Globalization, Competition, and the U.S. Price Level

by

Robert C. Feenstra

David E. Weinstein

May 26, 2009

Preliminary and Incomplete
(Please do not cite or quote without permission)

Abstract

This paper is the first attempt to derive theoretically and empirically the impact of globalization on markups and welfare in a monopolistic competition model. To achieve this, we work with a class of preferences that are new to that literature – the translog preferences, with symmetry imposed across products. Although the magnitude of the consumer gains assuming translog preferences is similar to that assuming CES preferences (0.7 percentage points between 1992 and 2005), the sources of these gains is quite different. We estimate that only one third of the gains arise from new varieties and two thirds arise from competition effects driving down markups of existing producers. Moreover, we estimate that these markup effects would have been substantially larger had there not been substantial exit from US manufacturing.

1. Introduction

A promise of the monopolistic competition models in trade is that they offered additional sources of the gains from trade, beyond that from comparative advantage. These additional sources included: consumer gains due to the expansion of import varieties; efficiency gains due to increasing returns to scale; and welfare gains due to reduced markups. While the first two sources of gains have received recent empirical attention,[1] the promise of the third source – reduced markups – has not yet been realized. To be sure, there are estimates of reduced markups due to trade for several countries: Levinsohn (1993) for Turkey; Harrison (1994) for the Ivory Coast; and Badinger (2007a) for European countries. But these cases rely on dramatic liberalizations to identify the change in markups and are not tied in theory to the monopolistic competition model. The reason that this model is not used to estimate the change in markups is because of the prominence of the constant elasticity of demand (CES) system, with its implied constant markups. To avoid that case, researchers have either not specified the demand side and relied on a natural experiment to identify the change in markups (as the above authors), or adopted some other system such as linear demand, as in Melitz and Ottaviano (2008).[2]

For these reasons, we do not have solid evidence about how the broad process of globalization affects markups, and particularly no evidence on the impact of such markup reductions on U.S. welfare. This paper is the first attempt to derive theoretically and empirically the impact of globalization on markups and welfare in a monopolistic competition model. To achieve that, we work with a class of preferences that are quite new to that literature – the

[1] The consumer gains due import variety have been estimated for the U.S. by Broda and Weinstein (2006). Gains due to increasing returns to scale, or more specifically due to the self-selection of efficient firms (as in Melitz, 2003) have been demonstrated for Canada by Trefler (2004) and for a broader sample of countries by Badinger (2007b, 2008). See also Head and Ries (1999, 2001) for Canada, and Tybout *et al* (1991, 1995) for Chile and Mexico.

[2] For example, Blonigen *et al* (2007), who study trade policy in the steel industry. They use linear demand and follow the methodology introduced in the industrial organization literature by Bresnahan (1982) and (1987). Because of the zero income elasticities in that system, it is perhaps best suited for partial equilibrium analysis.

translog preferences, with symmetry imposed across products. These preferences prove to be highly tractable even as the range of import varieties change.[3] Because the elasticity of demand is inversely related to a product's market share, markups fall as more firms enter, which we call the *pro-competitive effect*. On the other hand, domestic firms may exit as foreign competition intensifies offsetting some of this gain to consumers. This we will refer to as the *domestic exit effect*. Incorporating these two effects into the analysis allows us to estimate the impact of globalization on markups. Furthermore, this class of preferences also allows us to address a potential criticism of Broda and Weinstein (2006): that by assuming CES preferences, it may overstate the gains from import variety.[4] The translog system allows for an alternative estimate of the variety gains, which we find are much smaller than in the CES case and also smaller than the pro-competitive effect. But our *combined* consumer gains for the U.S. due to import variety and the pro-competitive effect are of the same magnitude as Broda and Weinstein's estimate for the CES case

Since markups depend on products market shares in the translog system, we begin in section 2 by summarizing the trends in U.S. market shares since 1990s. These market shares of U.S. producers have fallen dramatically due to import competition, while the number of firms in the U.S. market (as measured by the Herfindahl indexes of market concentration) has increased only slightly. It follows that the *per-firm* market shares have also fallen, which provides us with *prima facie* evidence that there has been an increase in competition and reduced markups. In fact, for the translog system, the sum of the Herfindahl indexes for U.S. producers and for

---

[3] Feenstra (2003) first showed that the reservation prices for unavailable goods could be obtained in a tractable form in the "symmetric" case, and this result was generalized in Bergin and Feenstra (2009).

[4] The gains from a new product variety can be thought of as the area under the demand curve and above the price when the product first appears. While the CES system has an infinite reservation price, this area under the demand curve is still bounded above (provided the elasticity of substitution is greater than unity). But it can be expected that the gains from new product varieties in this case might exceed the gain for other functional forms with *finite* reservation prices, as is the case of the translog system.

exporters to the U.S., weighted by their squared market shares, is precisely the right way to measure competition, and we show that these “market-level” Herfindahl indexes have fallen in many sectors.

Our results suggest that globalization has been exerting important economic impacts on the US economy. Our point estimate for the gains to US consumers from new varieties and decreased markups is 0.7 percentage points over the period 1992 to 2005. However, the impact on the merchandise sector (agriculture, manufacturing, and mining) was much more profound. Increased foreign competition drove down prices by 3.6 percentage points and average markups by five percent over this time period.

In section 3, we introduce the translog expenditure function, and solve for the ratio of expenditure functions (or exact price index) in the presence of new and disappearing goods, which allow the gains from new products to be measured. The pro-competitive effect of imports is discussed in section 4. Our analysis allows for multiple products supplied by each country, and show how the Herfindahl indexes of export sales by each country enter into our equations. Significantly, we have been able to obtain these indexes for most countries selling to the U.S., by land or by sea. In section 5 we discuss the procedure for estimating the system of demand and pricing equations, and results are presented in section 6.

2. Data Preview

One of the dramatic changes that globalization has wrought on the U.S. economy is the declining importance of U.S. supply of U.S. demand. To see this, we define U.S. domestic supply as aggregate U.S. sales less exports of agricultural, mining, and manufacturing goods (see the Data Appendix for detailed definitions of all of our variables). We define U.S. apparent consumption as domestic supply plus imports. Similarly, we define the U.S. suppliers’ share of

the U.S. market, i.e. what share of U.S. consumption was met by U.S. suppliers, as U.S. domestic supply divided by apparent consumption. Finally, we define each country's import share as the exports from that country to the U.S. divided by apparent consumption. As one can see from Table 1, while U.S. suppliers produced 84 percent of all goods demanded by U.S. consumers in 1992, this number fell to only 69 percent by 2005. The flip side of this decline was an almost doubling of the import share in these sectors. Over a third of this increase was due to increases in import shares from China and Mexico.

One possible explanation for what we see in Table 1 is that the rise in import penetration was confined to a few important sectors. We can examine whether this was the case by looking at more disaggregated data. In Figure 1, we plot the U.S. suppliers' share in 2005 against its level in 1992 for each HS 4-digit category. We also place a 45-degree line in the plot so that one can easily see which sectors experienced gains in U.S. shares and which experienced declines. As one can see from the figure, the vast majority of sectors lie below the 45-degree line, meaning that these sectors had greater import penetration in 2005 than they had in 1992. This establishes that the rise in import penetration, though quite pronounced in some sectors, was a general phenomenon that was common across virtually all merchandise sectors.

Along with the declining U.S. market share in many sectors, there has also been an exit of manufacturing firms. The Department of Census data reveals that in 1992, there were 337,409 firms in manufacturing. By 2002 this number had fallen to 309,696: an 8.2 percent decline. However, we will argue that this decline in the number of firms has been less than the decline in the U.S. market share, so that the *per-firm* shares of U.S. firms have also fallen. That will be the key feature leading to a decline in their markups.

To make this argument, it is convenient to work with Herfindahl indexes of market concentration, defined for each country selling to the U.S. We let i denote countries, j denote firms (each selling one product), k denote sectors and t denote time. Let s_{jt}^{ik} denote firm j's exports to the U.S. in sector k, as a share of country i's total exports to the U.S. in that sector. Then the Herfindahl for country i is

$$H_{it}^{k} = \sum_{j} \left(s_{jt}^{ik} \right)^2 \ .$$

The inverse of a Herfindahl can be thought of as the "effective number" of exporters, or U.S. firms, in an industry. Thus, a Herfindahl of one implies that there is one firm in the industry and an index of 0.5 would arise if there were two equally sized firms in the sector. Similarly, if we multiply the Herfindahl by the share of the country's suppliers in the market, one obtains the market share of a synthetic typical firm in the market. This is a very useful statistic because in many models of competition, e.g. Cournot competition, the markup of the firm rises or falls with its market share, and this feature will also hold in our translog system.

A challenge for our empirical work was obtaining these Herfindahl indexes, depending on the mode of transport. For land shipments from Canada we purchased Herfindahl indexes at the 4-digit Harmonized system (HS) level, constructed from firm-level export data to the U.S., in the years 1992 and 2005. For Mexico the Herfindahl indexes were constructed as described in the data Appendix. For all other major exporters to the U.S., we computeted these Herfindahl for *sea* shipments from PIERS (see the data Appendix), for 1992 and 2005.

The true Herfindahl of country i's exports in sector k can be written as

$$H_{it}^{k} = H_{it}^{kSea} \left(\frac{V_{it}^{kSea}}{V_{it}^{kTotal}} \right)^2 + H_{it}^{kNon-Sea} \left(1 - \frac{V_{it}^{kSea}}{V_{it}^{kTotal}} \right)^2 , \tag{1}$$

where V_{it}^{kSea} $\left(V_{it}^{kTotal}\right)$ denotes the value of sea (total) shipments and $H_{it}^{kNon-Sea}$ is the Herfindahl for non-sea exporters, which is defined analogously as the sea Herfindahl. We do not have a measure of $H_{it}^{kNon-Sea}$, but theory does place bounds on the size of the Herfindahl since the true index must be contained in the following set, obtained with $H_{it}^{kNon-Sea} = 1$ or 0:

$$\left[H_{it}^{kSea}\left(\frac{V_{it}^{kSea}}{V_{it}^{Total}}\right)^2, H_{it}^{kSea}\left(\frac{V_{it}^{kSea}}{V_{it}^{Total}}\right)^2 + \left(1-\frac{V_{it}^{kSea}}{V_{it}^{kTotal}}\right)^2 \right].$$

For most sectors the share of sea shipments in total shipments is quite high, so these bounds are quite tight. For the rest of the analysis we will assume that $H_{it}^{kSea} = H_{it}^{kNon-Sea}$, but our results do not change qualitatively if we assume that $H_{it}^{kNon-Sea} = 1$ or 0.[5]

For the U.S. Herfindahls, we rely on data from the Census of Manufactures, which like the Mexican Herfindahls, are at the NAICS 6-digit level. Unfortunately, this is more aggregate than the 4-digit HS level at which we have the foreign export Herfindahl indexes.[6] Accordingly, we need to convert the U.S. and Mexican Herfindahl indexes from the NAICS 6-digit level to the HS 4-digit level. Slightly abusing our earlier country notation, let $i \in I_k$ denote a 4-digit sector i *within* the NAICS code k. Then the Herfindahl for 4-digit sector i is $H_{it}^{k} \equiv \sum_{j \in J_i} (s_{jt}^{i})^2$, where s_{jt}^{i} is the share of firm $j \in J_i$ in sector i. We see that the overall Herfindahl in NAICS code k is:

$$\sum_{i \in I_k} H_{it}^{k}\left(s_{it}^{k}\right)^2 = \sum_{i \in I_k} \sum_{j \in J_i} (s_{jt}^{i})^2 (s_{it}^{k})^2 = \sum_{j \in J_k} (s_{jt}^{k})^2 \equiv H_{t}^{k}, \qquad (2)$$

[5] One can see this from a simple example. Our median sea Herfindahl is 0.6 and our median share of sea shipments is 0.8. This means that the true Herfindahl ranges from .38 to .42 and our estimate would be 0.41. Nevertheless, we are implicitly assuming that goods shipped by air and goods shipped by sea are not the same. We justify this assumption because it costs substantially more to ship goods by air, and thus the mode of shipment is likely to differentiate the goods in some important ways.

[6] The NAICS 6-digit has about **??** sectors, whereas the HS 4-digit has about **??** sectors.

where s_{it}^{k} is the share of 4-digit HS sector i within NAICS sector k, and $s_{jt}^{k} = s_{jt}^{i} s_{it}^{k}$ is the share of product j within the NAICS sector, $j \in J_k$. In words, the inner-product of the Herfindahl firm indexes and the squared country shares, on the left of (2) is exactly the right way to aggregate these indexes to obtain an *overall Herfindahl for the good k in question*, on the right of (2). One of the problems that we faced is that we know H_t^k but not H_{it}^k. A solution can be obtained by assuming that H_{it}^k is equal across all 4-digit sectors $i \in k$, in which case we solve for H_{it}^k as:

$$H_{it}^{k} = H_{t}^{k} / \sum_{i \in I_k} (s_{it}^{k})^2 . \tag{3}$$

In other words, the 4-digit HS Herfindahl is estimated by dividing the 6-digit NAICS Herfindahl by the corresponding Herfindahl index of 4-digit HS shares within the 6-digit sector. This simple solution assumes that the 4-digit HS Herfindahl indexes are constant within a sector, but is the best that we can do in the absence of additional data.

