy that is too high. Various general tests for misspecification are then applied to shed some light on this issue.

In the concluding remarks, I formulate some guidelines that a researcher should apply to get as robust estimates of elasticities of substitution as possible. Note that this paper does not judge the theoretical model underlying or the stochastic specification derived from it. Both are very convincingly formulated by Feenstra (1994) and BW2006. The paper does use some criteria to find out how the results vary using different estimators and different other specifications and a specific data set.

The paper is organized as follows. Section 2 discusses the underlying model and the stochastic specification used to estimate the elasticities. In section 3 some results of the literature are compared as

[6]See Chaney (2008)

a motivation. Additionally, possible sources of the differences are presented. In section 4, the elasticities are estimated under different specifications and it is discussed whether some general properties hold in the aggregate. Section 5 looks at the sensitivity of individual elasticities. Section 6 includes some tests for possible misspecification error. Section 7 tries to give some advice to researchers who need to estimate elasticities of substitution. Section 8 summarizes the results and discusses some implications.

2 Empirical Strategy

2.1 Model and Stochastic Specification

Following BW2006 the CES utility for every good, M_{gt}, is expressed as

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

where g is a single good and c is a variety belonging to this good. d is an unobserved taste parameter and m is the subutility derived from a single variety. σ_g is the elasticity of substitution being estimated by the stochastic model below: One elasticity is estimated for every good consisting of many varieties. The stochastic model comprises a demand part and a supply part. The demand side follows directly from the derivation of the minimum cost function of the CES utility, which is omitted here. Expressing it with changes in shares instead of quantities this becomes

$$\Delta \ln s_{gct} = \varphi_{gt} - (\sigma_g - 1) \Delta \ln p_{gct} + \epsilon_{gct}, \tag{2}$$

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

$$\Delta \ln p_{gct} = \psi_{gt} + \frac{\omega_g}{1 + \omega_g} \Delta \ln s_{gct} + \delta_{gct}. \tag{3}$$

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

$$\Delta^k \ln s_{gct} = -(\sigma_g - 1) \Delta^k \ln p_{gct} + \epsilon_{gct}^k, \text{ and} \tag{4}$$

$$\Delta^k \ln p_{gct} = \frac{\omega_g}{1+\omega_g}\Delta^k \ln s_{gct} + \delta^k_{gct}, \tag{5}$$

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

$$\left(\Delta^k \ln p_{gct}\right)^2 = \theta_{g1}\left(\Delta^k \ln s_{gct}\right)^2 + \theta_{g2}\left(\Delta^k \ln p_{gct}\Delta^k \ln s_{gct}\right) + u_{gct} \quad \text{or} \tag{6}$$

$$Y_{gct} = \theta_{g1}X_{1gct} + \theta_{g2}X_{2gct} + u_{gct}, \tag{7}$$

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

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

and in either case

$$\widehat{\sigma} = 1 + \left(\frac{2\widehat{\beta}-1}{1-\widehat{p}}\right)\widehat{\theta}_{g2}. \tag{8}$$

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

2.2 Choice of the Estimator

Estimating equation (7) with OLS, there will be a endogeneity bias present since prices and quantities of a demand and supply system are determined simultaneously. Normally this would be addressed by adding additional instruments and using IV estimation. However, instruments for the prices and the shares in the above stochastic model for every product group imported cannot easily be found. The panel structure of the data allows for another solution: It can be used to get unbiased estimators without the need of external instruments.[7] Intuitively, averages of the prices and quantities over time are used. These are then weighted by the number of periods a variety is available.

This can be implemented by running an OLS using the averages over time of equation (7):

[7] See for example Hsiao (1985) or Hausman and Griliches (1986)

$$\bar{Y}_{gc} = \theta_{g1}\bar{X}_{1gc} + \theta_{g2}\bar{X}_{2gc} + \bar{u}_{gc}, \tag{9}$$

where $\bar{Y}_{gc} = \sum_t Y_{gct}/T_{gct}$ is the mean Y_{gc} over all time periods where this specific variety is available. The OLS is then performed by repeating the average of a variety as many times as this variety is observed, i.e. T_{gct} times. Thus, this IV estimator can be interpreted as simple WLS without the need of external instruments.[8]

This estimator is then consistent but it is not the most efficient one since there is heteroskedasticity present. Feenstra (1994) applies feasible GLS (FGLS) to get the most efficient estimator. This is done by first estimating the error terms via the OLS of equation (9). Then, the observations are weighted by the inverse of the estimated standard errors.

2.3 Measurement Error and Heteroskedasticity

Feenstra (1994) introduces a constant into the model to correct for simple measurement error. Furthermore, FGLS is used to correct for a general heteroskedasticity. Broda and Weinstein (2006) refine this correction: First, they show that instead of a constant one should add a term to equation (7) that varies for every observation:

$$Y_{gct} = \chi^2 \frac{1}{T} \sum_t \left(\frac{1}{q_{gct}} + \frac{1}{q_{gct-1}} \right) + \theta_{g1} X_{1gct} + \theta_{g2} X_{2gct} + u_{gct}. \tag{10}$$

This is a generalization of Feenstra (1994). Unlike Feenstra's approach this allows for measurement error that depends on the quantity of varieties and the number of periods a variety exists. Broda and Weinstein (2006) then provide specific weights to adjust for heteroskedasticity: If the prices are measured with an error, then also the sample variances are measured with an error. By assuming that the variance of each observation of a variety is inversely related to the quantity with which it is imported, the data in equation (10) should be weighted by the following term:

$$T^{3/2} \left(\frac{1}{q_{gct}} + \frac{1}{q_{gct-1}} \right)^{-1/2}.$$

This can then be estimated via the WLS procedure explained above.[9] Hence, I there are basically three possible estimators. (1): A consistent but not efficient OLS. (2): An FGLS where the observations

[8] For details refer to Feenstra (1991).

[9] Note that this approach can also be interpreted as a GMM estimator. See BW2006.

are weighted by the inverse of the error terms. (3) Another FGLS where measurement errer is allowed to vary with the import value and where it is assumed that the variance of the observations are inversely related to the imported value.

3 Motivation and Estimation Specifications

Trade data from the U.S. from the period 1990-2001 is used for all estimates.[10] Note that using this trade data, a *variety* is defined as a good being imported from a particular country as in Armington (1969). A *good* can be defined at different aggregation levels, like those defined under the Standard International Trade Classification (SITC) or the Harmonized Tariff Schedule (HTS).

3.1 Motivation: How Estimated Elasticities Vary in the Literature

Table 1 compares some estimates from the literature with my estimates using a benchmark specification.[11] My estimates and the ones from BW2006 use U.S. import data from 1990 to 2001, available from the NBER. BGW2006 use U.S. COMTRADE data from 1994 to 2003.[12] GM2006 use U.S. data from the BACI for the period of 1994 to 2003.[13] Note that the differences are quite pronounced: The median elasticity can be as low as 2.3 in the BGW2006 estimates and as high as 5.8 in GM2006.[14]

Table 1: Summary Statistics of Estimated Sigmas

	My Est.	BW2006	BGW2006	GM2006
Elasticities estimated	13915	13972	168	3419
Mean	11.8	12.6	4.2	17.9
Median	3.4	3.1	2.3	5.8

US data is used for all estimates.

Comparing individual elasticities, the picture is even more extreme: Table 2 compares the 20 SITC-3 goods with the highest import values in the U.S. between 1990 and 2001. Most of the elasticitiy-pairs have a similar magnitude. However, there are large differences for example for the goods SITC-781, SITC-334 and others. It is one objective of this paper to shed some light on this issue.

[10] Robert C. Feenstra made the data available on the NBER data website: http://www.nber.org/data/. It can be downloaded as STATA or SAS file.

[11] this specification is presented below.

[12] Visit *http://comtrade.un.org/.*

[13] See *http://www.cepii.fr/anglaisgraph/bdd/baci.htm.*

[14] Considering the CES utility function this can make a big difference: In equation 1, the exponents consisting of σ_g tend to one quickly for high values of σ_g. For lower values as 2.3 or 5.8 however, the differences in the exponents are large.

Table 2: Comparison of Individual Sigmas

SITC-3	My Est.	BW2006	SITC-3	My Est.	BW2006	SITC-3	My Est.	BW2006
781	57.08	3.02	764	3.82	1.35	792	4.16	4.98
333	14.40	22.18	851	4.33	2.41	667	2.50	1.16
752	3.78	2.18	782	NA	6.70	515	2.76	1.55
776	2.19	1.22	842	5.33	2.55	763	3.13	1.23
784	2.75	2.79	713	3.28	2.69	772	1.81	1.16
334	4.70	11.53	841	5.53	3.02	778	2.29	4.76
845	5.02	6.70	641	1.89	2.06	...	...	...

The divergence may stem from different sources: One origin of the differences could be the time periods or the data sources used. However, the lowest and the highest median elasticity in Table 1 both stem from the same time period and from basically the same data source since the BACI database is based on COMTRADE. Furthermore, the estimates in Table 2 are generated using exactly the same data set and time period.

Secondly, the choice of the estimator may matter: As shown above at least three estimators are available as presented in Section 2.[15] I will use all three estimators to calculate the elasticities below.

There are some other sources that could possibly explain some of the differences besides the estimator; some where the choices of the researcher are important: Using trade data and the described methodology, a researcher has to decide on (at least) three points before he can estimate the elasticities of substitution: the definition of a variety and a good (i.e. the level of disaggregation), the choice of the reference variety (see equations (4) and (5)) and the definition of countries. All these different specifications will be discussed in turn.

3.2 Choice of the Estimator

In this paper, the elasticities are estimated using three linear estimators: First, the original FGLS as proposed by Feenstra (1994) is used.[16] This will be the benchmark case. As a second estimator I use the consistent but not efficient OLS that is also discussed above. The third estimator is the FGLS with the specific corrections of measurement error and heteroskedasticity as proposed by BW2006. Note that FGLS is more efficient than OLS if the samples are large and if the assumption about the heteroskedasticity is correct. However, the small sample properties are not clear: Thus, it is well possible that these estimators perfom worse than the simple OLS. Since many samples are small if

[15] Furthermore, some estimate the elasticities using a non-linear GMM as opposed to a linear estimator. I will not consider non-linear estimators here. On reason is that the results using these estimators rely on the optimization algorithm that is used. Thus, reproduction of results is difficult: For example, different software packages use differnt algorith as default. BW2006 and GM2006 both use a non-linear GMM and the results are very different as Table 1 shows

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

elasticities are estimated from disaggregated trade data, this is an important issue.