In Table 1, we present average Herfindahls at the HS 4-digit level for the U.S. and the 30 major exporters to the US.[7] As one can see from the table, the average U.S. Herfindahl rose from 0.23 to 0.25 over this period indicating that increased foreign competition was likely associated with some exit of U.S. firms from the market. If we multiply this average Herfindahl by the share of U.S. suppliers, we can compute the typical market share of a U.S. firm. Table 1 reveals that the share in the U.S. market of our synthetic typical firm fell slightly from 19.7 percent in 1992 to 19.1 percent 2005. The fact that share of the U.S. market held by U.S. suppliers fell dramatically, but the typical market share of a U.S. firm did not fall by that much indicates that the rise in imports over this time period was accompanied by a large amount of exit by U.S. firms.

[7] For the US, we have adjusted the NAICS 6-digit Herfindahls from the Bureau of Economic Analysis data so that they match the HTS 4-digit categories and detail that procedure in the Data Appendix.

One can get a sense of what happened to concentration in other countries by plotting the average export Herfindahl in 2005 against the value in 1992 when we only include sectors for which we could compute a Herfindahl in both years. The Herfindahl seems to have risen for most countries in the world indicating that the export market has become more concentrated over time. That said, the opposite trend seems to be true for many of the most important exporters to the US. In Figure 2, we label the points for the top ten exporters to the U.S. market. With the exception of Japan, Mexico, and the United Kingdom, all of the remaining top ten exporters to the U.S. saw their export Herfindahls decline over this time period.

In Figure 3 we plot changes in a country's Herfindahl of sales to the U.S. against changes in the market share of the country. Although there is a lot of noise in the data, there is a slight negative relationship indicating that increases in market share are associated with increases in firm entry and decreases in share are associated with exit. This suggests that analyses that define new varieties based on country-industry data are likely to understate variety growth and destruction.

Our data preview suggests that prior work on the impact of new varieties is likely to suffer from a number of biases. First, as foreign firms have entered the U.S. market, there has been exit by U.S. firms which serves to offset some of the gains of new varieties. Second, while U.S. Herfindahls rose, the Herfindahls of many of our largest suppliers fell. This suggests that there may have been substantial variety growth that is not captured in industry level analyses. Finally, because the market shares of foreign entrants are much smaller than those of domestic firms, the rise in foreign entry is likely to have depressed markups overall and therefore lowered prices. Thus estimates of the gains from new varieties estimated from industry-level data using CES aggregators could either be too large if domestic exit is an important source of variety loss

or too small if foreign firm entry and market power losses are important unmeasured variety gains. We turn to quantifying these gains and losses in the next section.

3. Translog Function

To introduce the translog function, we will initially simplifying our notation that distinguished countries, firms, and sectors, and instead just let the index i denote products (we will re-introduce countries and firms below). We consider a translog function defined over the universe of products, whose maximum number is denoted by the fixed number $\tilde{N}$. The translog unit-expenditure function is defined by:[8]

$$\ln e = \alpha_0 + \sum_{i=1}^{\tilde{N}} \alpha_i \ln p_i + \tfrac{1}{2} \sum_{i=1}^{\tilde{N}} \sum_{j=1}^{\tilde{N}} \gamma_{ij} \ln p_i \ln p_j \text{, with } \gamma_{ij} = \gamma_{ij} \text{.} \tag{4}$$

Note that the restriction that $\gamma_{ij} = \gamma_{ij}$ is made without loss of generality. To ensure that the expenditure function to be homogenous of degree one, we add the restrictions that:

$$\sum_{i=1}^{\tilde{N}} \alpha_i = 1, \quad \text{and} \quad \sum_{i=1}^{\tilde{N}} \gamma_{ij} = 0 \text{.} \tag{5}$$

In order to further require that all goods enter "symmetrically" in the γ_{ij} coefficients, we can impose the additional restrictions that:

$$\gamma_{ii} = -\gamma\left(\frac{\tilde{N}-1}{\tilde{N}}\right) < 0, \text{ and } \gamma_{ij} = \frac{\gamma}{\tilde{N}} > 0 \text{ for } i \neq j, \text{ with } i, j = 1, \ldots, \tilde{N} \text{.} \tag{6}$$

It is readily confirmed that the restriction in (6) satisfies the homogeneity conditions (5).

The share of each good in expenditure can be computed by differentiating (4)with respect to $\ln p_i$, obtaining:

---

[8] The translog direct and indirect utility functions were introduced by Christensen, Jorgenson and Lau (1975), and the expenditure function was proposed by Diewert (1976, p. 122).

$$s_i = \alpha_i + \sum_{j=1}^{\tilde{N}} \gamma_{ij} \ln p_j \,. \tag{7}$$

These shares must be non-negative, of course, but we will allow for a subset of goods to have zero shares, because they are not available for purchase. To be precise, suppose that $s_i > 0$ for $i=1,\ldots,N$, while $s_j = 0$ for $j=N+1,\ldots,\tilde{N}$. Then for the latter goods, we set $s_j = 0$ within the share equations (7), and use these $(\tilde{N} - N)$ equations to solve for the reservation prices $\tilde{p}_j$, $j=N+1,\ldots,\tilde{N}$, in terms of the observed prices p_i, $i=1,\ldots,N$. Then these reservation prices $\tilde{p}_j$ should appear in the expenditure function (4) for the unavailable goods $j=N+1,\ldots,\tilde{N}$.

In the presence of unavailable goods, then, the expenditure function becomes rather complex, involving their reservation prices. However, if we consider the symmetric case defined by (6), then it turns out that the expenditure function can be simplified considerably, so that the reservation prices no longer appear explicitly. Specifically, Bergin and Feenstra (2009) show that the expenditure function is simplified as:

$$\ln e = a_0 + \sum_{i=1}^{N} a_i \ln p_i + \tfrac{1}{2} \sum_{i=1}^{N}\sum_{j=1}^{N} b_{ij} \ln p_i \ln p_j \,, \tag{8}$$

where:

$$b_{ii} = -\gamma \frac{(N-1)}{N} < 0, \text{ and } b_{ij} = \frac{\gamma}{N} > 0 \text{ for } i \neq j \text{ with } i, j = 1,\ldots,N, \tag{9}$$

$$a_i = \alpha_i + \tfrac{1}{N}\left(1 - \sum\nolimits_{i=1}^{N} \alpha_i\right), \text{ for } i = 1,\ldots,N, \tag{10}$$

$$a_0 = \alpha_0 + \left(\frac{1}{2\gamma}\right)\left\{\sum\nolimits_{i=N+1}^{\tilde{N}} \alpha_i^2 + \left(\frac{1}{N}\right)\left(\sum\nolimits_{i=N+1}^{\tilde{N}} \alpha_i\right)^2\right\}. \tag{11}$$

Notice that the expenditure function in (8) looks like a conventional translog function defined over the goods $i=1,\ldots,N$, while the symmetry restrictions in (9) continue to hold. To interpret (10), it implies each of the coefficient α_i is increased by the same amount to ensure that

the coefficients a_i sum to unity over i=1,…,N. The final term a_0, appearing in (11), incorporates the coefficients α_i of the unavailable products. If the number of available products N rise, then a_0 falls, indicating a welfare gain from increasing the number of available products. As it is stated, however, (11) does not allow for the direct measurement of welfare gain because it depends on the unknown parameters α_i. We now develop an alternative formula for the welfare gain that depends on the observable expenditures shares on goods, and can therefore be measured.

Let us distinguish two periods t-1 and t, and re-introduce our notation that i denotes countries, while j denotes firms (each selling one good), so the pair (i, j) denotes a unique product variety. We assume that the countries i=M+1,…, $\widetilde{M}$ do not supply in either period, while the countries {1,…,M} are divided into two (overlapping) sets: the M_τ countries $i \in I_\tau$ sell in period τ = t-1,t; with their union $I_{t-1} \cup I_t = \{1,...,M\}$ and non-empty intersection $I_{t-1} \cap I_t \neq \emptyset$. We shall let $\bar{I} \subseteq I_{t-1} \cap I_t \neq \emptyset$ denote any non-empty subset of their intersection.

Firms in each country provide the set of varieties $j \in J_{it}$, with the number $N_{it} > 0$, so the total number of varieties available each period is $N_t \equiv \sum_{i \in I_t} N_{it}$. If a country supplies in period t but not t-1, then there is obviously an expansion in its set of varieties. But we can also measure an expansion in varieties by examining the Herfindahl indexes of exports for countries supplying *both* periods: a reduction in the Herfindahl indicates greater varieties. For our next result, we will need to specify a set of countries $i \in \bar{I}$ for which variety *does not* expand; in practice, we identify these countries by their constant Herfindahl indexes. For these countries we assume that there is unchanging sets of variety, $J_{it} \equiv \bar{J}_i$ for $i \in \bar{I}$, with the number $\bar{N}_i > 0$ in each country, so the total number of *unchanging* product varieties is $\bar{N} \equiv \sum_{i \in \bar{I}} \bar{N}_i$.

With this notation, the shares s_{ijt} are used in place of s_{it} in all our earlier formulas. We can decompose these product shares as $s_{ijt} = s^i_{jt} s_{it}$, where $s_{it} = \sum_{j \in J_{it}} s_{ijt}$ denotes the share of expenditure on all varieties from country i, and $s^i_{jt} \equiv s_{ijt} / s_{it}$ denote the expenditure share on variety j *within* the spending on country i, so that $\sum_{j \in J_{it}} s^i_{jt} = 1$. In practice we only observe the U.S. import shares s_{it} by country, while we will make inferences about the firm shares s^i_{jt} using the Herfindahl indexes of concentration for each product.

Returning to the expenditure function, the Törnqvist price index is exact for the translog function (Diewert, 1974), which means that the ratio of the unit-expenditure functions is measured by:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \sum_{i=1}^{M} \sum_{j \in J_i} \tfrac{1}{2}(s_{ijt} + s_{ijt-1})(\ln p_{ijt} - \ln p_{ijt-1}), \tag{12}$$

where $J_i \equiv J_{it} \cup J_{it-1}$ is the set of product varieties sold by country i over both periods. Of course, some of those products may be available in only one period, and likewise, some of the countries i = 1,…,M are selling in only one period. In such cases we again solve for the reservation prices for goods not available, using their respective shares equal to zero. Substituting these reservation prices back into (12) and simplifying, we obtain the following expression for the exact price index:

<u>Theorem 1</u>

Then the ratio of translog unit-expenditure functions can be written as:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \sum_{i \in \bar{I}} \sum_{j \in \bar{J}_i} \tfrac{1}{2}(\bar{s}_{ijt} + \bar{s}_{ijt-1})(\ln p_{ijt} - \ln p_{ijt-1}) + V, \tag{13}$$

where, the shares $\bar{s}_{ijt-1}$ and $\bar{s}_{ijt}$ are defined as:

$$\bar{s}_{ij\tau} \equiv s_{ij\tau} + \frac{1}{\bar{\bar{N}}}\left(1 - \sum_{i\in\bar{I}}\sum_{j\in\bar{J}_i} s_{ij\tau}\right), \text{ for } i \in \bar{I} \text{ and } \tau = t\text{-}1, t, \tag{14}$$

and,

$$V \equiv -\left(\frac{1}{2}\right)\left\{\sum_{i\notin\bar{I}} (H_{it}s_{it}^2 - H_{it-1}s_{it-1}^2) + \frac{1}{\bar{\bar{N}}}\left[\left(\sum_{i\notin\bar{I}} s_{it}\right)^2 - \left(\sum_{i\notin\bar{I}} s_{it-1}\right)^2\right]\right\}, \quad (\qquad) \quad (\qquad) \qquad \gamma$$

described in the Introduction. Accordingly, we will refer to V as a "partial" welfare effect of new goods; the "total" impact will also have to take into account the pro-competitive effect.

Second, to measure the welfare effect in (15) we need an estimate of γ. This parameter plays a similar role as the elasticity of substitution in the CES case, in that the welfare gains are reduced as either parameter rises. Obviously, we cannot compare the CES and translog cases without knowledge of these parameters.[9] In both cases, the parameters are estimated from the demand equations. For the translog case, the share equation is obtained by differentiating (8), using (9) and (10), and also using our notation for countries i and firms j, as:

$$s_{ijt} = (a_{ij} + a_t) - \gamma\left(\ln p_{ijt} - \overline{\ln p_t}\right),$$

where $a_t = (1 - \sum_{i \in I_t} \sum_{j \in J_{it}} \alpha_{ij})$ is a time-effect which ensures that $\sum_{i \in I_t} \sum_{j \in J_{it}} (\alpha_{ij} + a_t) = 1$, and $\overline{\ln p_t} = \frac{1}{N_t} \sum_{i \in I_t} \sum_{j \in J_{it}} \ln p_{ijt}$ is the average log-price of all available goods in period t. We have included a time subscript on the parameter a_t because it depend on the set of varieties available, which is changing over time.

Using $s_{ijt} = s^i_{jt} s_{it}$ and multiplying the share equation by s^i_{jt}, it becomes:

$$(s^i_{jt})^2 s_{it} = s^i_{jt}(a_{ij} + a_t) - \gamma\left(s^i_{jt} \ln p_{ijt} - s^i_{jt}\overline{\ln p_t}\right).$$

Summing this equation over $j \in J_{it}$, and noting that $\sum_{j \in J_{it}} s^i_{jt} = 1$, we obtain:

$$H_{it} s_{it} = a_{it} + a_t - \gamma\left(\ln p_{it} - \overline{\ln p_t}\right), \tag{16}$$

where $\ln p_{it} \equiv \sum_{j \in J_{it}} s^i_{jt} \ln p_{ijt}$ is the (weighted) geometric mean of prices, and $a_{it} \equiv \sum_{j \in J_{it}} s^i_{jt} a_{ij}$

---

[9] Feenstra and Shiells (1997, p. 258) compare the gains from a single new good in the CES and translog cases, by assuming that the new good has the same elasticity of demand in both cases. They show that the "partial" welfare gain from the new good in the translog case is about one-half of the welfare gain in the CES case.

is a geometric mean of the taste parameters. This average taste parameter will change as the set of selling firms shifts towards those with higher demand (or as a firms upgrade their quality). We therefore model the movement in these tastes parameters as:

$$a_{it} = a_i + \varepsilon_{it}, \tag{17}$$

where ε_{it} is an error term. Substituting (17) into (16), we obtain the share equations,

$$H_{it}s_{it} = a_i + a_t - \gamma\left(\ln p_{it} - \overline{\ln p_t}\right) + \varepsilon_{it} \ . \tag{18}$$

The parameter γ is obtained by estimating (18), recognizing that the intercept term differs across i and also over time, reflecting changes in the number of available goods as in (10). The important properties of these share equation is that the parameter γ *does not* depend on the set of goods available. However, we can expect that the price appearing in (18) are endogenous, as in a conventional supply and demand system. For the CES case, Feenstra (1994) showed how this endogeneity could be overcome even without the use of conventional instrument variables, but by exploiting heteroskedasticity in second-moments of the data. We will follow the same procedure in the translog case, as described in section 5. But first, we need to solve for the optimal prices charged by imperfectly competitive firms, in the next section.

4. Optimal Prices and the Pro-Competitive Effect

We will suppose that the available products are produced by single-product firms, acting as Bertrand competitors. The profit maximization problem for firm j in country i is,

$$\max_{p_{ijt}} \ p_{ijt}x_{ij}(p_t, E_t) - C_{ij}[x_{ij}(p_t, E_t)] \ ,$$

where $x_{ij}(p_t, E_t)$ denotes the demand arising from the translog system, with the price vector p_t and expenditure E_t, and $C_{ijt} = C_{ij}[x_{ij}(p_t, E_t)]$ denotes the costs of production. We denote the

elasticity of demand by $\eta_{ij}(p_t, E_t) \equiv -\partial \ln x_{ij}(p_t, E_t) / \partial \ln p_{ijt}$ Then the optimal price can be written as the familiar markup over marginal costs:

$$p_{ijt} = C_{ij}'[x_{ij}(p_t, E_t)]\left[\frac{\eta_{ij}(p_t, E_t)}{\eta_{ij}(p_t, E_t) - 1}\right]. \tag{19}$$

The elasticity of demand from the translog system is:

$$\eta_{ijt} = 1 - \left(\frac{\partial \ln s_{ijt}}{\partial \ln p_{ijt}}\right) = 1 + \frac{\gamma(N_t - 1)}{s_{ijt} N_t} \ .$$

It follows that the log-markup appearing in (19) is:

$$\ln\left[\frac{\eta_{ij}(p_t, E_t)}{\eta_{ij}(p_t, E_t) - 1}\right] = \ln\left\{1 + \frac{s_{ijt} N_t}{\gamma(N_t - 1)}\right\}.$$

Substituting these equations into (19), we obtain:

$$\ln p_{ijt} = \ln C'_{ijt} + \ln\left[1 + \frac{s_{ijt} N_t}{\gamma(N_t - 1)}\right], \tag{20}$$

where $C'_{ijt} \equiv C_{ij}'[x_{ij}(p_t, E_t)]$ denotes the time-dependant marginal costs.

We aggregate this equation across firms in each country by multiplying by s^i_{jt} and summing over j:

$$\ln p_{it} = \ln C'_{it} + \sum_{j \in J_{it}} s^i_{jt} \ln\left[1 + \frac{(s^i_{jt} s_{it}) N_t}{\gamma(N_t - 1)}\right], \tag{21}$$

where $\ln p_{it}$ is again the geometric mean of prices, and $\ln C'_{it} \equiv \sum_{j \in J_{it}} s^i_{jt} \ln C'_{ijt}$ is the geometric mean of marginal costs in country i. In order to evaluate this expression, we need to bring the summation (like an expectation) within the log expression, which means that we are ignoring Jensen's inequality; we argue below that this is a second-order approximation. In that case, we obtain the final form of our pricing equation:

$$\ln p_{it} \approx \ln C'_{it} + \ln\left[1 + \frac{H_{it}s_{it}N_t}{\gamma(N_t - 1)}\right]. \tag{22}$$

The pro-competitive effect is obtained by substituting the pricing equations (22) into (13) . The resulting expression involves both share-weighted and unweighted geometric means of the firm prices, because the shares $\bar{s}_{ij\tau}$ in (14) are an additive transformation of the shares $s_{ij\tau}$. In practice we will not be able to distinguish weighted and unweighted firm prices, and simply use import unit-values for either. So to eliminate this distinction in the theory, we strengthen our earlier assumption that countries supplying in both periods have unchanging sets of variety, $J_{it} \equiv \bar{J}_i$ for $i \in \bar{I}$. Specifically, we now assume that if there is no entry or exit of firms in a country, the firm shares are *equal and unchanging* within each such a country:

$$s^i_{j\tau} = \frac{1}{\bar{N}_i}, \text{ for } i \in \bar{I},\ \tau = \text{t-1,t}. \tag{23}$$

Notice that the *country shares* s_{it} still change for countries selling in both periods, so that (23) specifies that firms within these countries $i \in \bar{I}$ do not change size relative to their country sales. In that case, the pro-competitive effect becomes:

Theorem 2

The pricing equation (22) is obtained as a second-order approximation to (21) around the point where $(H_{it}s_{it}/\gamma)=0$ and (23) holds. Then using (22) and (23), the pro-competitive effect P is:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \sum_{i\in\bar{I}} \tfrac{1}{2}(\bar{s}_{it} + \bar{s}_{it-1})(\ln C'_{it} - \ln C'_{it-1}) + V + P\,,$$

with the shares $\bar{s}_{i\tau} \equiv s_{i\tau} + \frac{\bar{N}_i}{\bar{N}}\left(1 - \sum_{i\in\bar{I}} s_{i\tau}\right)$, for $i \in \bar{I}$ and τ = t-1, t, and,

$$P \equiv \sum_{i \in \bar{I}} \tfrac{1}{2}(\bar{s}_{it} + \bar{s}_{it-1}) \left\{ \ln\left[1 + \frac{H_{it}s_{it}N_t}{\gamma(N_t - 1)}\right] - \ln\left[1 + \frac{H_{it-1}s_{it-1}N_{t-1}}{\gamma(N_{t-1} - 1)}\right] \right\}. \qquad (24)$$

Using $\ln(1+x) \approx x$, the pro-competitive effect is approximated as:

$$P \approx V + \left(\frac{1}{2\gamma}\right) \sum_{i=1}^{N} (H_{it}s_{it}^2 - H_{it-1}s_{it-1}^2) + \frac{1}{2\gamma} \sum_{i \in \bar{I}} (\bar{s}_{it} + \bar{s}_{it-1}) \left[\frac{H_{it}s_{it}}{(N_t - 1)} - \frac{H_{it-1}s_{it-1}}{(N_{t-1} - 1)}\right]. \qquad (25)$$

Equation (24) is the final form for the pro-competitive impact that we will evaluate, while (25) allows us to see that it lowers the exact price index by more that the partial variety effect, whenever the final terms on the right of (25) are negative. If we ignore the final term in (25) because we assume N_{t-1} and N_t are large, then we can see that the pro-competitive effect lowers the price index by more than the partial variety effect provided that $\sum_{i=1}^{N} \ {}_{it}s_{it}^2$

We turn now to estimation of the translog parameter γ. We will specify that average costs from each exporting country take on the iso-elastic form:

$$\ln C'_{ijt} = \omega_{i0} + \omega \ln\left(\frac{s_{it}E_t}{p_{it}}\right) + \delta_{it},$$

where the term $(s_{it}E_t / p_{it})$ reflects the total quantity exported from country i, and δ_{it} is an error term. Substituting into (22), we obtain a modified pricing equation:

$$(1+\omega)\ln p_{it} = \omega_{i0} + \omega \ln s_{it} + \omega \ln E_t + \ln\left[1 + \frac{H_{it}s_{it}N_t}{\gamma(N_t - 1)}\right] + \delta_{it}. \qquad (27)$$

We see that the translog parameter γ appears in both the share equation (18) and the pricing equation (27): larger γ means that the goods are stronger substitutes and the markups are correspondingly smaller. It is also evident that the shares and prices are endogenously determined: shocks to either supply δ_{it} or demand ε_{it} will both be correlated with shares s_{it} and prices p_{it}. To control for this endogeneity will we estimate these equations simultaneously using a similar methodology to that proposed in the CES case by Feenstra (1994) and extended by Broda and Weinstein (2006).

The first step in our estimation is to difference (18) and (27) with respect to country k and with respect to time, thereby eliminating the terms $a_i + a_t$ and the overall average prices $\overline{\ln p_t}$ appearing in the share equations, and eliminating total expenditure $\ln E_t$. We also divide the share equation by γ and the pricing equation by $(1+\omega)$, and then express each equation in terms of its error term:

$$\frac{(\Delta\varepsilon_{it} - \Delta\varepsilon_{kt})}{\gamma} = \frac{[\Delta(H_{it}s_{it}) - \Delta(H_{kt}s_{kt})]}{\gamma} + (\Delta \ln p_{it} - \Delta \ln p_{kt}),$$

and,

$$\frac{(\Delta\delta_{it}-\Delta\delta_{kt})}{(1+\omega)}=(\Delta\ln p_{it}-\Delta\ln p_{kt})-\frac{\omega(\Delta\ln s_{it}-\Delta\ln s_{kt})}{(1+\omega)}$$
$$-\frac{1}{(1+\omega)}\left\{\Delta\ln\left[1+\frac{H_{it}s_{it}N_t}{\gamma(N_t-1)}\right]-\Delta\ln\left[1+\frac{H_{kt}s_{kt}N_t}{\gamma(N_t-1)}\right]\right\}.$$

We multiply these two equations together, and average the resulting equation over time, to obtain the estimating equation:

$$\overline{Y}_i=\frac{\omega}{(1+\omega)}\overline{X}_{1i}+\frac{\omega}{\gamma(1+\omega)}\overline{X}_{2i}-\left(\frac{1}{\gamma}\right)\overline{X}_{3i}+\frac{1}{(1+\omega)}\overline{Z}_{1i}(\gamma)+\frac{1}{\gamma(1+\omega)}\overline{Z}_{2i}(\gamma)+\overline{u}_i,\quad (28)$$

where the over-bar indicates that we are averaging that variable over time, and:

$$Y_{it}\equiv(\Delta\ln p_{it}-\Delta\ln p_{kt})^2,$$

$$X_{1it}\equiv(\Delta\ln s_{it}-\Delta\ln s_{kt})(\Delta\ln p_{it}-\Delta\ln p_{kt}),$$

$$X_{2it}\equiv(\Delta\ln s_{it}-\Delta\ln s_{kt})[(\Delta(H_{it}s_{it})-\Delta(H_{kt}s_{kt})],$$

$$X_{3it}\equiv(\Delta\ln p_{it}-\Delta\ln p_{kt})[(\Delta(H_{it}s_{it})-\Delta(H_{kt}s_{kt})],$$

$$Z_{1it}(\gamma)\equiv\left\{\Delta\ln\left[1+\frac{H_{it}s_{it}N_t}{\gamma(N_t-1)}\right]-\Delta\ln\left[1+\frac{H_{it}s_{kt}N_t}{\gamma(N_t-1)}\right]\right\}(\Delta\ln p_{it}-\Delta\ln p_{kt}),$$

$$Z_{2it}(\gamma)\equiv\left\{\Delta\ln\left[1+\frac{H_{it}s_{it}N_t}{\gamma(N_t-1)}\right]-\Delta\ln\left[1+\frac{H_{it}s_{kt}N_t}{\gamma(N_t-1)}\right]\right\}(\Delta H_{it}s_{it}-\Delta H_{kt}s_{kt}).$$

and, $$u_{it}\equiv\frac{(\Delta\varepsilon_{it}-\Delta\varepsilon_{kt})(\Delta\delta_{it}-\Delta\delta_{kt})}{\gamma(1+\omega)}.$$

We shall assume that the error terms in demand and the pricing equation are uncorrelated, which means that the error term in (28) becomes small, $\overline{u}_i\to 0$ in probability limit, as $T\to\infty$. That error term is therefore uncorrelated with any of the right-hand side variables as $T\to\infty$, and we can exploit those moment conditions by simply running OLS on (28). That procedure will give us consistent estimates of γ and ω provided that the right-hand side variables in (28) are not

perfectly collinear as $T \rightarrow \infty$. As in the CES case of Feenstra (1994), that condition will be assured if there is some heteroskedasticity in the error terms across countries i. In practice, we will use unit-values of import prices from each source country rather than the geometric mean. Also, we do not know the number of varieties N_t over all exporting firms and countries, so we shall treat it as arbitrarily large, $N_t/(N_t - 1) \rightarrow 1$.

Results

Equations (15) and (24) are the key equations for understanding how new varieties affect consumers through increased choice and lower markups. Before we present the final results, it is worth going through the components so that we can understand the forces at play.