3.3 Definition of a Variety and of a Good

A variety can be defined at the most disaggregated level. For the U.S. this is the 10th digit of the HTS. This means that goods from different countries within an HTS-10 good are counted as varieties. Alternatives are the 6th and 8th digit of the HTS. Taking HTS-8 for example, a variety then is a HTS-8 good from a particular country. It is not obvious that a variety must be defined at the HTS-10 level. In fact, the U.S. is the only country that publishes such disaggregated data. Many developed countries, as the countries of the E.U., only report data up to HTS-8. For many other countries, only HTS-6 data is available.

A question related to the definition of a *variety* is the definition of a *good*. For example, taking HTS-10 as the definition of a variety, one could define a good as HTS-10. Thus, a fresh apple from New Zealand is a variety of the HTS-10 good "fresh apples" and a fresh apple from Australia is another variety within this good. As an alternative, a good could also be defined as SITC-3: Then *all HTS-10 varieties* are part of this good. As an example, if the broader SITC-3 is "fruits", then fresh apples from New Zealand and Australia are varieties within this good, but also oranges from Spain. Furthermore, if the definition of a *variety* is changed, for example to HTS-6 which is broader than HTS-10, then within the SITC-3 good "fruits" varieties could be "fresh fruits" from New Zealand and Australia or "dried fruits" from France.

The right choice ultimately results in the question of how broad a variety or a good should be defined optimally. Since the purpose of the HTS and the SITC classification is the recording of these goods at the custom offices, probably none of these definitions defines varieties in an optimal way. Still, the researcher must make a decision. One question assessed in this contribution is how much this decision matters for the resulting elasticities.

3.4 Choice of the Reference Varieties

Secondly, there is the choice of the reference variety. As is shown in equations (4) and (5) in Section 2, a variety that is exported to the US in all periods has to be chosen to calculate differences and eliminate the unobserved random effects. For most goods, the researcher can choose from more than just one variety. As mentioned for example in Feenstra (1994), imports at high values tend to have lower measurement issues. Thus, under the benchmark specification shown in Table 1, the variety that exhibits the *highest* import value is always chosen as the reference variety. Under an alternative specification, the imported variety with the second highest value is chosen. As a third specification, the variety with the *lowest* value is chosen. Using these specifications, I will be able to assess whether there is a possible measurement error for varieties imported at low values and whether these measurement errors matter for the resulting elasticities.

3.5 Definition of Countries

A third aspect is the definition of countries which is of central importance because different varieties are defined as goods stemming from different countries. The benchmark specification uses basically the countries as they are defined in the original data set.[17] As a result, more than 150 different countries are defined. As a second specification, about 30 geographically motivated country blocks are set up. The definitions of the blocks are shown in Table 5 in the appendix. This set-up addresses the question of how the inflexible Armington definition of a variety matters for the resulting elasticities.

To sum up, the elasticities will be estimated in this paper using the following specifications: First, three estimators are used. Secondly, goods will be defined as SITC-3, SITC-5 and HTS.[18] Varieties will be defined as HTS-10, HTS-8 and HTS-6. Another dimension is the choice of the reference varieties with three specificatons. Finally, an additional specification using country blocks is added. This will result in 108 different estimates of the elasticities.[19]

4 Aggregate Properties of the Estimated Elasticities

Tables 6 to 8 in the appendix display the summary statistics for the three estimators. They are structured as follows: The first three columns display the benchmark case for all three definitions of a good. The second three columns display the analoguous results for the country blocks, columns seven to nine the results for the second largest reference varieties and the last three columns show the results for the case where the lowest reference variety is chosen. A further dimension is added by the definition of a variety: Thus, the first couple of rows display results for a variety defined as HTS-6, the middle rows use HTS-8 and the last ones HTS-10. Finally, the definition of a good is varied as follows: Columns

[17] As in BW2006 however, some adjustments are made: Countries of the former USSR, the former CSSR and of former Yugoslavia, as well as other countries divided by a civil war are aggregated.

[18] The chosen HTS level depends of the definition of a variety: Is a variety is defined at the HTS-10 level, then the good is also defined as HTS-10. If a variety is defined as HTS-6, then the most disaggregated definition of a good is also HTS-6.

[19] This is calculated as 3 (estimators) x 3 (definitions of a good) x 3 (definitions of a variety) x 4 (3 different reference varieties plus the country blocks).

(1), (4), (7) and (10) define a good as HTS, columns (2), (5), (8) and (11) define a good as SITC-5, etc. The structure of the other tables in the appendix are very similar.

First note the differences in the magnitude of the median elasticity:[20] Using Feenstra's FGLS (Table 6), all the medians lie between 2.7 and 3.4. Using OLS (Table 7), the elasticities are generally lower, lying between 2.1 and 2.9. The third estimator (Table 8) yields higher results, lying between 3.3 and 4.8. Thus, as a first observation, the choice of the estimator matters for the results.

Considering the choice of a variety, the tables reveal that under almost all specifications the median elasticities increase when going at a more disaggregated level. For example, using FGLS and the HTS definition of a good, the median elasticity increases from 3.1 (variety defined as HTS-6) to 3.4 (variety defined as HTS-10). This is expected since more aggregated varieties are "more different from each other". Also note that the decrease is not very substantial.[21] Hence, it is not that crucial for research, at what level of disaggregation the data is available.

Another variation in the tables is the coice of the definition of a good. Here it is expected that if goods are aggregated, the varieties within these goods become more different and thus the elasticities of substitution should fall. This is what happens most of the time: For example in Table 6, if a variety is defined as HTS-6, the median elasticity is 3.1 when a good is defined as HTS-6, 3.0 when a good is defined as SITC-5, and 2.7 when a hood is defined as SITC-3. Note however that under the FGLS estimator of BW2006 (Table 8), the opposite is the case. Note that the definition of a good has an influence on the elasticities, but again, the median does not change very much.

Using the different reference varieties and the country block specifications, the results stay pretty stable. The only real exception is last specification of the FGLS of BW2006 (Table 8): Using those varieties with the lowest values as reference varieties, the median elasticity falls quite substantially. This may hint at measurement errors present in the lower valued varieties and/or problems with the heteroskedasticty correction of the estimator.

To sum up, the aggregate statistics imply that the choice of the estimator matters more than the choice of the level of disaggregation in goods and varieties. Secondly, using different reference varieties or a different definition of countries does not seem to have a large effect except using the last estimator.

To further explore the sensitivity of the estimates, two basic properties are defined that elasticities of substitution should always exhibit: First, aggregating the goods into a composite good should lead to lower elasticities since varieties in a composite good are less homogeneous. I will analyse this

[20] Means are heavily influenced by a few outlyers.

[21] By this I mean that the elasticities do not vary too much economically. Thus, an elasticity of 3.1 will yield similar results in economic applications as an elasticity of 3.4.

property below, it is henceforth called the *aggregation property.* Furthermore, goods can be classified as *homogeneous* or as *differentiated.* One possibility is the classification after Rauch (1999). Estimated elasticities should then be larger for goods classified as homogeneous and lower for those classified as differentiated. This property will be called the *differentiation property.*

4.1 The Aggregation Property

If goods are aggregated elasticities should fall. Note however that the statistics shown in Tables 6 to 8 are not really adequate to address this question: Not the median of *all* HTS goods should be higher than the one of *all* SITC-3 goods, but the elasticity of an SITC-3 good should in principle be lower than the *lowest* elasticity of all *corresponding* HTS goods. This property is from now on called the *aggregation property.* Of course, in practice this a very strict requirement and will not always be satisfied. Tables 9 to 11 try to evaluate this question: The first rows in these tables show how many percent of the SITC-3 goods satisfy the strict aggregation property, i.e. the percentage of SITC-3 goods where the lowest elasticity of the corresponding HTS goods is higher than the elasticity of the SITC-3 good. Under all but one specifications this is the case in less than 8%. In the third row, the weighted mean of the HTS categories is compared to the elasticity of the SITC-3 good. This is fulfilled in about 65% to 85% all SITC-3 goods, a value well above 50%. The last row compares the median of the HTS-goods with the SITC3 elasticity.

Note that the estimator of BW2006 (Table 8) performs worst in this "test": The median elasticity of the HTS good is higher than the elasticity of the SITC-3 good in only about one third of all cases. Note however that the last specification again deviates a lot from this result. Feenstra's FGLS and OLS (Tables 6 and 7) perform very similarly. Note however that the specification where the lowest-value variety is taken as reference variety also performs worse than the other specifications. The other specifications yield pretty similar results.

4.2 The Differentiation Property

To test the differentiation property, the classification after Rauch (1999) is used.[22] Tables 12 to 14 display summary statistics for homogeneous, reference priced and differentiated goods under the different specifications. The property is satisfied if homogeneous goods exhibit the largest elasticities and

[22] After this classification, goods classified as homogeneous are traded on organized exchanges. Reference priced goods are not traded in volumes that allow trade on an organized exchange. Nonetheless, they are not differentiated, meaning that prices can be quoted without mentioning the name of the manufacturer. Differentiated products on the other hand have differences over a multitude of dimensions including for example the brand name or the place of selling.

if differentiated goods exhibit the lowest elasticities.

Again, under most specifications, the differentiation property is satisfied. The exception are the elasticities estimated using a simple OLS: the median elasticity of differentiated goods is always at least as high as the median elasticity of homogeneous goods. Using the Feenstra's FGLS, the the property is satisfied except if the last reference variety is used. For the BW2006 estimator, the property is always satisfied.

Defining two aggregate properties that any elasticities of substitution should satisfy, some points can be noted: It seems that the specification using the lowest-valued reference variety performs worst. Thus, besides the choice of the estimator, the choice of the reference variety seems important as well. Furthermore, it is maybe surprising that the specification using country blocks (30 instead of 150 countries defined) does not change the aggregate results much. Additionally, the FGLS of BW2006 performs worst in the aggregation property "test". Using OLS, the differentiation property is not met. Feenstra's FGLS on the other hand seems to perform quite well.