We begin with the partial variety effect, V. The last term in equation (15) is likely to be small as long as the number of firms in the market is large and we will ignore it for the time being but include it in the final estimation. The first term, however, highlights two important factors in the importance of new varieties on welfare. First $1/(2\gamma)$, captures the fact that consumers care more about goods that are inelastically demanded (i.e. have low γ's) than goods that have close substitutes. Second, the term in curly brackets can be understood by breaking it up into its components. $H_{i\tau}s_{i\tau}$ is the typical firm's market share and can be thought of as related of the quality of the variety that is either introduced or destroyed. In order to compute the net impact of variety creation and destruction, we need to aggregate these, but we place more weight on goods that have higher market shares than those with lower shares. As a result, we aggregate these across varieties by weighting them by $s_{i\tau}$ and create $H_{i\tau}s_{i\tau}^2$. Essentially, the intuition for this result is that the partial variety effect will have negative effect on the price level if the market share of new entrants is, on average, larger than that of firms that exit. Thus, equation (15)

indicates that the partial variety effect will be driven by the level of differentiation among goods and how important new varieties are in demand. Similarly, we can see from equation (25) that the value of the partial markup effect, P, is dependent on the variety effect, changes in $H_{i\tau}s_{i\tau}^2$ for the set of *common* goods, and a term that will be close to zero if the number of varieties is large.

We can obtain some intuition for what our results will be by plotting $\sum_i H_{i05}s_{i05}^2$ against $\sum_i H_{i92}s_{i92}^2$. We begin by plotting this for all goods in Figure 4a. If points lie along the 45-degree line through the origin (and we ignore the terms that will approximately equal zero when the number of varieties is large), then this implies that V and/or P will be zero for those points. We do this for the 4-digit HS data in our sample. As one can see from the figure, there is a much higher density of points below the 45-degree line than above it. This implies that market share of the market share of the typical firm from the typical country fell over this time. *Ceteris paribus*, this is likely to produce negative variety and markup effects.

We can break up the plot into common and non-common varieties in order to get an understanding of what is likely to be driving V and P. Technically, a new variety appears whenever a new firm enters a market. Since we simply observe Herfindahls and not firms, we decided to define a new variety as the appearance or disappearance of an HS-10 digit export from a country or whenever an HS-4 level Herfindahl moves by +/- 20 percent. We will explore the robustness of our results to this criterion later, but this seems like a reasonable starting point.

By plotting the movements in the Herfindahl index times the share squared in 1992 and 2005, one can obtain some sense of what to expect in terms of the signs of the partial variety and markup effects. Figure 4b plots $\sum_i H_{i05}s_{i05}^2$ against $\sum_i H_{i92}s_{i92}^2$ for the set of new and disappearing goods. The plot reveals a slight tendency for these weighted market shares to fall.

This suggests that we should expect to see a modest variety effect. Figure 4c performs the same plot for the set of common varieties. As one can see from equation (25), this relationship will determine sign of the second term in the P equation. As one can see from the figure, the vast majority of points lie below the 45 degree line. This indicates that the market share of the typical surviving firm fell over this time period. According to our theory, the decline in market share is likely to be associated with a decline in markups that drives down both domestic and import prices and therefore is welfare enhancing.

In order to understand the full impact of these changes on welfare, we need to estimate γ for each sector. However, we had to solve a number of data problems before proceeding. First, while, theoretically we could have estimated γ at the 10-digit level, but in practice this is impossible because we do not have enough 10-digit varieties in most sectors. In order to make sure that we had enough data to obtain precise estimates, we decided to assume that the γs at the 10-digit level within an HS-4-digit sector were the same. This assumption meant that we typically had 99 varieties when we estimated a γ for an HS-4 sector.

A second complication arises because we have U.S. shipments data at the NAICS-6 digit level but we need to compute shares at the HS-10 digit level. Thus, we had to allocate NAICS-6 production data to each HS-10 sector. In order to do this, we assumed that the share of U.S. production in each HS-10 was the same as that of the U.S. in the NAICS-6 digit sector that contains it.

Finally, following Broda and Weinstein (2006), we also had a problem stemming from the fact that there is enormous measurement error in unit values associated with import flows that are very small. Broda and Weinstein propose a weighting scheme based on the quantity of imports at the HS-10 level. Unfortunately, we could not implement precisely that scheme

because the U.S. quantity indexes were defined at the NAICS-6 digit level and not at the HS-10 digit level. We therefore decided to us the Broda and Weinstein weighting scheme using value of shipments instead of quantity of shipments since shipment values are likely to be highly correlated with shipment quantities.

Finally, as in Broda and Weinstein (2006), we also faced the problem that only 85 percent of our estimates of γ had the right sign if we estimate them without constraints. If γ is less than zero, then this implies that demand is inelastic and the welfare gains associated from new and disappearing varieties are infinite. Since we wanted to rule this out and because the formula for V is very sensitive to small values of γ, we decided to place a constraint on γ limiting it to have a smallest value of 0.05. In order to do this, we used a grid search procedure over γ and ω to minimize the sum squared errors in equation (28). In this procedure we set an initial γ of 0.05 and increased it by 10 percent over the range [.05, 110]. Similarly, we set an initial ω of -5 and increased it by 0.1 over the range [-5, 15].

Because we ultimately estimated one thousand γs, it is not possible to display all of them here. We display the sample statistics for γ in Table 2. The median γ was 0.17 and the average was 17. The large average γ is driven by the fact that their distribution is not symmetric and γ can take on very large values. It is difficult to have strong priors for what a reasonable value of gamma should be. One way possible benchmark is the implied markup. Given that the median U.S. Herfindahl in 2005 was 0.25 and the U.S. market share of the U.S. market was 0.67, our estimated gamma implies that the typical U.S. firm the merchandise sector had a markup of 0.45 which is not that different from other studies of markups in manufacturing (c.f. Domowitz, Hubbard, and Paterson).

We now are ready to present aggregate estimates of P and V for all merchandize consumed in the US. In order to do this, we aggregated P and V computed at the HS-4 level according to the following formula

$$\hat{P} = \sum_k \tfrac{1}{2}(s_{kt} + s_{kt-1})P_k \text{ and } \hat{V} = \sum_k \tfrac{1}{2}(s_{kt} + s_{kt-1})V_k \tag{29}$$

where we reintroduce the sectoral subscript, k, and hence P_k and V_k are the values for P and V computed at the HS-4 level and $s_{k\tau}$ is the share of that sector in U.S. absorption. Our baseline estimate for P and V are -0.021 and -.015, which means that the partial gain from varieties is about 1.5 percentage points and the associated decline in markups due to new varieties is 2.1 percentage points. Thus the combined impact is to lower the U.S. merchandise price index by 3.6 percentage points between 1992 and 2005. Given that U.S. merchandise demand constituted 18.5 percent of GDP in 2002,this corresponds to a 0.67 percent gain for U.S. consumers.[10] Of this gain, 0.39 percentage points comes from lower markups and the remaining 0.28 percentage points comes from the pure variety effect.

The magnitudes of these numbers are perhaps easiest to understand relative to Broda and Weinstein's (2006) estimates for the period 1990 to 2001. Those authors used a CES aggregator and obtained a gain to consumers of 0.8 percent. Similarly, when those authors tried to calibrate their estimates to a model in which there was endogenous exit in response to new entry, they obtained an adjusted estimate of 0.67 percentage points which is remarkably close to the estimates obtained in this paper. This suggests that the aggregate welfare gains are quite similar in the two papers.

---

[10] We define merchandise demand as U.S. GDP in agriculture, mining, and manufacturing less exports plus imports in those sectors.

Nevertheless there are some important differences. In particular, while the CES aggregator ascribes all of the welfare gain to new varieties, the pure impact of new varieties is only one quarter as large. By contrast, much of the gain due to new varieties is due to declines in markups in the translog case. Indeed, trade has its most important impacts through this channel.

A second major difference between the translog and CES case is that the translog case makes explicit adjustments for changes in domestic and foreign firm-level entry exit. To get some sense of how important this is for our results, we can recomputed P and V setting all of the Herfindahls equal to one. This is most equivalent to the assumptions underlying estimates based on the CES case in which no entry and exit are permitted. When we do this V hardly changes – falling slightly to -0.015 – still only one third as large as the original Broda and Weinstein estimate. However, P falls dramatically to -0.083 for a combined decline in merchandise prices of 9.8 percent. In other words, had firms not exited, markups would have fallen by 20 percent. This drop is three times larger than what we estimate when we allow for firm-level entry and exit to occur, which suggests that a major reason why markups and prices did not fall faster in the U.S. was due to the substantial exit of firms in the face of increased foreign import competition.

5. Conclusions

Our results suggest that in order to understand the role played by new varieties in the global economy at a macro level, it is important to understand what has been happening at the firm level. The tremendous amount of entry of foreign countries into U.S. markets has been offset to some degree by the exit of firms within countries. Nevertheless we find that the level of exit has not been sufficiently large to offset the gains from new varieties.

We also find that while the translog specification suggests that the pure variety effects are much smaller than the CES specification, this is largely offset by the fact that the translog

specification allows for substantial markup effects. As a result of these markup effects the point estimates of the CES and translog are quite similar with the major difference being where the two functional forms assign the gains and losses.

Theory Appendix

Proof of Theorem 1:

For convenience we denote the firm-country pairs (i,j) instead by the index i, where products i=1,…,N are available in period t-1 or t. These are divided into two (overlapping) sets: the products $i \in I_\tau$ sell in period τ = t-1,t; with their union $I_{t-1} \cup I_t = \{1,...,N\}$ and non-empty intersection $I_{t-1} \cap I_t \neq \varnothing$. We shall let $\bar{I} \subseteq I_{t-1} \cap I_t \neq \varnothing$ denote any non-empty subset of their intersection, and without loss of generality we order the goods so that the first N_1 goods denoted i=1,…, N_1 are in $\bar{I}$, and therefore available both periods (N_1 equals $\overline{N}$ as used in the text); while the next N_2 goods denoted i= N–N_2,…,N are available in either one or both periods, but are not in $\bar{I}$. These two categories exhaust the N goods, N= N_1+N_2. The expenditure function is an shown in equations (8) – (11), and Törnqvist price index is,

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \sum_{i=1}^{N} \tfrac{1}{2}(s_{it} + s_{it-1})(\ln p_{it} - \ln p_{it-1}).$$

Let B denote the NxN matrix $B = -\gamma I_N + (\gamma / N) L_{NxN}$, where I_N is the NxN identity matrix and L_N is an NxN matrix with all elements equal to unity. We partition the B matrix into the same two mutually exclusive groups, and likewise for the vector a:

$$a = \begin{bmatrix} a^1 \\ a^2 \end{bmatrix}, \text{ and } \quad B = \begin{bmatrix} B^{11} & B^{12} \\ B^{21} & B^{22} \end{bmatrix}.$$

The diagonal elements in the matrix B are $B^{kk} = -(\gamma / N)[N\ I_{N_k} - L_{N_k x N_k}]$, and the off-diagonal elements are $B^{12} = B^{21} = (\gamma / N)[L_{N_1 x N_2}]$. Similarly, we partition the share vectors $s_\tau^1 = (s_{1\tau},...,s_{N_1,\tau})'$ and $s_\tau^2 = (s_{N_1+1,\tau},...,s_{N\tau})'$, and the price vectors p_τ^1 and p_τ^2, τ = t-1,t. If $\bar{I} = I_{t-1} \cap I_t$, then all the goods i= N–N_2,…,N are new or disappearing , with either $s_{it-1}^2 = 0$ or

$s_{it}^2 = 0$. More generally, with $\bar{I} \subset I_{t-1} \cap I_t$ then *some* of the goods i= N–N_2,…,N are new or disappearing, with zero share. So we use the notation $\tilde{p}_\tau^2$ to denote the reservation prices for those goods with zero share in period τ = t-1,t, but the same vector uses *actual* prices for those goods with positive shares.

Then the share equations in periods t-1 and t for the goods i= N–N_2,…,N are:

$$s_{t-1}^2 = a^2 + B^{21} \ln p_{t-1}^1 + B^{22} \ln \tilde{p}_{t-1}^2,$$

$$s_t^2 = a^2 + B^{21} \ln p_t^1 + B^{22} \ln \tilde{p}_t^2,$$

where some of these shares can be zero. From these equations we solve for the reservation prices for new and disappearing goods (and actual prices for the goods with positive shares):

$$B^{22} \ln \tilde{p}_{t-1}^2 = (s_{t-1}^2 - a^2 - B^{21} \ln p_{t-1}^1),$$

and, $$B^{22} \ln \tilde{p}_t^2 = (s_t^2 - a^2 - B^{21} \ln p_t^1).$$

It follows that,

$$(\ln \tilde{p}_t^2 - \ln \tilde{p}_{t-1}^2) = \left[B^{22}\right]^{-1}\left[(s_t^2 - s_{t-1}^2) - B^{21}(\ln p_t^1 - \ln p_{t-1}^1)\right]. \tag{A1}$$

Substituting (A1) into the Törnqvist price index, we obtain:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = \frac{(s_t^1 + s_{t-1}^1)'}{2}(\ln p_t^1 - \ln p_{t-1}^1) - \tfrac{1}{2}(s_t^2 + s_{t-1}^2)'\left[B^{22}\right]^{-1} B^{21}(\ln p_t^1 - \ln p_{t-1}^1)$$
$$+ \tfrac{1}{2}(s_t^2 + s_{t-1}^2)'\left[B^{22}\right]^{-1}(s_t^2 - s_{t-1}^2) \tag{A2}$$

From the definition of matrix B, the matrix appearing in (A1) can be written as:

$$B^{22} = -\left(\frac{\gamma}{N}\right)[N\ I_{N_2} - L_{N_2 \times N_2}], \tag{A3}$$

where $[N\ I_{N_2} - L_{N_2 \times N_2}]$ has an eigenvector $L_{N_2 x1}$ with the associated eigenvalue of N_1, so its inverse matrix has the reciprocal eigenvalue. Then by definition of B^{21} we can simplify the second term on the right of (A2) as:

$$-\tfrac{1}{2}(s_t^2+\tilde{s}_{t-1}^2)'\left[B^{22}\right]^{-1}B^{21}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\tfrac{1}{2}(s_t^2+s_{t-1}^2)'\left(\frac{N}{\gamma}\right)[N\ I_{N_2}-L_{N_2xN_2}]^{-1}B^{21}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\tfrac{1}{2}(s_t^2+s_{t-1}^2)'[N\ I_{N_2}-L_{N_2xN_2}]^{-1}L_{N_2xN_1}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\left(\frac{1}{2N_1}\right)(s_t^2+s_{t-1}^2)'\,L_{N_2xN_1}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\left(\frac{1}{2N_1}\right)\begin{bmatrix}\sum_{i=N-N_2}^{N}(s_{it}+s_{it-1})\\ \vdots\\ \sum_{i=N-N_2}^{N}(s_{it}+s_{it-1})\end{bmatrix}'(\ln p_t^1-\ln p_{t-1}^1).$$

Notice that $\tfrac{1}{2}\left(\sum_{i=N-N_2}^{N}(s_{it}+s_{it-1})\right)$ equals $1-\tfrac{1}{2}\left(\sum_{i=1}^{N_1}s_{it}+s_{it-1}\right)$. Substituting these results into the right-hand side of (A2), we can combine the first and second terms as:

$$\frac{(s_t^1+s_{t-1}^1)'}{2}(\ln p_t^1-\ln p_{t-1}^1)-\tfrac{1}{2}(s_t^2+s_{t-1}^2)'\left[B^{22}\right]^{-1}B^{21}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\left\{\frac{(s_t^1+s_{t-1}^1)'}{2}+\left(\frac{1}{N_1}\right)\begin{bmatrix}1-\tfrac{1}{2}\left(\sum_{i=1}^{N_1}s_{it}+s_{it-1}\right)\\ \vdots\\ 1-\tfrac{1}{2}\left(\sum_{i=1}^{N_1}s_{it}+s_{it-1}\right)\end{bmatrix}'\right\}(\ln p_t^1-\ln p_{t-1}^1)$$

$$=\sum_{i=1}^{N_1}\tfrac{1}{2}(\bar{s}_{it}+\bar{s}_{it-1})(\ln p_{it}-\ln p_{it-1}),$$

where,

$$\bar{s}_{i\tau}\equiv s_{i\tau}+\tfrac{1}{N_1}\left(1-\sum_{i=1}^{N_1}s_{i\tau}\right),\ \text{for } i=1,\ldots,N_1, \text{ and } \tau=t\text{-}1, t.$$

Reintroducing the notation (i,j) to denote each product, and noting that N_1 equals $\overline{N}$ as used in the text, this gives us equation (14).

The final term in (A2) is also simplified using (A3). Substituting for B^{22} and dropping the negative sign for notation convenience, the final term in (A3) becomes:

$$\left(\frac{1}{2\gamma}\right)(s_t^2+s_{t-1}^2)'\left[I_{N_2}-\left(\frac{1}{N}\right)L_{N_2 x N_2}\right]^{-1}(s_t^2-s_{t-1}^2)'$$

$$=\left(\frac{1}{2\gamma}\right)(s_t^2+s_{t-1}^2)'\left\{I_{N_2}+\left(\frac{1}{N}\right)L_{N_2 x N_2}+\left(\frac{1}{N}\right)^2 L_{N_2 x N_2}^2+\left(\frac{1}{N}\right)^3 L_{N_2 x N_2}^3\cdots\right\}(s_t^2-s_{t-1}^2)'$$

$$=\left(\frac{1}{2\gamma}\right)\left\{\sum_{i=N-N_2}^{N}[(s_{it})^2-(s_{it-1})^2]+\left(\frac{1}{N}\right)\left[\left(\sum_{i=N-N_2}^{N}s_{it}\right)^2-\left(\sum_{i=N-N_2}^{N}s_{it}\right)^2\right]\left[1+\left(\frac{N_2}{N}\right)+\left(\frac{N_2}{N}\right)^2+\ldots\right]\right\}$$

$$=\left(\frac{1}{2\gamma}\right)\left\{\sum_{i=N-N_2}^{N}[(s_{it})^2-(s_{it-1})^2]+\left(\frac{1}{N_1}\right)\left[\left(\sum_{i=N-N_2}^{N}s_{it}\right)^2-\left(\sum_{i=N-N_2}^{N}s_{it-1}\right)^2\right]\right\}.$$

Again reintroducing the notation (i,j) to denote each product, and noting i= $N–N_2,\ldots,N$ are not in the set $\bar{I}$ this gives us equation (15). QED

Proof of Theorem 2:

First, we need to show that (22) is a second-order approximation to (21), around the point where (23) holds and (1/γ)=0. To this end, write the term on the right of (21) as $\sum_j s_{jt}^i \ln(1+s_{jt}^i x)$, with $x = N_t/\gamma(N_t-1)$. We wish to show that the first and second derivatives of this function with respect to s_{jt}^i and x equal the first and second derivatives of $\ln[1+\sum_j (s_{jt}^i)^2 x]$, evaluated using (23) and x = 0. We have:

$$\left.\frac{\partial}{\partial s_{jt}^i}\right|_{\substack{(23),\\ x=0}}\sum_j s_{jt}^i \ln(1+s_{jt}^i x)=0=\left.\frac{\partial}{\partial s_{jt}^i}\right|_{\substack{(23),\\ x=0}}\ln[1+\sum_j (s_{jt}^i)^2 x]$$

$$\left.\frac{\partial^2}{\partial s_{kt}^i\partial s_{jt}^i}\right|_{\substack{(23),\\ x=0}}\sum_j s_{jt}^i \ln(1+s_{jt}^i x)=0=\left.\frac{\partial^2}{\partial s_{kt}^i\partial s_{jt}^i}\right|_{\substack{(23),\\ x=0}}\ln[1+\sum_j (s_{jt}^i)^2 x]$$

$$\left.\frac{\partial}{\partial x}\right|_{\substack{(23),\\ x=0}}\sum_j s_{jt}^i \ln(1+s_{jt}^i x)=\sum_j (s_{jt}^i)^2=\left.\frac{\partial}{\partial x}\right|_{\substack{(23),\\ x=0}}\ln[1+\sum_j (s_{jt}^i)^2 x]$$

$$\left.\frac{\partial^2}{\partial s^i_{jt}\partial x}\right|_{\substack{(23),\\ x=0}} \sum_j s^i_{jt}\ln(1+s^i_{jt}x) = 2s^i_{jt} = \left.\frac{\partial^2}{\partial s^i_{jt}x}\right|_{\substack{(23),\\ x=0}} \ln[1+\sum_j (s^i_{jt})^2 x]$$

$$\left.\frac{\partial^2}{\partial x^2}\right|_{\substack{(23),\\ x=0}} \sum_j s^i_{jt}\ln(1+s^i_{jt}x) = 0 = \left.\frac{\partial^2}{\partial x^2}\right|_{\substack{(23),\\ x=0}} \ln[1+\sum_j (s^i_{jt})^2 x],$$

where the last equality relies on $s^i_{kt} = s^i_{jt}$, from (23).

Then using (23), we replace $s_{ij\tau}$ in (14) by s_{it} / N_i, and use this in (13) to obtain:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = V + \sum_{i\in\bar{I}} \tfrac{1}{2}(s_{it}+s_{it-1}) \sum_{j\in\bar{J}_i} \tfrac{1}{N_i}(\ln p_{ijt} - \ln p_{ijt-1}) +$$

$$\tfrac{1}{\bar{N}}\left(1 - \tfrac{1}{2}\sum_{i\in\bar{I}}\sum_{j\in\bar{J}_i}\frac{s_{it}}{N_i} - \tfrac{1}{2}\sum_{i\in\bar{I}}\sum_{j\in\bar{J}_i}\frac{s_{it-1}}{N_i}\right)\sum_{i\in\bar{I}}\sum_{j\in\bar{J}_i}(\ln p_{ijt} - \ln p_{ijt-1})$$

$$= V + \sum_{i\in\bar{I}} \tfrac{1}{2}(s_{it}+s_{it-1})(\overline{\ln p_{it}} - \overline{\ln p_{it-1}}) + \tfrac{1}{\bar{N}}\left(1 - \tfrac{1}{2}\sum_{i\in\bar{I}} s_{it} - \tfrac{1}{2}\sum_{i\in\bar{I}} s_{it-1}\right)\sum_{i\in\bar{I}} N_i\ (\overline{\ln p_{it}} - \overline{\ln p_{it-1}}),$$

where $\overline{\ln p_{it}} \equiv \frac{1}{N_i}\sum_{j\in\bar{J}_i} \ln p_{ijt}$ is the unweighted mean of the log-prices for country j. Again from assumption (23), these are identical to the weighted mean of log-prices we define in the text, $\ln p_{it} \equiv \sum_{j\in\bar{J}_i} s^i_{jt} \ln p_{ijt}$. Then using the shares in (14) with (22), we re-write the above result as:

$$\ln\left(\frac{e_t}{e_{t-1}}\right) = V + \sum_{i\in\bar{I}} \tfrac{1}{2}(\bar{s}_{it}+\bar{s}_{it-1})(\ln p_{it} - \ln p_{it-1}) = V + \sum_{i\in\bar{I}} \tfrac{1}{2}(\bar{s}_{it}+\bar{s}_{it-1})(\ln C'_{it} - \ln C'_{it-1}) + P,$$

with P defined as in (24). Then using $\ln(1+x) \approx x$, P can be re-written as:

$$\sum_{i\in\bar{I}} \tfrac{1}{2}(\bar{s}_{it}+\bar{s}_{it-1})\left\{\ln\left[1+\frac{H_{it}s_{it}N_t}{\gamma(N_t-1)}\right] - \ln\left[1+\frac{H_{it-1}s_{it-1}N_{t-1}}{\gamma(N_{t-1}-1)}\right]\right\}$$

$$\approx \sum_{i\in\bar{I}} \tfrac{1}{2}(\bar{s}_{it}+\bar{s}_{it-1})\left[\frac{H_{it}s_{it}N_t}{\gamma(N_t-1)} - \frac{H_{it-1}s_{it-1}N_{t-1}}{\gamma(N_{t-1}-1)}\right]$$

$$= \frac{1}{2\gamma}\sum_{i\in\bar{I}}(\bar{s}_{it} + \bar{s}_{it-1})\left[(H_{it}s_{it} - H_{it-1}s_{it-1}) + \frac{H_{it}s_{it}}{(N_t - 1)} - \frac{H_{it-1}s_{it-1}}{(N_{t-1} - 1)}\right]$$

Using the formula for the defined shares in (14), we can re-write P as:

$$P = \frac{1}{2\gamma}\sum_{i\in\bar{I}}\left[(s_{it} + s_{it-1}) + \tfrac{N_i}{\bar{N}}\left(\sum_{i\notin\bar{I}} s_{it} + \sum_{i\notin\bar{I}} s_{it-1}\right)\right](H_{it}s_{it} - H_{it-1}s_{it-1})$$
$$+ \frac{1}{2\gamma}\sum_{i\in\bar{I}}(\bar{s}_{it} + \bar{s}_{it-1})\left[\frac{H_{it}s_{it}}{(N_t - 1)} - \frac{H_{it-1}s_{it-1}}{(N_{t-1} - 1)}\right]$$
$$= \frac{1}{2\gamma}\sum_{i\in\bar{I}}(s_{it} + s_{it-1})(H_{it}s_{it} - H_{it-1}s_{it-1}) + \frac{1}{2\gamma}\left(\sum_{i\notin\bar{I}} s_{it} + \sum_{i\notin\bar{I}} s_{it-1}\right)\sum_{i\in\bar{I}}\tfrac{N_i}{\bar{N}}(H_{it}s_{it} - H_{it-1}s_{it-1})$$
$$+ \frac{1}{2\gamma}\sum_{i\in\bar{I}}(\bar{s}_{it} + \bar{s}_{it-1})\left[\frac{H_{it}s_{it}}{(N_t - 1)} - \frac{H_{it-1}s_{it-1}}{(N_{t-1} - 1)}\right]$$

From (23) note that $H_{it} = H_{it-1} = 1/N_i$ for $i \in \bar{I}$ and using this repeatedly we can simplify P as:

$$P = \frac{1}{2\gamma}\sum_{i\in\bar{I}}(H_{it}s_{it}^2 - H_{it-1}s_{it-1}^2) - \frac{1}{2\gamma\bar{N}}\left(\sum_{i\notin\bar{I}} s_{it} + \sum_{i\notin\bar{I}} s_{it-1}\right)\left(\sum_{i\notin\bar{I}} s_{it} - \sum_{i\notin\bar{I}} s_{it-1}\right)$$
$$+ \frac{1}{2\gamma}\sum_{i\in\bar{I}}(\bar{s}_{it} + \bar{s}_{it-1})\left[\frac{H_{it}s_{it}}{(N_t - 1)} - \frac{H_{it-1}s_{it-1}}{(N_{t-1} - 1)}\right]$$

Then substituting for V from (15), we obtain the result shown in (25). QED

Data Appendix (To Be Added)

We start by providing an overview of our data sources and data construction methods and then describe some stylized facts about what implications they suggest for the economy. In order to do this we purchased two waves of U.S. firm-level import data from PIERS. PIERS collects data from the bill of lading for every container that enters a U.S. port. Although purchasing the disaggregated data is prohibitively expensive, we were able to obtain information on shipments to the U.S. for the 50,000 largest exporters to the US. For each firm in our sample, we obtained information for 1992 and 2005 on the estimated value, quantity and country of origin of the top five HTS-4 digit sectors in which the firm was active. Moreover, we obtained this information for the top ten HTS-4 digit sectors for the largest 250 firms in each year.