5 The Sensitivity of Individual Sigmas

Some researchers may only need some elasticities from a few product categories for their work. For that purpose, aggregate properties are not that important. What matters is the behaviour of the individual elasticities. In this section I will look at some elasticities more closely. To get a somewhat appropriate selection of individual goods, the sigmas for the 20 SITC-3 goods with the highest shares in imported value are chosen as examples.[23]

5.1 Is it homogeneous or is it differentiated?

Tables 15 and 16 in the appendix show the estimates of these 20 goods under some different specifications: In Table 15 the benchmark case is compared under the three different estimators. In Table 16 three specifications for Feenstra's FGLS estimator are displayed. All the other results are not shown to save space.

In the one column of the tables the value of the estimated sigma is displayed. One could now calculate absolute or relative differences between the individual sigmas. However, note that for elasticities with high values, the absolute or relative difference in the sigma does not matter in economic terms:

[23] Defining the goods as SITC-3, there are many observations for most of the goods. Furthermore, when the goods with the highest import values are considered, relevant goods like petroleum, footwear or motor vehicles are in this selection. Another advantage is that the higher the quantities that are imported, the lower is the measurement error and the more exact is the data.

Consider the sigmas of the good SITC 781 in Table 16, defining a variety as HTS-6. The values go from 21.39 to 122.01 which would yield a very high absolute and relative deviation. However, a value of 21 means about the same as a value of 122 if one talks about elasticities of substitution under a CES framework.[24]

Thus, another measure that can be used to evaluate whether the estimated elasticities are similar economically under different specifications is proposed: The columns in bold script labeled "lower" of Tables 15 and 16 display the percentage of other SITC-3 sigmas that are estimated as being *lower* than the one in question: Consider good SITC 781 of Table 15: 92.28% of all other sigmas are estimated as being lower than the one estimated for the good SITC 781 when using Feenstra's FGLS estimator. Using OLS, the estimated elasticity is a lot higher in absolute terms, but about the same percentage of other SITC-3 goods are estimated as being lower, namely 95.37%. The measure is unaffected by the high absolute and relative difference between the sigmas.

Why does this measure make sense? For one thing, it is a relative measure that takes into account all the other sigmas estimated under one specification. More importantly, this measure illustrates the main point that these elasticities should express, namely whether the varieties of these goods are differentiated or not. As another example from Table 16, take SITC 772 with varieties defined as HTS-6. In the benchmark case, 83.40% of all other products have a lower elasticity. Using the different reference variety however, only 11.58% of the other sigmas are lower. Thus, the estimate from the first specification implies that the good is *very homogeneous* whereas under the second specification, the good seems *fairly differentiated*; always in comparison to the other goods.

Consider now the last three columns of Tables 15 and 16. There, the absolute difference between two specifications is given. If this difference is greater than 20% it is displayed in bold script. As an example, consider SITC 764 of Table 16 if a variety is defined as HTS-6: If the alternative specification with different country definitions is used, 56.37% of all sigmas are lower than the one of SITC 764. Using the specification with different reference varieties, only 35.91% of all sigmas are lower. Thus, the absolute difference is 20.46%.

This exemplifies that some elasticities react very sensitively to different specifications. But how sensitive are they on average? In Table 3, the mean and median differences are displayed for all the elasticities of SITC-3 goods and all specifications: In the first three columns, the differences within each estimator are displayed. The median difference in the percentage of lower elasticities is around 5% to

[24] Consider again equation (1): Note that the exponential terms involving σ_g's get very close to one using 21 or 122 as the σ_g. Thus, the utility under both σ_g's will be very similar.

12%, where Feenstra's FGLS has the highest median deviation. The mean of the difference is between 10% and 20%. Columns four to six of Table 3 displays the deviations between estimators. There, the deviations are much higher, with a mean of 28% and a median of 23%. The choice of the estimator again seems to lead to more potential differences.

Table 3: Summary Statistics: Deviations of Individual Sigmas

	Within Estimators			Between Estimators		
	FGLS	OLS	BW2006	FGLS - OLS	OLS - BW2006	FGLS - BW2006
Number of Comparisons	2125	2183	2188	2057	2121	2089
Mean Deviation	17.9%	11.0%	14.4%	28.1%	28.7%	28.0%
Median Deviation	12.4%	5.4%	7.7%	23.2%	23.9%	23.2%
Maximum Deviation	87.6%	89.6%	95.4%	94.2%	91.5%	92.7%
Minimum Deviation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

5.2 Standard Errors and Confidence Intervals

One could argue now that maybe the elasticities are not precisely estimated, i.e. that the standard errors are high. Table 17 in the appendix shows all the standard errors and confidence intervals for Feenstra's FGLS estimator under three specifications.[25] Most of the errors are very small. Note that the confidence intervals of most goods do not overlap using different specifications.

This is a sign of heteroskedasticity or other general misspecification in the estimation equation for these goods. This does not mean that all the estimates are bad: If one looks at them a bit more closely, it is obvious that for most of the goods the estimates under different specifications are fairly close to each other. And in that sense, they are robust economically. It is likely however that the standard errors are too small. Consequently, these errors feign a high accuracy of the estimates. Thus, it is not sufficient to look at the standard errors and confidence intervals and conclude that the elasticities are estimated accurately.

Summarizing the results of Section 5, many of the individual elasticities are estimated quite robustly using an economic interpretation. The differences between estimators however are much larger than those within estimators. Furthermore, the standard errors and confidence intervals seem to be estimated as too low. This may hint at heteroskedisticity or other a general misspecification in th estimates. Using some general tests, this is further explored in the next section.

[25]The standard errors and confidence intervals have been derived by Robert C. Feenstra in an unpublished appendix. It is available on his website: *http://www.econ.ucdavis.edu/faculty/fzfeens/papers.html.*

6 Tests for Misspecification and Heteroskedasticity

The Ramsey RESET-test is a general test for misspecification. It tests whether non-linear combinations of the explaining variables add more explanatory power. If this is the case, it is also an indication for omitted variable bias, an issue which is often tested using this test. If the Null is rejected it is also interpreted as general misspecification. The first row of Table 4 displays the percentage of tests conducted under a specific estimator that were not rejected at the 5% confidence level. For the GLS and the OLS, this percentages are close to 8% which seems very low. Using the GLS proposed by BW2006, this value is virtually zero. Thus, there seems to be some kind of misspecification error present in these estimation equations. In principle, this could also be related to measurement error in the data or any other misspecification.

Table 4: Percentage of Tests Where H_0 is Not Rejected

	FGLS Feenstra	OLS	FGLS BW2006
Number of Tests	2816	2945	2992
Ramsey	7.90%	7.70%	0.20%
White	2.30%	2.10%	2.20%

Using a White-Test, there is evidence for some form of heteroskedasticity present in the data, even if the data is corrected by an FGLS weighting: As is shown in the second row of Table 4, the null-hypothesis of homoskedasticity is rejected in the vast majority of all cases. It could be that despite using an FGLS estimator, some more complex form of heteroskedasticity is present. Note however that since the White test is a very general test, this could also be another indication of a general misspecification.

These result seem to imply that the estimated elasticities are not reliable at all. I do not share this opinion. Note that the two tests are very general. Any possible misspecification could lead to a rejection of the H_0 hypothesis: Problems in the data like measuerement errors, misspecification of the utility model, problems with endogeneity, some form of heteroskedasticity, and more. Overall, the results are still pretty stable under different specifications. Thus, as a consequence of the above tests, I would not reject the whole approach to estimate elasticities. What could be deduced from this section is that the FGLS of BW2006 is again performing pretty poorly compared to the other two. Again, this could be hinting at some problems with the assumed form of heteroskedasticity.

7 Concluding Remarks

Estimating elasticities from disaggregated data, there are some points that should be considered doing research: First, the choice of the estimator may influence the results quite strongly. This is the case for the overall magnitude of the elasticities as well as for the comparison of individual elasticities. There is mixed evidence on the question of which estimator performs best. Also note that this question probably depends on the data set used, the time period considered, the methodology of data acquisition (i.e the characteristics of possible measurement errors), etc. Using the U.S. import data from 1990 to 2001, Feenstra's FGLS seems to provide adequate results. Central properties are met using this estimator, while a simple OLS and the FGLS provided by BW2006 seem to exhibit more problems.

A further issue using this methodology is the choice of the reference variety which can be very important: I have shown that if the researcher chooses the second most important variety instead of the most important one the results are still stable. However, using the reference varieties with the lowest values that assumingly exhibit the highest measurement errors often changes the results. Furthermore, the central properties do not always hold under this specification. On the other hand, redefinition of countries does not change the varieties in an important way.

To sum up, using Feenstra's FGLS, the estimated elasticities meet central proporties of elasticities of substitution. Furthermore, individual elasticities seem to be quite robust under different specifications. Some elasticities however do react sensitively to changes in the specfication. Despite that, they exhibit very small standard errors. This is a sign of heteroskedasticity and misspecification. A presumption that is confirmed by very general tests for misspecification and heteroskedasticity carried out in this paper. As a consequence, the standard errors should be taken with caution as they feign a high accuracy of the estimated elasticities.

A last point is the disaggregation of the data used to estimate the elasticites. It is shown that the elasticities decrease if goods or/and varieties are aggregated. This is an expected results and is also found in other studies. I vary the aggregation level of a variety from HTS-10 to HTS-6, which is of course still fairly differentiated. My results imply that the overall magnitude of the varieties does not change much when the level of aggregation is varied.

References

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

Anderson, James E. and Eric van Wincoop, “Trade Costs”, *Journal of Economic Literature*, 2004, 84(1), 691-751.

Blonigen, Bruce A. and Wesley W. Wilson, “Explaining Armington: What Determines Substitutability Between Home and Foreign Goods?”, *Canadian Journal of Economics*, 1999, 32(1), 1-21.

Broda, C., J. Greenfield, D. E. Weinstein, “From Groundnuts to Globalization: A Structural Estimate of Trade and Growth”, *Working Paper*, 2006.

Broda, C. and D. E. Weinstein, “Globalization and the Gains from Trade”, *The Quarterly Journal of Economics*, 2006, 121(2), 541-585.

Chaney, Thomas, “Distorted gravity: Heterogeneous Firms, Market Structure and the Geography of International Trade”, *Working Paper*, 2006.

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

Feenstra, Robert C., “New Goods and Index Numbers: U.S. Import Prices”, *NBER Working Paper*, 1991, No. 1902, 1-40.

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

Feenstra, R. C. and J. R. Markusen, “Accounting for Growth with New Inputs”, *International Economic Review*, 1994, 35(2), 429-447.

Gaulier, G. and I. Méjean, “Import Prices, Variety and the Extensive Margin of Trade”, *Working Paper*, 2006.

Griliches, Zvi and Jerry A. Hausman, “Errors in Variables in Panel Data”, *Journal of Econometrics*, 1986, 31(1), 93-118.

Hanson, Gordon H., “Market Potential, Increasing Returns, and Geographic Concentration”, *mimeo*, University of Michigan, 1998.

Hsiao, Cheng, "Benefits and Limitations of Panel Data", *Econometric Reviews*, 1985, 4(1), 121-174.

Imbs, Jean and Isabelle Méjean, "Elasticity Optimism", *Working Paper*, 2009.

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

Ruhl, Kim J., "Solving the Elasticity Puzzle in International Economics", *Job Market Paper*, 2003.

Romalis John, "NAFTA's and CUSFTA's Impact on International Trade", *Review of Economics and Statistics*, 2007, 89(3), 416-435.

Appendix

Table 5: Definition of Country Blocks

Newly defined Country Blocks	No.
Southern Europe	1
Central Europe	2
Northern Europe	3
Great Britain, Ireland	4
Eastern Europe	5
South-Eastern Europe + Turkey	6
Russia	7
Baltic States	8
Former USSR States	9
Northern Africa States	10
Southern African States	11
Central African States	12
Eastern African States	13
Western African States	14
Arab States	15
Israel	16
India, Sri Lanka, Nepal	17
Pakistan, Afghanistan	18
China	19
Hongkong, Taiwan, Macao	20
Korea (North and South)	21
Japan	22
South East Asia	23
Canada	24
USA	25
Mexico	26
Central America	27
Caribbean	28
South America	29
Australia, New Zealand	30
Oceanic Island States	31

Table 6: Aggregate Results Under Different Specifications; Feenstra's FGLS Estimator

	FGLS, HTS-6, BM			FGLS, HTS-6, Country			FGLS, HTS-6, Second Ref.			FGLS, HTS-6, Last Ref.		
	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3
Elasticities estimated	4322	2547	241	4414	2616	243	4327	2545	239	4197	2461	218
Mean	6.1	5.2	3.9	5.5	6.2	4.0	9.4	7.4	4.6	8.5	6.0	4.9
Standard deviation (Mean)	0.5	0.2	0.4	0.3	1.3	0.3	2.1	1.9	0.9	1.6	0.5	0.5
Median	**3.1**	**3.0**	**2.7**	**2.9**	**2.9**	**2.8**	**3.1**	**3.0**	**2.9**	**3.1**	**3.0**	**3.0**
Maximum elasticity	1305.0	362.8	96.8	791.9	3450.2	56.2	5995.7	4762.2	203.4	5995.7	795.7	62.2
Minimum elasticity	1.0	1.0	1.4	1.0	1.1	1.4	1.0	1.0	1.6	1.0	1.0	1.6
	FGLS, HTS-8, BM			FGLS, HTS-8, Country			FGLS, HTS-8, Second Ref.			FGLS, HTS-8, Last Ref.		
	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3
Elasticities estimated	8282	2527	244	8413	2581	241	8249	2503	241	8012	2383	225
Mean	7.3	5.7	5.5	7.3	7.1	5.0	7.6	5.6	4.3	7.1	6.1	4.2
Standard deviation (Mean)	0.4	0.5	1.4	0.7	1.7	1.1	0.8	0.3	0.4	0.4	0.4	0.3
Median	**3.2**	**3.0**	**2.7**	**3.0**	**3.0**	**2.9**	**3.1**	**3.0**	**2.8**	**3.1**	**3.1**	**2.9**
Maximum elasticity	1354.7	1012.0	340.5	4727.4	4240.0	259.6	4957.8	423.3	59.0	2378.0	746.8	53.6
Minimum elasticity	1.0	1.0	1.4	1.0	1.1	1.4	1.0	1.0	1.5	1.0	1.0	1.4
	FGLS, HTS-10, BM			FGLS, HTS-10, Country			FGLS, HTS-10, Second Ref.			FGLS, HTS-10, Last Ref.		
	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3
Elasticities estimated	13915	2486	240	14181	2554	236	13843	2458	235	13413	2354	213
Mean	11.8	6.3	5.9	9.1	7.8	13.8	11.5	5.5	6.6	9.5	6.8	4.2
Standard deviation (Mean)	1.4	0.6	1.3	1.2	1.9	8.8	2.1	0.3	2.0	0.9	0.7	0.3
Median	**3.4**	**3.1**	**2.9**	**3.2**	**3.0**	**2.9**	**3.3**	**3.1**	**2.9**	**3.3**	**3.2**	**3.0**
Maximum elasticity	14747.6	1012.0	272.8	15982.0	4240.0	2062.4	25864.5	393.2	436.4	7882.5	1433.4	47.0
Minimum elasticity	1.0	1.0	1.4	1.0	1.1	1.6	1.0	1.0	1.6	1.0	1.0	1.6

Table 7: Aggregate Results Under Different Specifications; OLS Estimator

	OLS, HTS-6, BM			OLS, HTS-6, Country			OLS, HTS-6, Second Ref.			OLS, HTS-6, Last Ref.		
	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3
Elasticities estimated	4314	2556	248	4356	2571	242	4332	2553	250	4238	2508	243
Mean	8.8	10.1	3.5	8.4	45.4	3.7	4.9	4.8	3.1	6.1	5.6	3.9
Standard deviation (Mean)	3.3	5.5	0.5	2.1	38.3	1.0	0.3	0.4	0.3	0.4	0.4	0.6
Median	**2.4**	**2.3**	**2.2**	**2.3**	**2.2**	**2.2**	**2.4**	**2.3**	**2.2**	**2.6**	**2.5**	**2.4**
Maximum elasticity	14085.6	14085.6	122.0	8291.1	98406.8	240.2	608.3	608.3	63.7	949.8	531.7	127.6
Minimum elasticity	1.0	1.0	1.4	1.0	1.0	1.3	1.0	1.0	1.2	1.0	1.0	1.2
	OLS, HTS-8, BM			OLS, HTS-8, Country			OLS, HTS-8, Second Ref.			OLS, HTS-8, Last Ref.		
	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3
Elasticities estimated	8339	2562	246	8426	2568	245	8322	2560	249	8126	2496	248
Mean	11.6	10.1	2.8	8.0	7.7	39.5	6.1	5.0	2.9	6.6	5.4	3.9
Standard deviation (Mean)	3.5	5.5	0.1	1.2	1.5	36.2	0.4	0.4	0.1	0.3	0.3	0.6
Median	**2.5**	**2.4**	**2.2**	**2.5**	**2.3**	**2.1**	**2.5**	**2.4**	**2.3**	**2.7**	**2.6**	**2.5**
Maximum elasticity	24926.3	14085.6	28.8	8291.1	3524.3	8873.6	2258.7	608.3	18.8	1270.3	465.9	127.6
Minimum elasticity	1.0	1.0	1.4	1.0	1.0	1.3	1.0	1.0	1.2	1.0	1.0	1.2
	OLS, HTS-10, BM			OLS, HTS-10, Country			OLS, HTS-10, Second Ref.			OLS, HTS-10, Last Ref.		
	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3
Elasticities estimated	14122	2557	250	14316	2573	245	14075	2540	249	13688	2475	241
Mean	91.2	11.5	9.1	8.6	6.0	3.0	13.9	5.5	3.4	8.3	5.7	3.5
Standard deviation (Mean)	66.8	5.7	4.3	0.8	0.6	0.3	4.0	0.6	0.4	0.5	0.4	0.2
Median	**2.7**	**2.4**	**2.3**	**2.7**	**2.3**	**2.2**	**2.7**	**2.4**	**2.3**	**2.9**	**2.6**	**2.6**
Maximum elasticity	924074.7	14085.6	863.1	8291.1	890.1	51.4	45053.9	1067.8	79.5	5448.3	465.9	30.1
Minimum elasticity	1.0	1.0	1.4	1.0	1.0	1.3	1.0	1.0	1.5	1.0	1.0	1.5

Table 8: Aggregate Results Under Different Specifications; BW2006 FGLS Estimator

	BW, HTS-6, BM			BW, HTS-6, Country			BW, HTS-6, Second Ref.			BW, HTS-6, Last Ref.		
	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3	HTS-6	SITC-5	SITC-3
Elasticities estimated	4366	2601	250	4310	2566	247	4403	2599	248	4377	2599	249
Mean	69.7	91.1	7.1	151.8	207.0	7.4	65.9	87.3	6.5	64.4	83.6	3.4
Standard deviation (Mean)	44.1	73.4	1.5	102.2	168.3	1.5	43.7	73.4	0.5	44.0	73.4	0.2
Median	**3.5**	**3.6**	**4.0**	**3.3**	**3.4**	**3.9**	**3.4**	**3.5**	**4.1**	**2.6**	**2.5**	**2.1**
Maximum elasticity	190741.0	190741.0	372.8	429416.9	429416.9	354.4	190741.0	190741.0	67.4	190741.0	190741.0	23.2
Minimum elasticity	1.0	1.0	1.1	1.0	1.0	1.1	1.0	1.0	1.2	1.0	1.0	1.2
	BW, HTS-8, BM			BW, HTS-8, Country			BW, HTS-8, Second Ref.			BW, HTS-8, Last Ref.		
	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3	HTS-8	SITC-5	SITC-3
Elasticities estimated	8397	2632	249	8267	2602	247	8530	2624	252	8494	2604	252
Mean	66.4	102.5	6.5	201.4	186.6	8.1	63.0	99.3	7.3	63.9	95.7	3.5
Standard deviation (Mean)	28.6	73.6	0.5	98.6	165.1	1.7	28.2	73.8	0.8	28.5	74.3	0.2
Median	**3.6**	**3.7**	**4.2**	**3.3**	**3.5**	**4.0**	**3.5**	**3.6**	**4.5**	**2.8**	**2.6**	**2.3**
Maximum elasticity	190741.0	190741.0	111.8	651450.1	429416.9	354.4	190741.0	190741.0	166.7	190741.0	190741.0	35.4
Minimum elasticity	1.0	1.0	1.2	1.0	1.0	1.2	1.0	1.0	1.2	1.0	1.0	1.1
	BW, HTS-10, BM			BW, HTS-10, Country			BW, HTS-10, Second Ref.			BW, HTS-10, Last Ref.		
	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3	HTS-10	SITC-5	SITC-3
Elasticities estimated	14193	2618	250	14056	2606	247	14505	2619	252	14460	2599	249
Mean	518.7	92.4	48.0	932.4	186.7	6.1	492.2	89.8	9.1	490.2	86.8	4.2
Standard deviation (Mean)	434.5	73.0	40.8	523.6	164.9	0.3	425.1	72.9	2.2	426.4	73.5	0.4
Median	**3.8**	**3.9**	**4.8**	**3.5**	**3.7**	**4.5**	**3.6**	**3.8**	**4.6**	**2.9**	**2.6**	**2.3**
Maximum elasticity	6159197.0	190741.0	10208.2	6159197.0	429416.9	41.1	6159197.0	190741.0	553.1	6159197.0	190741.0	66.7
Minimum elasticity	1.0	1.0	1.2	1.0	1.0	1.2	1.0	1.0	1.1	1.0	1.0	1.1