The Piers data has a number of limitations relative to other firm level data sets. The first is relatively minor: we do not have the universe of exporters but only the largest ones. This turns out not to be a serious problem because the aggregate value of these exporters is typically within 5 percent of total sea shipments. Thus, smaller exporters are unlikely to have a qualitatively important impact on our results.

A larger problem is that the PIERS data only comprises sea shipments and thus we have no information in these data on land and air shipments. Figure 5 shows the distribution of exports by sea to the U.S. by country excluding Canada and Mexico. The median country in the figure exports about 80 percent of its goods by sea. Thus for the typical country in our sample, the sea data covers a large fraction of their exports. Table 3 breaks this information down for the largest exporters to the US. Two things are clear from this table. Again with the exception of Canada and Mexico, most of our largest trading partners export well over half of all of their goods by sea. Secondly, however, as Harrigan (20XX) and Hummels (20XX) have emphasized, air is also

an important means of transportation for many countries. We therefore will need to make use of information on air shipments as well to obtain a full picture of what is happening to imports into the U.S. at the firm level.

Constructing the Mexican Herfindahls was somewhat more involved. We were able to obtain information from the *Encuesta Industrial Anual* (Annual Industrial Survey) of the *Instituto Nacional de Estadistica y Geografia*. Firm-level exports for 205 CMAP94 categories for 1993. We also obtained the export Herfindahl for 232 categories at the NAICS 6-digit level **[for what year?].** These categories cover the most important Mexican export sectors. We then used a concordance file to match these to HS 4-digit categories.

References

Badinger, Harald, 2007a, “Has the EU’s Single Market Programme Fostered Competition? Testing for a Decrease in Markup Ratios in EU Industries,” *Oxford Bulletin of Economics and Statistics*, 69 (4): 497-519

Badinger, Harald, 2007b, “Market size, Trade, Competition and Productivity: Evidence from OECD Manufacturing Industries. *Applied Economics*, 39 (17): 2143 - 2157.

Badinger, Harald, 2008. “Trade policy and Productivity,” *European Economic Review*, 52, 867-891.

Bergin, Paul and Robert C. Feenstra, 2009, “Pass-through of Exchange Rates and Competition Between Fixers and Floaters,” *Journal of Money, Credit and Banking*, February, 41(s1), 35-70.

Blonigen, Bruce A., Benjamin H. Liebman, and Wesley W. Wilson, 2007, “Trade Policy and Market Power: The Case of the U.S. Steel Industry, NBER working paper no 13761.

Bresnahan, Timothy F., 1982, “The Oligopoly Solution Concept is Identified,” *Economic Letters*, Vol.10: 87-92.

Bresnahan, Timothy F., 1989, “Empirical Studies of Industries with Market Power,” in Richard Schmalensee and Robert Willig, eds., *Handbook of Industrial Organization, Volume 2*. Amsterdam: North-Holland, 1011-57.

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

Broda, C., D. Greenfield and D. E. Weinstein, 2006, “From Groundnuts to Globalization: A Structural Estimate of Trade and Growth,” University of Chicago and Columbia University.

Christensen, Laurits R., Dale W. Jorgenson and Lawrence J. Lau, 1975, “Transcendental Logarithmic Utility Functions”, *American Economic Review* 65, 367-383.

Diewert, W. Erwin, 1974, “Applications of Duality Theory,” in *Frontiers of Quantitative Economics* Vol. II, edited by M. Intriligator and D. Kendrick, North-Holland, Amsterdam, 106-171.

Diewert, W. E., 1976, “Exact and Superlative Index Numbers,” *Journal of Econometrics*, 4, 115-145.

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

Feenstra, Robert C., 2003, "A Homothetic Utility Function for Monopolistic Competition Models, Without Constant Price Elasticity," *Economic Letters,* 78, 79-86.

Feenstra, Robert C. and Clinton Shiells , 1997, "Bias in U.S. Import Prices and Demand," in Timothy Bresnahan and Robert Gordon, eds. *New Products: History, Methodology and Applications,* NBER and Univ. of Chicago Press, 1997, 249-276.

Feenstra, Robert C., John Romalis and Peter Schott, 2002, "U.S. Imports, Exports and Tariff Data, 1989-2001," NBER Working Paper no. 9387.

Harrison, Ann E., 1994, "Productivity, imperfect competition and trade reform: Theory and evidence," February, 36(1/2), 53-73.

Head, K. C. and J. Ries, 1999, "Rationalization effects of tariff reductions," *Journal of International Economics*, 47(2), April, 295-320.

Head, K. C. and J. Ries, 2001, "Increasing Returns Versus National Product Differentiation as an Explanation for the Pattern of US-Canada Trade," *American Economic Review*, 91(4), September, 858-876.

Levinsohn, James, 1993, "Testing the Imports-As-Market-Discipline Hypothesis," *Journal of International Economics,* August, 35(1/2), 1-22.

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

Melitz, Marc J. and Giancarlo I. P. Ottaviano, 2008. "Market Size, Trade, and Productivity," *Review of Economic Studies*, 75(1), 295-316.

Trefler, D., 2004, "The Long and Short of the Canada-U.S. Free Trade Agreement," *American Economic Review,* 94(4), September, 870-895.

Tybout, J. R., J. de Melo, and V. Corbo, 1991, "The effects of Trade Reform on Scale and Technical Efficiency," New Evidence from Chile," *Journal of International Economics,* 31(3/4), 231-250.

Tybout, J. R. and M. D. Westbrook, 1995, "Trade Liberalization and Dimensions of Efficiency Change in Mexican Manufacturing Industries," *Journal of International Economics,* 39(1/2), 53-78.

References

Badinger, Harald, 2007a, “Has the EU’s Single Market Programme Fostered Competition? Testing for a Decrease in Markup Ratios in EU Industries,” *Oxford Bulletin of Economics and Statistics*, 69 (4): 497-519

Badinger, Harald, 2007b, “Market size, Trade, Competition and Productivity: Evidence from OECD Manufacturing Industries. *Applied Economics*, 39 (17): 2143 - 2157.

Badinger, Harald, 2008. “Trade policy and Productivity,” *European Economic Review*, 52, 867-891.

Bergin, Paul and Robert C. Feenstra, 2009, “Pass-through of Exchange Rates and Competition Between Fixers and Floaters,” *Journal of Money, Credit and Banking*, February, 41(s1), 35-70.

Blonigen, Bruce A., Benjamin H. Liebman, and Wesley W. Wilson, 2007, “Trade Policy and Market Power: The Case of the U.S. Steel Industry, NBER working paper no 13761.

Bresnahan, Timothy F., 1982, “The Oligopoly Solution Concept is Identified,” *Economic Letters*, Vol.10: 87-92.

Bresnahan, Timothy F., 1989, “Empirical Studies of Industries with Market Power,” in Richard Schmalensee and Robert Willig, eds., *Handbook of Industrial Organization, Volume 2*. Amsterdam: North-Holland, 1011-57.

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

Broda, C., D. Greenfield and D. E. Weinstein, 2006, “From Groundnuts to Globalization: A Structural Estimate of Trade and Growth,” University of Chicago and Columbia University.

Christensen, Laurits R., Dale W. Jorgenson and Lawrence J. Lau, 1975, “Transcendental Logarithmic Utility Functions”, *American Economic Review* 65, 367-383.

Diewert, W. Erwin, 1974, “Applications of Duality Theory,” in *Frontiers of Quantitative Economics* Vol. II, edited by M. Intriligator and D. Kendrick, North-Holland, Amsterdam, 106-171.

Diewert, W. E., 1976, “Exact and Superlative Index Numbers,” *Journal of Econometrics*, 4, 115-145.

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

Feenstra, Robert C., 2003, "A Homothetic Utility Function for Monopolistic Competition Models, Without Constant Price Elasticity," *Economic Letters,* 78, 79-86.

Feenstra, Robert C. and Clinton Shiells , 1997, "Bias in U.S. Import Prices and Demand," in Timothy Bresnahan and Robert Gordon, eds. *New Products: History, Methodology and Applications,* NBER and Univ. of Chicago Press, 1997, 249-276.

Feenstra, Robert C., John Romalis and Peter Schott, 2002, "U.S. Imports, Exports and Tariff Data, 1989-2001," NBER Working Paper no. 9387.

Harrison, Ann E., 1994, "Productivity, imperfect competition and trade reform: Theory and evidence," February, 36(1/2), 53-73.

Head, K. C. and J. Ries, 1999, "Rationalization effects of tariff reductions," *Journal of International Economics*, 47(2), April, 295-320.

Head, K. C. and J. Ries, 2001, "Increasing Returns Versus National Product Differentiation as an Explanation for the Pattern of US-Canada Trade," *American Economic Review*, 91(4), September, 858-876.

Levinsohn, James, 1993, "Testing the Imports-As-Market-Discipline Hypothesis," *Journal of International Economics,* August, 35(1/2), 1-22.

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

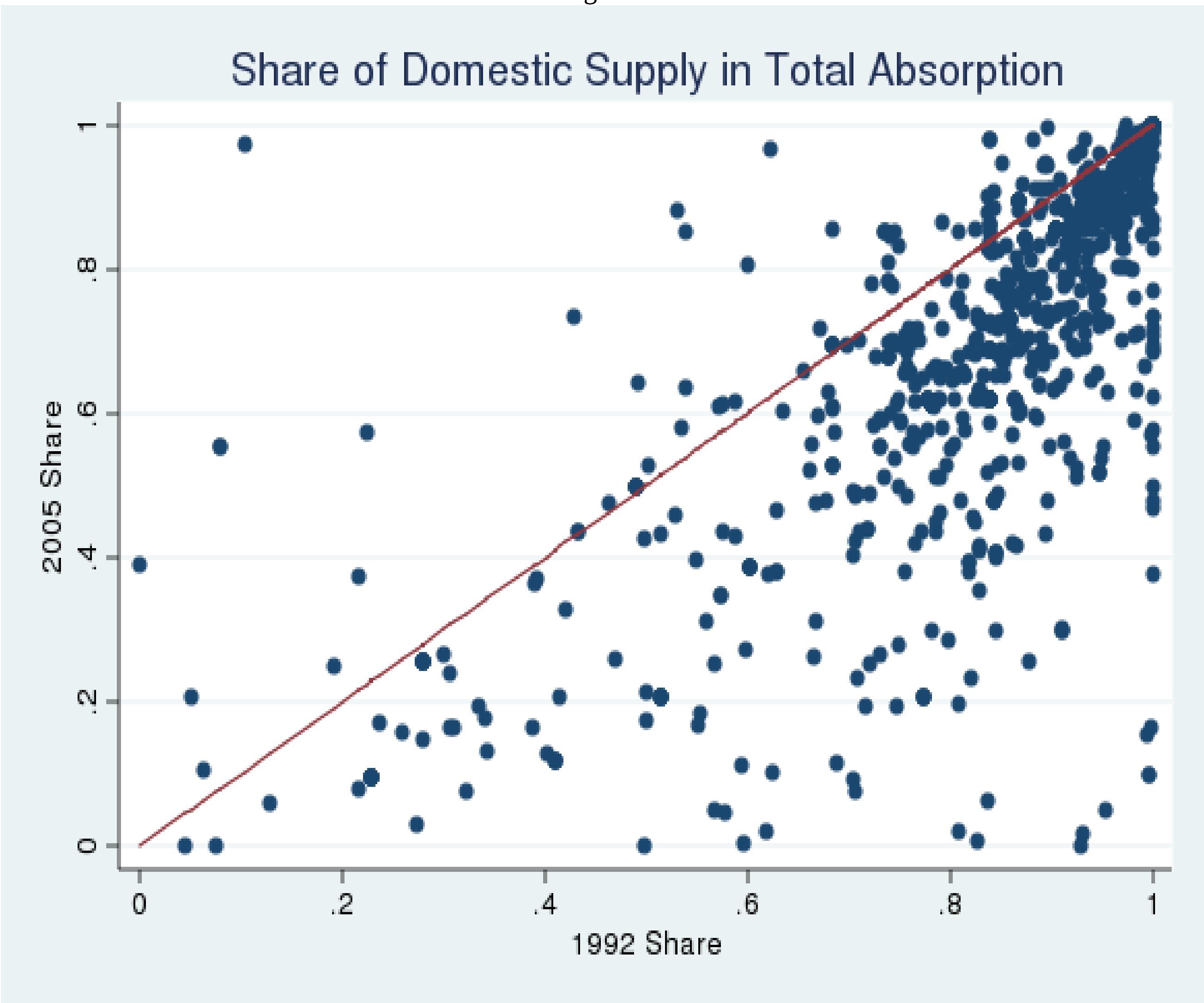
Melitz, Marc J. and Giancarlo I. P. Ottaviano, 2008. "Market Size, Trade, and Productivity," *Review of Economic Studies*, 75(1), 295-316.

Trefler, D., 2004, "The Long and Short of the Canada-U.S. Free Trade Agreement," *American Economic Review,* 94(4), September, 870-895.