Table 9: Aggregation Property, Different Specifications; Feenstra's FGLS

	FGLS, HTS-6, BM	FGLS, HTS-6, Country	FGLS, HTS-6, Second Ref.	FGLS, HTS-6, Last Ref.
No. SITC-3	241	243	239	218
Min	**5.9%**	**4.5%**	**2.5%**	**2.8%**
Max	91.6%	92.2%	90.3%	86.6%
W.A. Mean	**74.9%**	**69.5%**	**70.6%**	**66.8%**
W.G. Mean	71.1%	60.9%	64.3%	55.8%
Median	**61.1%**	**51.0%**	**58.0%**	**46.5%**
	FGLS, HTS-8, BM	FGLS, HTS-8, Country	FGLS, HTS-8, Second Ref.	FGLS, HTS-8, Last Ref.
No. SITC-3	244	241	241	225
Min	**4.1%**	**3.3%**	**4.2%**	**3.1%**
Max	94.6%	94.6%	92.1%	90.6%
W.A. Mean	**81.0%**	**76.3%**	**75.4%**	**71.4%**
W.G. Mean	73.1%	67.6%	68.3%	63.4%
Median	**58.7%**	**53.9%**	**55.4%**	**48.2%**
	FGLS, HTS-10, BM	FGLS, HTS-10, Country	FGLS, HTS-10, Second Ref.	FGLS, HTS-10, Last Ref.
No. SITC-3	240	236	236	213
Min	**1.3%**	**1.7%**	**0.4%**	**1.4%**
Max	95.8%	94.1%	95.7%	96.7%
W.A. Mean	**83.2%**	**80.5%**	**80.3%**	**76.3%**
W.G. Mean	74.4%	70.8%	71.2%	62.6%
Median	**59.2%**	**52.1%**	**59.2%**	**45.5%**

Table 10: Aggregation Property, Different Specifications; OLS

	OLS, HTS-6, BM	OLS, HTS-6, Country	OLS, HTS-6, Second Ref.	OLS, HTS-6, Last Ref.
No. SITC-3	248	242	250	243
Min	**3.2%**	**3.7%**	**3.6%**	**3.7%**
Max	92.7%	92.6%	92.0%	89.3%
W.A. Mean	**74.2%**	**74.4%**	**70.4%**	**68.3%**
W.G. Mean	66.9%	63.6%	63.2%	59.3%
Median	**54.4%**	**56.2%**	**52.0%**	**45.7%**
	OLS, HTS-8, BM	OLS, HTS-8, Country	OLS, HTS-8, Second Ref.	OLS, HTS-8, Last Ref.
No. SITC-3	246	245	249	248
Min	**3.3%**	**2.0%**	**3.2%**	**3.2%**
Max	95.9%	94.7%	95.6%	92.3%
W.A. Mean	**80.9%**	**80.0%**	**79.5%**	**72.6%**
W.G. Mean	72.8%	68.2%	69.1%	64.1%
Median	**60.6%**	**57.1%**	**59.0%**	**49.2%**
	OLS, HTS-10, BM	OLS, HTS-10, Country	OLS, HTS-10, Second Ref.	OLS, HTS-10, Last Ref.
No. SITC-3	250	245	249	241
Min	**1.6%**	**1.2%**	**0.8%**	**1.2%**
Max	94.8%	95.9%	96.4%	95.4%
W.A. Mean	**85.2%**	**84.9%**	**84.7%**	**79.3%**
W.G. Mean	75.2%	70.6%	73.8%	64.7%
Median	**57.6%**	**59.6%**	**58.1%**	**42.3%**

Table 11: Aggregation Property, Different Specifications; BW2006 FGLS

	BW, HTS-6, BM	BW, HTS-6, Country	BM, HTS-6, Second Ref.	BW, HTS-6, Last Ref.
No. SITC-3	250	247	248	249
Min	**7.2%**	**6.1%**	**3.6%**	**14.1%**
Max	89.6%	89.5%	87.5%	91.6%
W.A. Mean	**69.6%**	**64.0%**	**66.5%**	**77.1%**
W.G. Mean	52.8%	49.4%	49.2%	67.9%
Median	**41.2%**	**39.3%**	**36.3%**	**65.5%**
	BW, HTS-8, BM	BW, HTS-8, Country	BW, HTS-8, Second Ref.	BW, HTS-8, Last Ref.
No. SITC-3	249	247	252	252
Min	**3.2%**	**5.3%**	**2.8%**	**8.7%**
Max	92.8%	93.1%	92.9%	95.6%
W.A. Mean	**73.5%**	**74.1%**	**68.7%**	**81.3%**
W.G. Mean	53.8%	52.6%	50.8%	70.6%
Median	**38.2%**	**31.2%**	**31.0%**	**65.9%**
	BW, HTS-10, BM	BW, HTS-10, Country	BW, HTS-10, Second Ref.	BW, HTS-10, Last Ref.
No. SITC-3	250	247	252	249
Min	**3.6%**	**2.8%**	**3.2%**	**7.6%**
Max	95.2%	95.5%	92.9%	96.4%
W.A. Mean	**73.6%**	**74.9%**	**73.0%**	**79.1%**
W.G. Mean	51.6%	49.0%	48.8%	68.3%
Median	**32.4%**	**30.8%**	**29.0%**	**62.7%**

Table 12: Differentiation Property Under Different Specifications, Rauch Liberal Classification, Feenstra's FGLS

	FGLS, HTS-6, BM			FGLS, HTS-6, Country			FGLS, HTS-6, Second Ref.			FGLS, HTS-6, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	100	185	348	101	188	348	98	182	346	95	171	313
Mean	6.1	3.9	3.8	6.5	3.5	4.6	4.9	4.1	3.8	5.0	4.3	5.0
Standard Error (Mean)	1.1	0.2	0.2	1.7	0.2	0.9	0.4	0.5	0.3	0.5	0.5	0.5
Median	**3.8**	**3.0**	**2.8**	**3.5**	**3.0**	**2.7**	**3.3**	**2.9**	**2.9**	**3.2**	**2.8**	**3.1**
Maximum elasticity	102.2	24.5	44.0	170.5	17.5	297.6	24.5	92.8	95.5	24.5	86.6	133.2
Minimum elasticity	1.5	1.4	1.1	1.5	1.5	1.3	1.5	1.4	1.2	1.4	1.4	1.2
	FGLS, HTS-8, BM			FGLS, HTS-8, Country			FGLS, HTS-8, Second Ref.			FGLS, HTS-8, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	99	184	347	101	185	345	95	182	341	95	168	317
Mean	6.5	3.9	4.2	4.8	3.7	5.2	5.5	4.3	3.9	5.8	3.6	5.9
Standard Error (Mean)	1.1	0.2	0.3	0.4	0.2	1.3	0.5	0.5	0.3	0.9	0.2	0.7
Median	**3.8**	**3.0**	**2.9**	**3.3**	**3.0**	**2.7**	**3.8**	**2.8**	**2.9**	**2.8**	**2.8**	**3.2**
Maximum elasticity	102.2	24.5	76.2	23.3	38.4	418.8	26.4	92.8	73.0	62.4	19.5	133.2
Minimum elasticity	1.5	1.4	1.1	1.5	1.5	1.4	1.5	1.4	1.2	1.4	1.4	1.2
	FGLS, HTS-10, BM			FGLS, HTS-10, Country			FGLS, HTS-10, Second Ref.			FGLS, HTS-10, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	91	183	342	94	181	339	88	183	338	89	168	306
Mean	6.2	4.2	5.5	4.9	3.7	4.0	5.1	4.7	6.5	5.2	4.5	7.4
Standard Error (Mean)	0.7	0.5	0.6	0.5	0.3	0.2	0.4	0.7	1.2	0.5	0.6	1.1
Median	**3.5**	**2.9**	**3.2**	**3.4**	**3.0**	**2.9**	**3.8**	**2.9**	**3.0**	**3.4**	**2.9**	**3.4**
Maximum elasticity	32.0	85.3	122.3	35.3	38.4	45.0	21.5	92.8	285.6	25.0	85.3	227.6
Minimum elasticity	1.5	1.5	1.3	1.6	1.3	1.4	1.5	1.5	1.4	1.4	1.4	1.4

Table 13: Differentiation Property Under Different Specifications, Rauch Liberal Classification, OLS

	OLS, HTS-6, BM			OLS, HTS-6, Country			OLS, HTS-6, Second Ref.			OLS, HTS-6, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	101	191	352	101	192	346	100	187	354	98	185	347
Mean	4.6	2.9	3.3	6.7	2.9	3.1	8.0	3.1	4.2	4.4	3.2	5.4
Standard Error (Mean)	0.8	0.2	0.2	2.4	0.3	0.2	4.1	0.3	0.9	0.6	0.2	1.0
Median	**2.4**	**2.1**	**2.4**	**2.4**	**2.1**	**2.2**	**2.7**	**2.1**	**2.4**	**2.5**	**2.3**	**2.7**
Maximum elasticity	71.8	15.9	44.0	227.6	52.3	35.7	409.6	36.7	331.5	40.5	35.0	239.1
Minimum elasticity	1.3	1.2	1.1	1.3	1.3	1.2	1.3	1.3	1.2	1.1	1.4	1.2
	OLS, HTS-8, BM			OLS, HTS-8, Country			OLS, HTS-8, Second Ref.			OLS, HTS-8, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	100	191	353	101	189	348	98	188	355	99	185	350
Mean	4.5	2.8	3.8	3.5	2.9	3.2	7.9	3.0	3.6	5.2	3.3	5.2
Standard Error (Mean)	0.8	0.1	0.3	0.3	0.3	0.2	4.2	0.2	0.2	0.8	0.3	0.7
Median	**2.4**	**2.2**	**2.4**	**2.3**	**2.2**	**2.3**	**2.7**	**2.2**	**2.4**	**2.8**	**2.3**	**2.9**
Maximum elasticity	71.8	13.8	95.1	22.9	52.3	63.1	409.6	18.5	42.4	57.2	35.0	196.3
Minimum elasticity	1.3	1.2	1.1	1.3	1.3	1.2	1.3	1.3	1.2	1.1	1.4	1.2
	OLS, HTS-10, BM			OLS, HTS-10, Country			OLS, HTS-10, Second Ref.			OLS, HTS-10, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	102	191	351	102	188	346	102	188	350	101	181	335
Mean	4.1	2.9	4.3	6.9	2.9	3.4	8.6	9.7	4.1	4.3	4.5	7.7
Standard Error (Mean)	0.5	0.1	0.4	2.6	0.3	0.2	4.0	5.8	0.5	0.6	1.0	1.9
Median	**2.5**	**2.3**	**2.5**	**2.4**	**2.1**	**2.4**	**2.5**	**2.3**	**2.6**	**2.8**	**2.4**	**3.0**
Maximum elasticity	35.9	18.1	82.3	262.6	52.3	41.5	409.6	1067.8	176.5	52.4	180.9	524.2
Minimum elasticity	1.4	1.2	1.2	1.3	1.3	1.2	1.3	1.3	1.3	1.2	1.4	1.2

Table 14: Differentiation Property Under Different Specifications, Rauch Liberal Classification, BW2006 FGLS

	BW, HTS-6, BM			BW, HTS-6, Country			BW, HTS-6, Second Ref.			BW, HTS-6, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	103	188	356	101	191	361	104	187	353	104	187	352
Mean	11.2	13.0	7.5	16.3	7.5	8.6	20.3	10.0	6.1	17.8	8.4	8.0
Standard Error (Mean)	2.9	4.7	1.2	6.4	1.8	2.4	12.7	4.0	0.7	12.7	4.0	4.3
Median	**5.5**	**4.2**	**3.4**	**5.8**	**3.8**	**3.2**	**5.7**	**4.1**	**3.4**	**3.1**	**2.4**	**2.0**
Maximum elasticity	276.9	744.7	318.6	635.4	336.4	780.5	1325.4	744.7	167.2	1325.4	744.7	1490.7
Minimum elasticity	1.3	1.3	1.0	1.3	1.2	1.0	1.3	1.4	1.1	1.1	1.2	1.1
	BW, HTS-8, BM			BW, HTS-8, Country			BW, HTS-8, Second Ref.			BW, HTS-8, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	104	189	355	102	189	362	106	186	355	103	186	348
Mean	11.2	13.9	6.4	16.0	7.4	8.1	8.1	11.7	489.0	6.4	9.8	5.0
Standard Error (Mean)	2.8	4.7	0.7	6.3	1.7	1.4	0.7	4.3	482.7	1.0	4.3	0.8
Median	**5.8**	**4.4**	**3.5**	**5.9**	**3.9**	**3.4**	**5.7**	**4.4**	**3.8**	**2.9**	**2.4**	**2.1**
Maximum elasticity	276.9	744.7	167.2	635.4	320.6	349.4	34.5	744.7	171350.3	88.3	744.7	167.2
Minimum elasticity	1.3	1.3	1.0	1.3	1.2	1.0	1.3	1.4	1.2	1.1	1.2	1.1
	BW, HTS-10, BM			BW, HTS-10, Country			BW, HTS-10, Second Ref.			BW, HTS-10, Last Ref.		
	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.	Homog.	Ref.	Diff.
Number of Elasticities	104	188	352	103	189	357	106	186	353	103	179	347
Mean	8.5	8.9	10.3	9.1	8.7	6.6	26.1	6.7	6.1	8.3	4.2	4.1
Standard Error (Mean)	0.9	2.5	3.5	1.1	2.5	0.9	16.4	0.4	0.4	2.2	0.3	0.6
Median	**5.8**	**4.8**	**3.9**	**6.3**	**4.3**	**3.8**	**5.8**	**4.8**	**3.9**	**3.4**	**2.5**	**2.2**
Maximum elasticity	53.7	479.5	1135.5	87.3	469.8	260.5	1729.2	42.8	101.5	219.3	33.7	197.6
Minimum elasticity	1.1	1.4	1.2	1.1	1.2	1.2	1.5	1.4	1.1	1.3	1.2	1.1

Table 15: Estimates of Individual Sigmas Using Different Estimators

	HTS-6								
	(a) BM, FGLS		(b) BM, OLS		(c) BM, BW		Comparison		
sitc3	sigma	**lower**	sigma	**lower**	sigma	**lower**	(a) to (b)	(b) to (c)	(a) to (c)
781	26.12	**92.28%**	122.01	**95.37%**	21.39	**94.21%**	3.09%	1.16%	1.93%
333	14.07	**91.12%**	12.81	**93.44%**	6.78	**72.97%**	2.32%	**20.46%**	**18.15%**
752	2.84	**52.12%**	2.98	**74.52%**	1.45	**2.70%**	**22.39%**	**71.81%**	**49.42%**
776	2.37	**30.89%**	1.98	**32.82%**	3.17	**32.43%**	1.93%	0.39%	1.54%
784	5.09	**81.08%**	3.51	**79.92%**	3.52	**40.15%**	1.16%	**39.77%**	**40.93%**
334	7.81	**88.03%**	2.75	**69.50%**	12.58	**88.80%**	18.53%	19.31%	0.77%
845	3.43	**67.57%**	3.43	**79.54%**	6.23	**70.27%**	11.97%	9.27%	2.70%
764	2.54	**37.84%**	2.35	**54.83%**	4.97	**59.07%**	16.99%	4.25%	**21.24%**
851	4.35	**76.83%**	3.30	**78.76%**	15.52	**92.28%**	1.93%	13.51%	15.44%
782	NA	**NA**	NA	**NA**	2.26	**15.44%**	NA	NA	NA
713	2.58	**40.54%**	2.70	**67.18%**	3.30	**36.29%**	**26.64%**	**30.89%**	4.25%
842	5.33	**82.24%**	3.91	**84.56%**	5.46	**64.09%**	2.32%	**20.46%**	18.15%
841	4.31	**76.06%**	4.01	**84.94%**	4.80	**57.92%**	8.88%	**27.03%**	18.15%
641	1.84	**8.88%**	1.82	**22.39%**	6.29	**70.66%**	13.51%	**48.26%**	**61.78%**
792	3.57	**69.11%**	3.24	**77.99%**	3.73	**44.40%**	8.88%	**33.59%**	**24.71%**
515	3.31	**65.25%**	2.28	**52.51%**	2.75	**23.55%**	12.74%	**28.96%**	**41.70%**
667	1.77	**6.56%**	1.89	**26.64%**	NA	**NA**	**20.08%**	NA	NA
772	5.51	**83.40%**	1.79	**18.15%**	2.27	**16.22%**	**65.25%**	1.93%	**67.18%**
763	5.40	**82.63%**	3.17	**76.45%**	2.12	**12.74%**	6.18%	**63.71%**	**69.88%**
248	2.32	**30.12%**	2.16	**45.95%**	2.78	**24.32%**	15.83%	**21.62%**	5.79%
	HTS-8								
	(a) BM, FGLS		(b) BM, OLS		(c) BM, BW		Comparison		
sitc3	sigma	**lower**	sigma	**lower**	sigma	**lower**	(a) to (b)	(b) to (c)	(a) to (c)
781	65.75	**93.44%**	NA	**NA%**	19.75	**91.89%**	NA	NA	1.54%
333	15.63	**91.12%**	12.90	**94.21%**	26.96	**93.82%**	3.09%	0.39%	2.70%
752	3.71	**72.20%**	3.80	**83.40%**	1.54	**2.70%**	11.20%	**80.69%**	**69.50%**
776	3.06	**57.92%**	1.97	**29.73%**	4.23	**48.65%**	**28.19%**	18.92%	9.27%
784	5.34	**83.01%**	2.27	**49.81%**	2.86	**22.01%**	**33.20%**	**27.80%**	**61.00%**
334	7.98	**87.64%**	2.58	**61.00%**	4.39	**50.58%**	**26.64%**	10.42%	**37.07%**
845	4.91	**81.08%**	4.32	**85.71%**	11.20	**84.56%**	4.63%	1.16%	3.47%
764	3.73	**72.59%**	2.74	**67.95%**	3.72	**37.84%**	4.63%	**30.12%**	**34.75%**
851	3.69	**71.43%**	2.90	**71.43%**	8.39	**76.06%**	0.00%	4.63%	4.63%
782	NA	**NA**	NA	**NA**	5.72	**61.78%**	NA	NA	NA
713	2.40	**32.82%**	2.84	**71.04%**	3.48	**33.20%**	**38.22%**	**37.84%**	0.39%
842	6.21	**86.10%**	4.51	**86.49%**	5.99	**64.86%**	0.39%	**21.62%**	**21.24%**
841	8.60	**88.03%**	5.10	**88.42%**	5.98	**64.48%**	0.39%	**23.94%**	**23.55%**
641	1.82	**6.95%**	1.81	**20.08%**	6.74	**69.88%**	13.13%	**49.81%**	**62.93%**
792	2.93	**51.74%**	2.75	**68.73%**	4.66	**53.67%**	16.99%	15.06%	1.93%
515	3.01	**55.98%**	2.96	**73.75%**	NA	**NA**	17.76%	NA	NA
667	2.45	**33.59%**	2.02	**34.75%**	NA	**NA**	1.16%	NA	NA
772	2.22	**23.17%**	1.87	**23.17%**	2.13	**12.36%**	0.00%	10.81%	10.81%
763	NA	**NA**	3.52	**81.85%**	10.29	**83.01%**	NA	1.16%	NA
248	2.84	**49.81%**	1.68	**8.49%**	5.20	**58.69%**	**41.31%**	**50.19%**	8.88%
HTS-10									
	(a) BM, FGLS		(b) BM, OLS		(c) BM, BW		Comparison		
sitc3	sigma	**lower**	sigma	**lower**	sigma	**lower**	(a) to (b)	(b) to (c)	(a) to (c)
781	57.08	**91.51%**	NA	**NA**	17.35	**90.73%**	NA	NA	0.77%
333	14.40	**89.58%**	12.89	**94.21%**	6.29	**61.39%**	4.63%	**32.82%**	**28.19%**
752	3.78	**67.57%**	3.79	**81.08%**	1.55	**2.32%**	13.51%	**78.76%**	**65.25%**
776	2.19	**21.24%**	2.17	**40.93%**	3.78	**34.36%**	19.69%	6.56%	13.13%
784	2.75	**41.31%**	2.23	**42.47%**	5.50	**55.21%**	1.16%	12.74%	13.90%
334	4.70	**77.22%**	2.57	**56.37%**	2.17	**11.58%**	**20.85%**	**44.79%**	**65.64%**
845	5.02	**79.15%**	5.04	**88.42%**	7.13	**66.80%**	9.27%	**21.62%**	12.36%
764	3.82	**67.95%**	3.22	**74.90%**	4.45	**44.40%**	6.95%	**30.50%**	**23.55%**
851	4.33	**73.36%**	3.22	**75.29%**	9.67	**80.69%**	1.93%	5.41%	7.34%
782	NA	**NA**	NA	**NA**	4.83	**49.03%**	NA	NA	NA
713	3.28	**58.69%**	2.88	**67.57%**	3.73	**33.20%**	8.88%	**34.36%**	**25.48%**
842	5.33	**81.08%**	5.10	**88.80%**	6.44	**62.93%**	7.72%	**25.87%**	18.15%
841	5.53	**81.85%**	5.44	**89.19%**	7.34	**69.11%**	7.34%	**20.08%**	12.74%
641	1.89	**9.65%**	1.82	**16.99%**	8.41	**76.45%**	7.34%	**59.46%**	**66.80%**
792	4.16	**71.43%**	3.31	**76.06%**	7.14	**67.57%**	4.63%	8.49%	3.86%
515	2.76	**42.08%**	2.72	**61.78%**	174.07	**95.75%**	19.69%	**33.98%**	**53.67%**
667	2.50	**32.05%**	2.39	**50.19%**	NA	**NA**	18.15%	NA	NA
772	1.81	**6.56%**	1.84	**19.31%**	2.20	**12.36%**	12.74%	6.95%	5.79%
763	3.13	**55.60%**	3.35	**76.83%**	8.28	**75.68%**	**21.24%**	1.16%	**20.08%**
248	1.95	**11.58%**	1.81	**15.06%**	5.94	**59.85%**	3.47%	**44.79%**	**48.26%**