Tybout, J. R., J. de Melo, and V. Corbo, 1991, "The effects of Trade Reform on Scale and Technical Efficiency," New Evidence from Chile," *Journal of International Economics,* 31(3/4), 231-250.

Tybout, J. R. and M. D. Westbrook, 1995, "Trade Liberalization and Dimensions of Efficiency Change in Mexican Manufacturing Industries," *Journal of International Economics,* 39(1/2), 53-78.

Figure 1



Share of Domestic Supply in Total Absorption
2005 Share
0
.2
.4
.6
.8
1
0
.2
.4
.6
.8
1
1992 Share

Figure 2

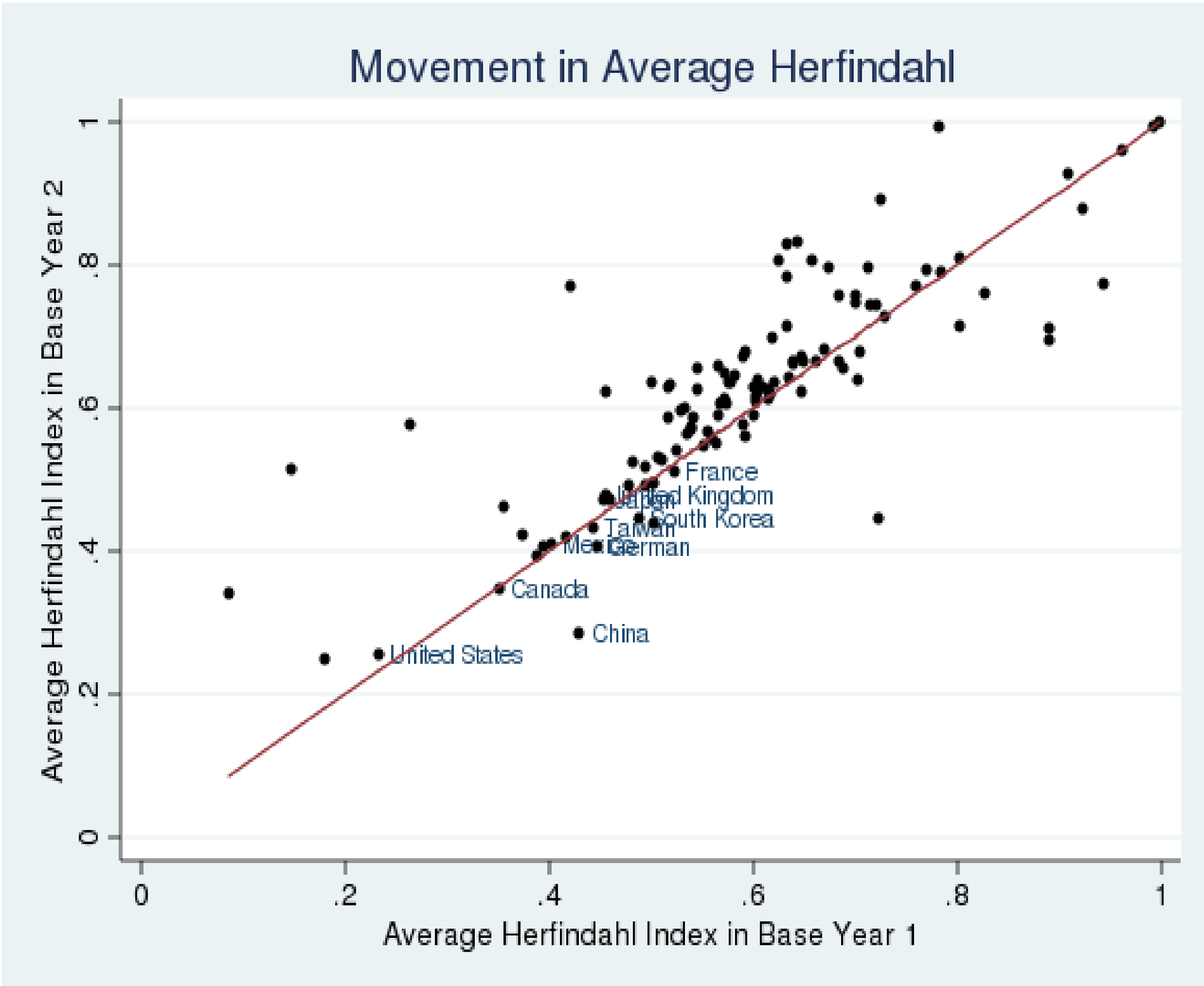

Movement in Average Herfindahl
Average Herfindahl Index in Base Year 2
Average Herfindahl Index in Base Year 1
0
.2
.4
.6
.8
1
France
United Kingdom
Japan
South Korea
Taiwan
Mexico
German
Canada
China
United States

Figure 3

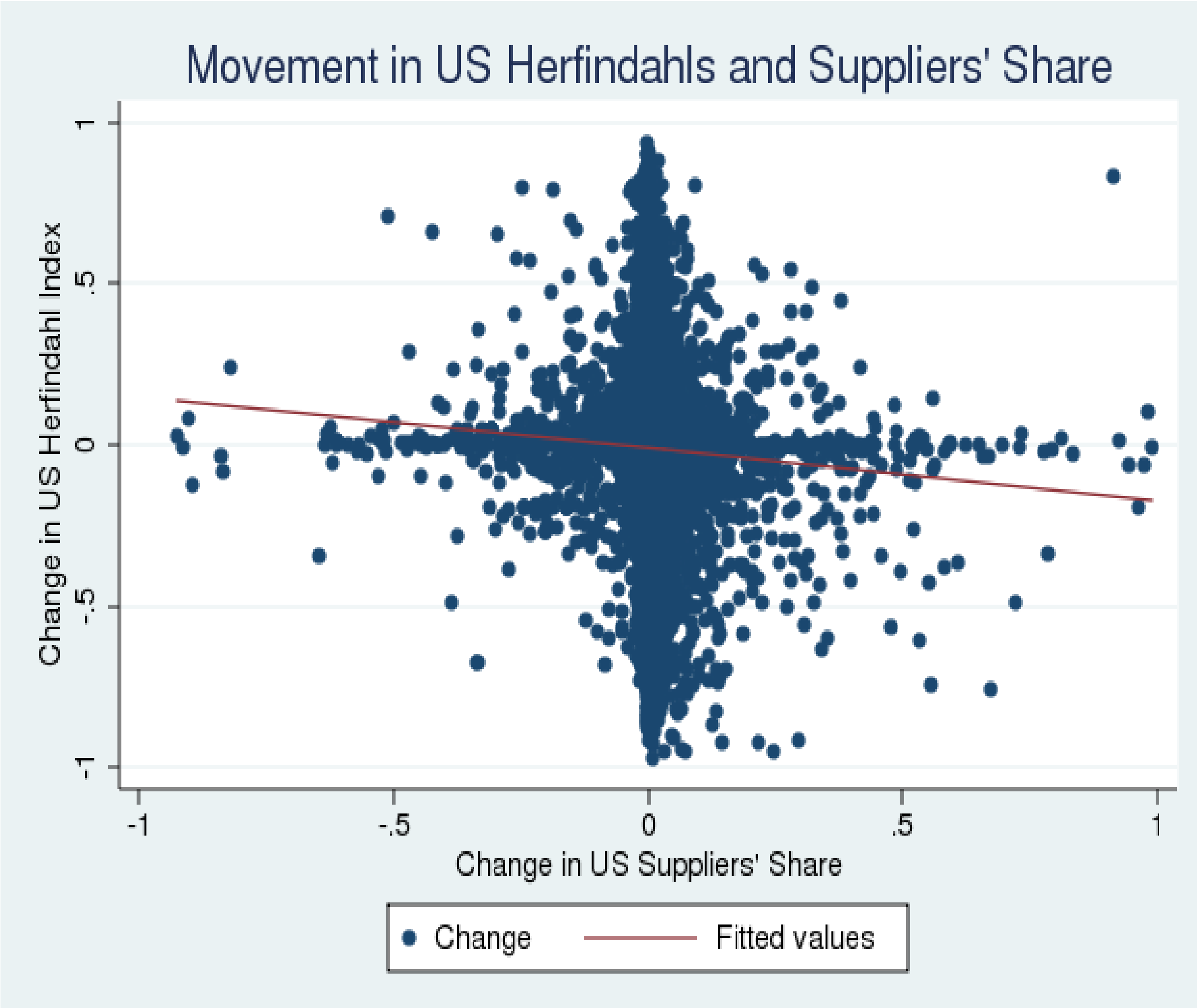

Movement in US Herfindahls and Suppliers' Share
Change in US Herfindahl Index
1
.5
0
-.5
-1
-1
-.5
0
.5
1
Change in US Suppliers' Share
Change
Fitted values