Table 16: Estimates of Individual Sigmas Under Different Specifications

	HS-6, Benchmark		HS-6, Country		HS-6, Second Ref.			Differences	
sitc3	sigma	lower	sigma	lower	sigma	lower	a) to b)	b) to c)	a) to c)
781	26.12	**91.89%**	29.50	**91.12%**	25.62	**90.35%**	0.77%	0.77%	1.54%
333	13.98	**90.73%**	13.12	**89.19%**	17.26	**89.96%**	1.54%	0.77%	0.77%
752	2.84	**52.12%**	2.64	**47.49%**	3.89	**69.11%**	4.63%	**21.62%**	16.99%
776	2.37	**30.89%**	2.07	**18.53%**	1.99	**14.67%**	12.36%	3.86%	16.22%
784	5.09	**81.08%**	3.04	**58.30%**	3.81	**67.18%**	**22.78%**	8.88%	13.90%
334	7.89	**87.64%**	7.32	**86.49%**	6.91	**84.56%**	1.16%	1.93%	3.09%
845	3.43	**67.57%**	4.67	**79.92%**	3.68	**65.64%**	12.36%	14.29%	1.93%
764	2.54	**37.84%**	2.95	**56.37%**	2.62	**35.91%**	18.53%	**20.46%**	1.93%
851	4.35	**76.83%**	4.40	**77.61%**	4.38	**75.68%**	0.77%	1.93%	1.16%
782	NA	**NA**	NA	**NA**	NA	**NA**	NA	NA	NA
713	2.58	**40.54%**	3.16	**63.71%**	3.38	**59.46%**	23.17%	4.25%	18.92%
842	5.33	**82.24%**	4.31	**76.83%**	4.34	**75.29%**	5.41%	1.54%	6.95%
841	4.31	**76.06%**	10.15	**87.64%**	8.28	**87.26%**	11.58%	0.39%	11.20%
641	1.84	**8.88%**	1.94	**14.29%**	1.90	**8.88%**	5.41%	5.41%	0.00%
792	3.57	**69.11%**	3.27	**66.41%**	2.77	**41.70%**	2.70%	**24.71%**	**27.41%**
515	3.31	**65.25%**	3.80	**72.97%**	2.18	**20.85%**	7.72%	**52.12%**	**44.40%**
667	1.77	**6.56%**	2.13	**21.24%**	1.79	**4.25%**	14.67%	16.99%	2.32%
772	5.51	**83.40%**	2.17	**22.78%**	1.93	**11.58%**	**60.62%**	11.20%	71.81%
763	5.40	**82.63%**	6.84	**84.94%**	3.23	**55.98%**	2.32%	**28.96%**	**26.64%**
248	2.32	**30.12%**	2.49	**36.68%**	3.05	**52.12%**	6.56%	15.44%	**22.01%**
	HS-8, Benchmark		HS-8, Country		HS-8, Second Ref.			Differences	
sitc3	sigma	lower	sigma	lower	sigma	lower			
781	65.75	**93.05%**	70.88	**92.66%**	59.02	**92.28%**	0.39%	0.39%	0.77%
333	15.63	**90.73%**	17.35	**91.51%**	14.59	**89.58%**	0.77%	1.93%	1.16%
752	3.71	**72.20%**	3.79	**71.04%**	3.91	**70.66%**	1.16%	0.39%	1.54%
776	3.06	**57.92%**	2.01	**12.74%**	2.58	**38.61%**	**45.17%**	**25.87%**	19.31%
784	5.34	**83.01%**	3.65	**69.50%**	2.83	**47.10%**	13.51%	**22.39%**	**35.91%**
334	7.98	**87.26%**	5.39	**84.17%**	NA	**NA**	3.09%	NA	NA
845	4.91	**81.08%**	4.58	**80.31%**	4.01	**73.36%**	0.77%	6.95%	7.72%
764	3.73	**72.59%**	3.80	**71.81%**	2.69	**43.24%**	0.77%	**28.57%**	**29.34%**
851	3.69	**71.43%**	3.30	**64.09%**	4.91	**79.92%**	7.34%	15.83%	8.49%
782	NA	**NA**	NA	**NA**	NA	**NA**	NA	NA	NA
713	2.40	**32.82%**	2.53	**37.84%**	4.31	**75.68%**	5.02%	**37.84%**	**42.86%**
842	6.21	**85.71%**	4.84	**82.63%**	4.53	**77.99%**	3.09%	4.63%	7.72%
841	8.60	**87.64%**	7.26	**88.03%**	5.23	**81.08%**	0.39%	6.95%	6.56%
641	1.82	**6.95%**	1.80	**4.25%**	2.13	**20.08%**	2.70%	15.83%	13.13%
792	2.93	**51.74%**	3.18	**61.39%**	3.07	**54.05%**	9.65%	7.34%	2.32%
515	3.01	**55.98%**	2.97	**54.05%**	3.11	**56.76%**	1.93%	2.70%	0.77%
667	2.45	**33.59%**	5.58	**85.33%**	3.03	**52.51%**	**51.74%**	**32.82%**	18.92%
772	2.22	**23.17%**	2.13	**19.69%**	1.82	**5.79%**	3.47%	13.90%	17.37%
763	NA	**NA**	NA	**NA**	3.94	**71.81%**	NA	NA	NA
248	2.84	**49.81%**	2.80	**49.42%**	1.60	**0.39%**	0.39%	**49.03%**	**49.42%**
	HS-10, Benchmark		HS-10, Country		HS-10, Second Ref.			Differences	
sitc3	sigma	lower	sigma	lower	sigma	lower			
781	57.08	**91.12%**	63.30	**90.35%**	NA	**NA**	0.77%	NA	NA
333	14.40	**89.19%**	14.11	**89.19%**	17.01	**90.35%**	0.00%	1.16%	1.16%
752	3.78	**67.57%**	4.07	**69.88%**	4.20	**67.95%**	2.32%	1.93%	0.39%
776	2.19	**21.24%**	2.13	**19.69%**	2.19	**19.31%**	1.54%	0.39%	1.93%
784	2.75	**41.31%**	3.32	**57.53%**	2.59	**39.00%**	16.22%	18.53%	2.32%
334	4.70	**77.22%**	6.00	**81.47%**	6.94	**82.24%**	4.25%	0.77%	5.02%
845	5.02	**79.15%**	5.13	**78.38%**	5.45	**79.54%**	0.77%	1.16%	0.39%
764	3.82	**67.95%**	4.75	**76.45%**	4.29	**69.11%**	8.49%	7.34%	1.16%
851	4.33	**73.36%**	4.07	**69.50%**	3.36	**55.98%**	3.86%	13.51%	17.37%
782	NA	**NA**	NA	**NA**	NA	**NA**	NA	NA	NA
713	3.28	**58.69%**	3.51	**60.62%**	4.30	**69.50%**	1.93%	8.88%	10.81%
842	5.33	**81.08%**	5.63	**80.31%**	5.90	**80.69%**	0.77%	0.39%	0.39%
841	5.53	**81.85%**	5.89	**81.08%**	9.15	**86.10%**	0.77%	5.02%	4.25%
641	1.89	**9.65%**	1.94	**10.04%**	1.80	**4.63%**	0.39%	5.41%	5.02%
792	4.16	**71.43%**	5.30	**79.54%**	3.06	**50.19%**	8.11%	**29.34%**	**21.24%**
515	2.76	**42.08%**	2.79	**40.54%**	2.59	**38.61%**	1.54%	1.93%	3.47%
667	2.50	**32.05%**	2.57	**34.36%**	3.86	**65.25%**	2.32%	**30.89%**	**33.20%**
772	1.81	**6.56%**	1.83	**6.18%**	1.83	**6.18%**	0.39%	0.00%	0.39%
763	3.13	**55.60%**	3.10	**50.97%**	3.72	**63.71%**	4.63%	12.74%	8.11%
248	1.95	**11.58%**	2.59	**34.75%**	2.16	**18.15%**	**23.17%**	16.60%	6.56%

Table 17: Standard Errors and Confidence Intervals of the Estimated Sigmas

	Benchmark			Country Blocks			Reference Variety		
HTS-6									
	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE
781	26.119	**(21.406 ; 33.957)**	3.995	29.501	**(24.092 ; 38.504)**	4.758	25.617	**(21.728 ; 31.443)**	3.119
333	13.979	**(12.433 ; 16.049)**	0.558	13.115	**(12.890 ; 13.358)**	0.485	17.264	**(15.030 ; 20.303)**	0.920
752	2.836	**(2.780 ; 2.898)**	0.070	2.636	**(2.631 ; 2.641)**	0.008	3.891	**(3.681 ; 4.156)**	0.202
776	2.367	**(2.328 ; 2.411)**	0.033	2.066	**(2.058 ; 2.074)**	0.008	1.994	**(1.994 ; 1.994)**	0.019
784	5.087	**(4.701 ; 5.592)**	0.361	3.040	**(3.011 ; 3.072)**	0.091	3.812	**(3.587 ; 4.085)**	0.166
334	7.890	**(6.159 ; 11.416)**	0.620	7.317	**(5.995 ; 9.602)**	0.522	6.914	**(5.605 ; 9.304)**	0.483
845	3.426	**(3.426 ; 3.426)**	0.017	4.668	**(4.629 ; 4.708)**	0.036	3.682	**(3.682 ; 3.682)**	0.007
764	2.545	**(2.464 ; 2.634)**	0.047	2.946	**(2.850 ; 3.052)**	0.059	2.623	**(2.555 ; 2.699)**	0.023
851	4.347	**(4.239 ; 4.465)**	0.050	4.397	**(4.281 ; 4.523)**	0.046	4.383	**(4.262 ; 4.515)**	0.065
782	NA	**NA**	NA	NA	**NA**	NA	NA	**NA**	NA
713	2.579	**(2.496 ; 2.677)**	0.039	3.164	**(3.040 ; 3.301)**	0.071	3.376	**(3.217 ; 3.555)**	0.079
842	5.331	**(5.291 ; 5.371)**	0.059	4.307	**(4.280 ; 4.335)**	0.022	4.344	**(4.344 ; 4.344)**	0.007
841	4.309	**(4.285 ; 4.333)**	0.026	10.154	**(9.728 ; 10.625)**	0.280	8.279	**(7.422 ; 9.666)**	0.465
641	1.841	**(1.839 ; 1.843)**	0.004	1.940	**(1.938 ; 1.941)**	0.007	1.896	**(1.896 ; 1.896)**	0.005
792	3.575	**(3.575 ; 3.575)**	0.042	3.271	**(3.193 ; 3.357)**	0.063	2.771	**(2.748 ; 2.794)**	0.036
515	3.308	**(2.974 ; 3.835)**	0.188	3.802	**(3.305 ; 4.697)**	0.297	2.184	**(2.142 ; 2.230)**	0.024
667	1.766	**(1.740 ; 1.794)**	0.014	2.133	**(2.071 ; 2.205)**	0.031	1.794	**(1.768 ; 1.822)**	0.017
772	5.515	**(5.340 ; 5.707)**	0.321	2.174	**(2.130 ; 2.223)**	0.021	1.929	**(1.904 ; 1.955)**	0.022
763	5.404	**(4.602 ; 6.809)**	0.463	6.836	**(5.396 ; 10.659)**	0.997	3.230	**(3.021 ; 3.498)**	0.075
248	2.325	**(2.255 ; 2.402)**	0.042	2.492	**(2.399 ; 2.599)**	0.054	3.055	**(2.853 ; 3.303)**	0.104
HTS-8	Benchmark			Country Blocks			Reference Variety		
	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE
781	65.750	**(47.672 ; 107.914)**	15.248	70.883	**(53.129 ; 107.745)**	15.948	59.023	**(49.571 ; 73.199)**	9.328
333	15.629	**(12.270 ; 21.208)**	1.858	17.350	**(13.302 ; 24.350)**	2.237	14.587	**(11.968 ; 19.495)**	1.849
752	3.714	**(3.714 ; 3.714)**	0.030	3.789	**(3.789 ; 3.789)**	0.014	3.909	**(3.909 ; 3.909)**	0.013
776	3.060	**(2.961 ; 3.168)**	0.063	2.009	**(2.009 ; 2.009)**	0.011	2.577	**(2.516 ; 2.644)**	0.028
784	5.341	**(4.976 ; 5.785)**	0.208	3.650	**(3.531 ; 3.781)**	0.069	2.828	**(2.759 ; 2.905)**	0.020
334	7.982	**(6.985 ; 9.408)**	0.874	5.388	**(4.912 ; 6.039)**	0.311	NA	**NA**	NA
845	4.911	**(4.906 ; 4.916)**	0.005	4.584	**(4.583 ; 4.583)**	0.018	4.011	**(4.011 ; 4.011)**	0.014
764	3.731	**(3.646 ; 3.824)**	0.076	3.805	**(3.701 ; 3.918)**	0.083	2.693	**(2.693 ; 2.693)**	0.034
851	3.686	**(3.686 ; 3.686)**	0.011	3.296	**(3.296 ; 3.296)**	0.011	4.906	**(4.773 ; 5.050)**	0.043
782	NA	**NA**	NA	NA	**NA**	NA	NA	**NA**	NA
713	2.403	**(2.395 ; 2.412)**	0.018	2.530	**(2.511 ; 2.549)**	0.022	4.306	**(4.195 ; 4.428)**	0.105
842	6.214	**(6.214 ; 6.214)**	0.012	4.840	**(4.825 ; 4.855)**	0.025	4.533	**(4.533 ; 4.533)**	0.017
841	8.602	**(8.274 ; 8.963)**	0.214	7.265	**(7.083 ; 7.461)**	0.130	5.229	**(5.192 ; 5.266)**	0.035
641	1.821	**(1.821 ; 1.821)**	0.002	1.803	**(1.803 ; 1.803)**	0.002	2.134	**(2.131 ; 2.138)**	0.012
792	2.931	**(2.794 ; 3.093)**	0.078	3.176	**(3.069 ; 3.295)**	0.044	3.066	**(2.935 ; 3.212)**	0.074
515	3.015	**(3.007 ; 3.023)**	0.012	2.970	**(2.970 ; 2.970)**	0.004	3.115	**(3.074 ; 3.159)**	0.036
667	2.452	**(2.309 ; 2.627)**	0.058	5.577	**(5.182 ; 6.059)**	0.349	3.029	**(2.878 ; 3.212)**	0.095
772	2.222	**(2.167 ; 2.282)**	0.024	2.132	**(2.125 ; 2.138)**	0.009	1.816	**(1.807 ; 1.824)**	0.007
763	NA	**NA**	NA	NA	**NA**	NA	3.941	**(3.591 ; 4.431)**	0.116
248	2.838	**(2.735 ; 2.957)**	0.052	2.802	**(2.717 ; 2.898)**	0.039	1.601	**(1.599 ; 1.603)**	0.007
HTS-10	Benchmark			Country Blocks			Reference Variety		
	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE	Sigma	**Confidence Int.**	StE
781	57.076	**(50.082 ; 66.533)**	7.106	63.301	**(53.327 ; 78.254)**	8.962	NA	**NA**	NA
333	14.395	**(11.519 ; 19.081)**	1.600	14.107	**(11.308 ; 18.624)**	1.549	17.008	**(10.661 ; 232.29)**	7.090
752	3.780	**(3.780 ; 3.780)**	0.009	4.069	**(4.069 ; 4.069)**	0.030	4.202	**(4.202 ; 4.202)**	0.060
776	2.188	**(2.188 ; 2.188)**	0.008	2.131	**(2.131 ; 2.131)**	0.008	2.193	**(2.193 ; 2.193)**	0.008
784	2.749	**(2.693 ; 2.811)**	0.027	3.315	**(3.184 ; 3.468)**	0.067	2.594	**(2.573 ; 2.616)**	0.024
334	4.700	**(4.504 ; 4.921)**	0.172	6.000	**(5.723 ; 6.317)**	0.309	6.941	**(6.447 ; 7.594)**	0.544
845	5.020	**(5.020 ; 5.020)**	0.006	5.135	**(5.135 ; 5.135)**	0.004	5.451	**(5.451 ; 5.451)**	0.015
764	3.819	**(3.735 ; 3.910)**	0.065	4.751	**(4.516 ; 5.039)**	0.151	4.288	**(4.152 ; 4.437)**	0.093
851	4.334	**(4.334 ; 4.334)**	0.011	4.066	**(4.066 ; 4.066)**	0.009	3.364	**(3.364 ; 3.364)**	0.006
782	NA	**NA**	NA	NA	**NA**	NA	NA	**NA**	NA
713	3.282	**(3.266 ; 3.297)**	0.018	3.508	**(3.484 ; 3.532)**	0.031	4.303	**(4.164 ; 4.456)**	0.088
842	5.332	**(5.321 ; 5.342)**	0.015	5.635	**(5.628 ; 5.642)**	0.009	5.905	**(5.905 ; 5.905)**	0.003
841	5.533	**(5.533 ; 5.533)**	0.028	5.893	**(5.893 ; 5.893)**	0.027	9.153	**(9.096 ; 9.210)**	0.115
641	1.891	**(1.891 ; 1.891)**	0.006	1.943	**(1.943 ; 1.943)**	0.008	1.800	**(1.798 ; 1.802)**	0.002
792	4.165	**(4.029 ; 4.314)**	0.073	5.302	**(5.302 ; 5.302)**	0.120	3.062	**(3.051 ; 3.072)**	0.011
515	2.756	**(2.748 ; 2.765)**	0.014	2.792	**(2.784 ; 2.800)**	0.015	2.587	**(2.571 ; 2.604)**	0.019
667	2.499	**(2.430 ; 2.575)**	0.052	2.574	**(2.478 ; 2.689)**	0.068	3.859	**(3.332 ; 5.400)**	0.560
772	1.809	**(1.809 ; 1.809)**	0.006	1.835	**(1.835 ; 1.835)**	0.003	1.827	**(1.827 ; 1.827)**	0.008
763	3.132	**(3.132 ; 3.132)**	0.014	3.100	**(3.100 ; 3.100)**	0.011	3.716	**(3.590 ; 3.854)**	0.022
248	1.950	**(1.945 ; 1.955)**	0.011	2.589	**(2.522 ; 2.663)**	0.035	2.164	**(2.164 ; 2.164)**	0.016