Figure 4a

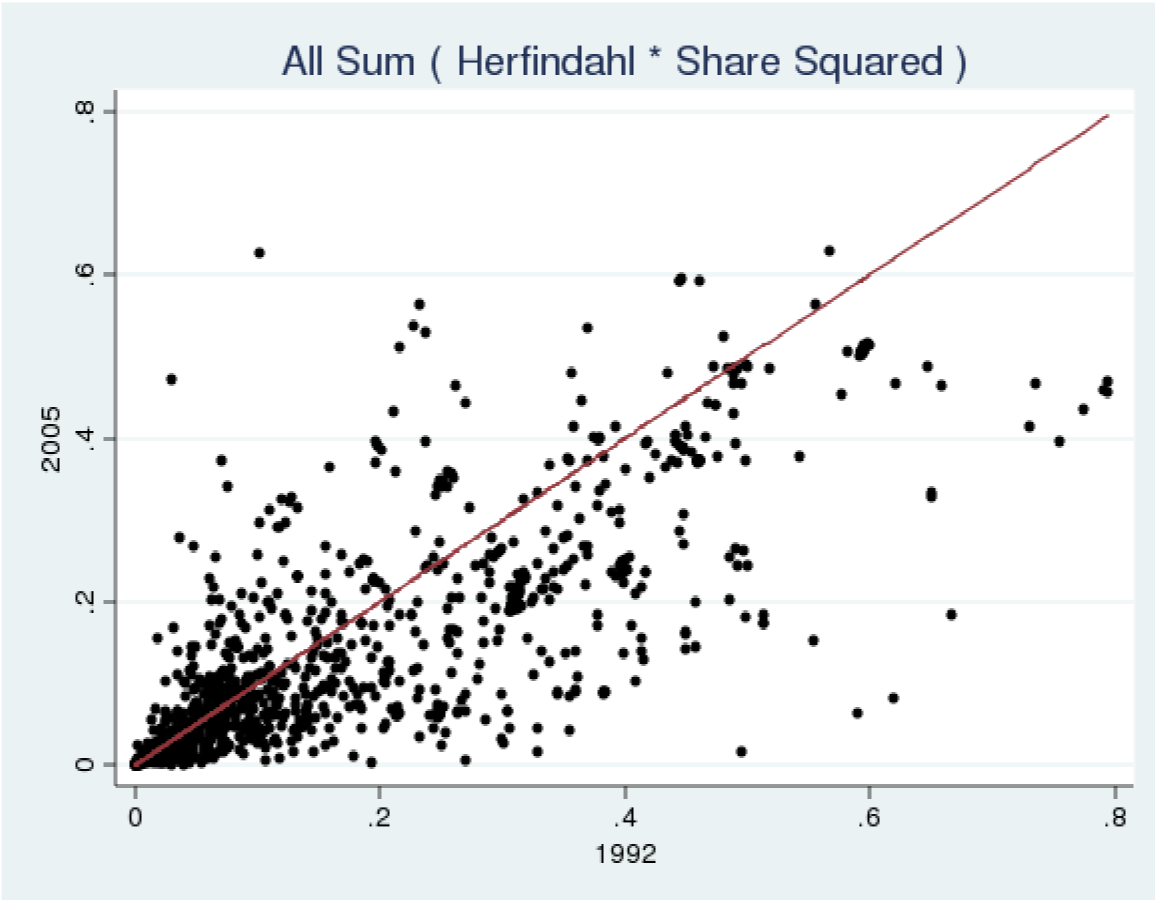


Figure 4 b

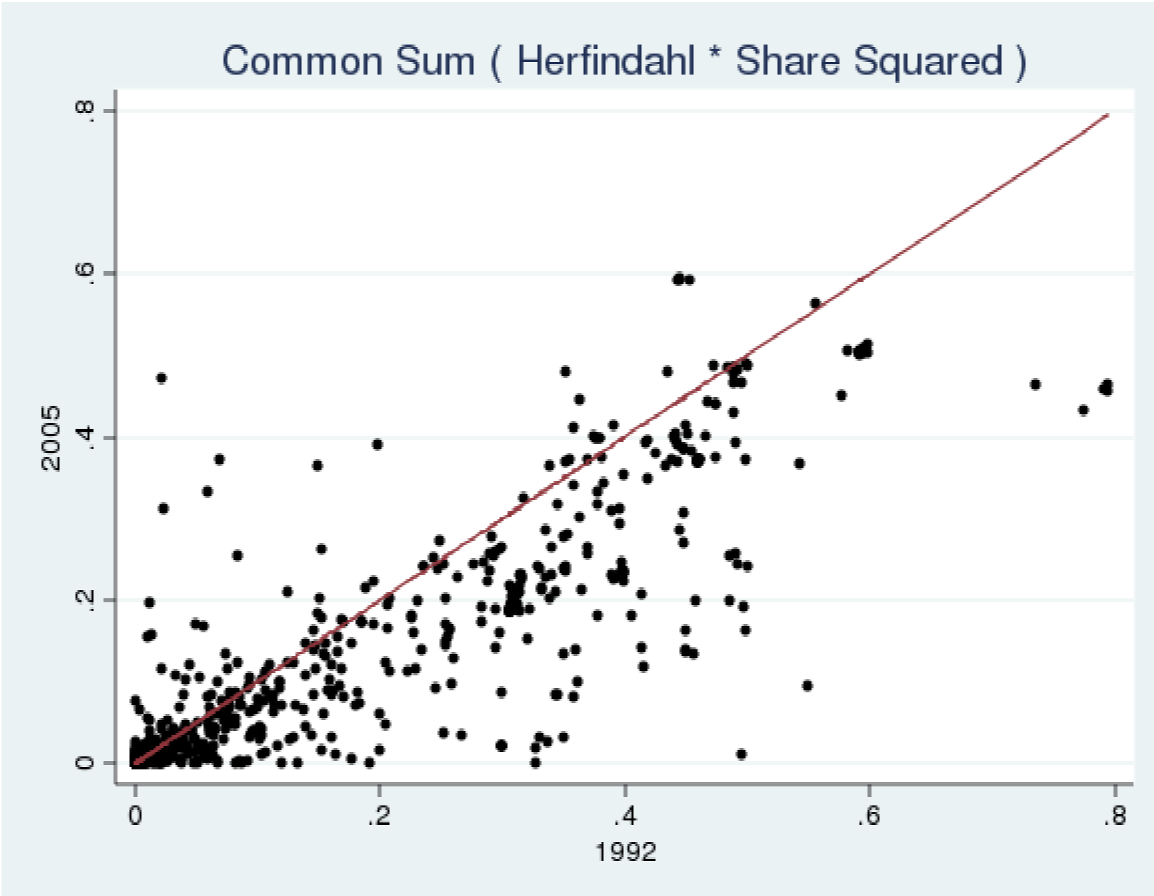


Figure 4 c

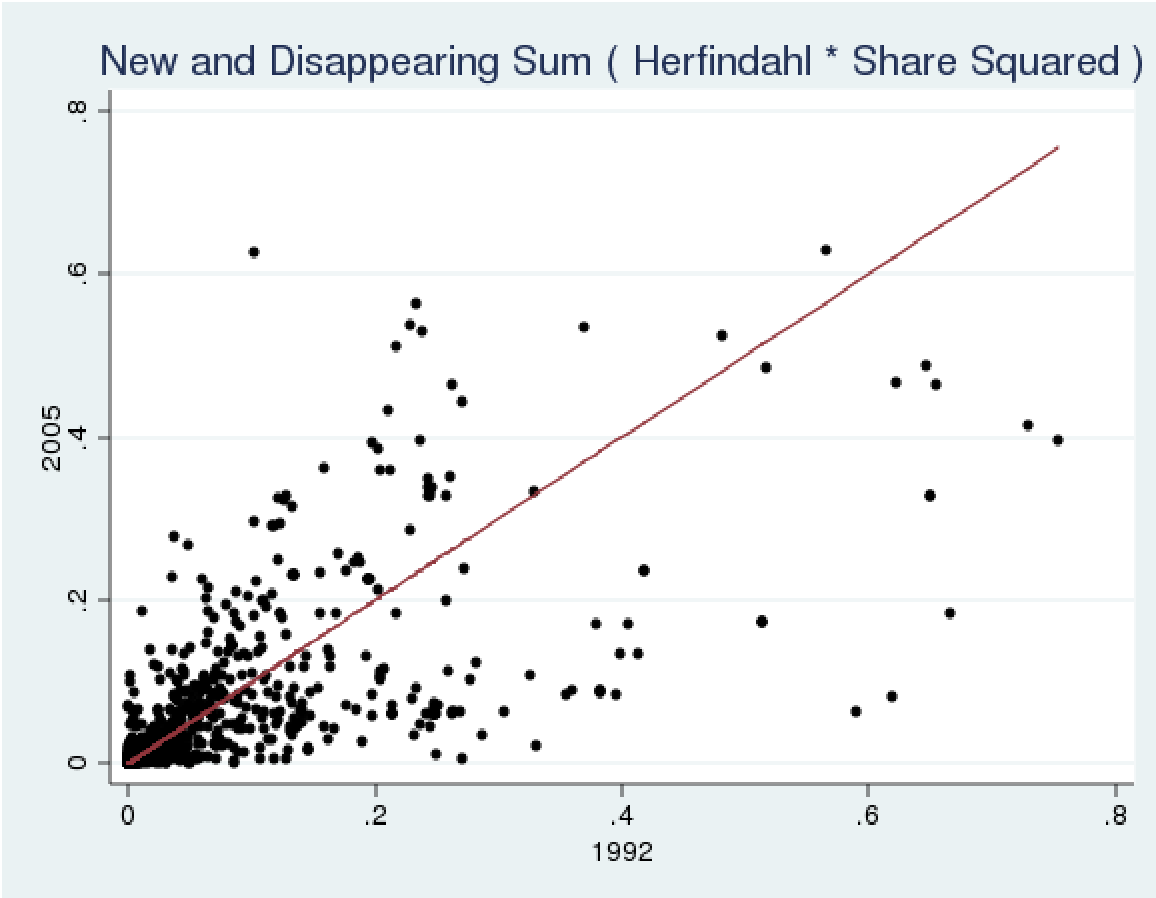

New and Disappearing Sum (Herfindahl * Share Squared)
0
.2
.4
.6
.8
2005
0
.2
.4
.6
.8
1992

Figure 5

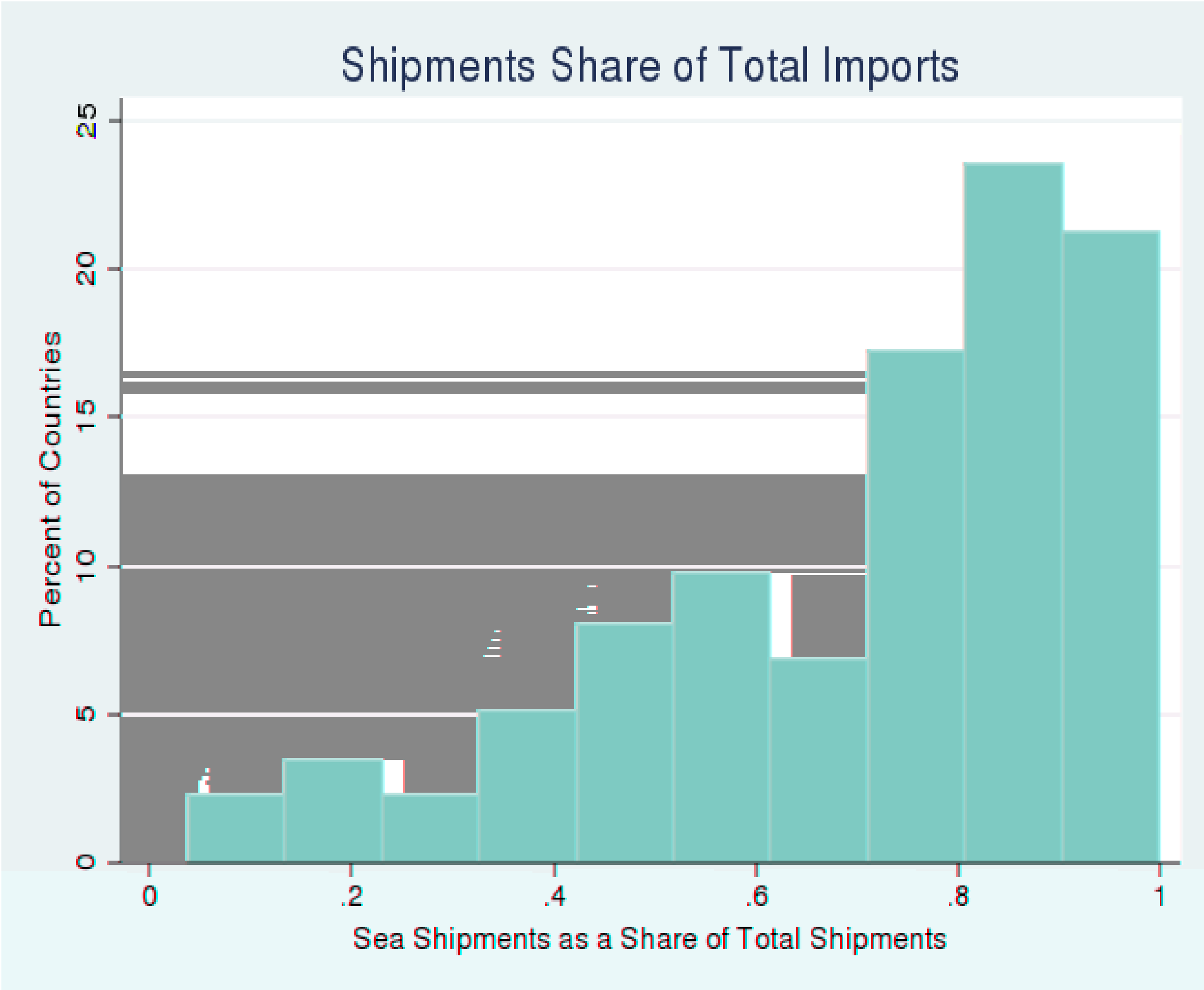

Shipments Share of Total Imports
Percent of Countries
0
5
10
15
20
25
0
.2
.4
.6
.8
1
Sea Shipments as a Share of Total Shipments

Table 1

Ranking in Terms of Share of U.S. Total Absorption

1992							2005					
Rank	Country	Herfin-dahil Index	Share	Avg. HitSit	WeightAvg. HitSit		Rank	Country	Herfin-dahi Index	Share	Avg. HitSit	WeightAvg. HitSit
1	United States	0.229	0.858	0.197	0.157		1	United States	0.252	0.672	0.191	0.165
2	Canada	0.351	0.027	0.046	0.062		2	Canada	0.346	0.059	0.053	0.075
3	Japan	0.454	0.025	0.038	0.039		3	China	0.283	0.043	0.030	0.016
4	Mexico	0.403	0.009	0.017	0.046		4	Mexico	0.409	0.032	0.021	0.065
5	German	0.448	0.007	0.028	0.023		5	Japan	0.473	0.026	0.023	0.058
6	China	0.430	0.007	0.020	0.018		6	German	0.409	0.016	0.025	0.044
7	Taiwan	0.442	0.006	0.013	0.013		7	United Kingdom	0.475	0.009	0.014	0.017
8	South Korea	0.488	0.005	0.007	0.013		8	South Korea	0.445	0.009	0.006	0.018
9	United Kingdom	0.455	0.005	0.019	0.018		9	Venezuala	0.674	0.008	0.006	0.071
10	France	0.522	0.003	0.013	0.020		10	Saudi Arabia	0.756	0.006	0.005	0.044
11	Saudi Arabia	0.683	0.003	0.008	0.050		11	Taiwan	0.431	0.006	0.008	0.015
12	Singapore	0.483	0.003	0.005	0.011		12	France	0.508	0.006	0.012	0.017
13	Italy	0.502	0.003	0.013	0.021		13	Italy	0.437	0.006	0.012	0.010
14	Venezuala	0.647	0.003	0.009	0.025		14	Ireland	0.668	0.006	0.007	0.150
15	Hong Kong	0.389	0.003	0.007	0.007		15	Nigeria	0.639	0.006	0.005	0.025
16	Malaysia	0.540	0.003	0.009	0.018		16	Malaysia	0.568	0.006	0.011	0.012
17	Brazil	0.511	0.002	0.007	0.019		17	Brazil	0.527	0.005	0.009	0.015
18	Thailand	0.526	0.002	0.008	0.015		18	India	0.494	0.004	0.013	0.008
19	Nigeria	0.604	0.002	0.005	0.017		19	Russia	0.574	0.004	0.006	0.015
20	Indonesia	0.497	0.001	0.012	0.021		20	Thailand	0.540	0.003	0.007	0.014
21	Neterlands	0.460	0.001	0.008	0.016		21	Israel	0.591	0.003	0.007	0.012
22	Phillippines	0.534	0.001	0.010	0.016		22	Belgium/Luxembo	0.494	0.003	0.009	0.044
23	Belgium/Luxembo	0.478	0.001	0.008	0.014		23	Neterlands	0.472	0.003	0.006	0.013
24	India	0.502	0.001	0.008	0.005		24	Singapore	0.522	0.003	0.003	0.011
25	Switzerland	0.590	0.001	0.007	0.021		25	Indonesia	0.517	0.003	0.010	0.009
26	Sweden	0.601	0.001	0.005	0.009		26	Sweden	0.593	0.003	0.005	0.013
27	Australia	0.616	0.001	0.011	0.028		27	Algeria	0.797	0.002	0.008	0.023
28	Colombia	0.609	0.001	0.003	0.008		28	Switzerland	0.578	0.002	0.006	0.015
29	Israel	0.567	0.001	0.005	0.007		29	Iraq	0.293	0.002	0.016	0.016
30	Angola	0.593	0.001	0.006	0.012		30	Angola	0.561	0.002	0.003	0.009

Table 2

Gamma Distribution		
Statistic	Value	Standard Deviation
Mean	13.15	1.93
Median	0.17	0.01
Median Number of Varieties	98.50	n/a

Table 3	
Percent of Total Imports with Herfindahl Index Information	
Country	**Percent**
United States	85.50
Canada	99.77
Japan	99.06
Mexico	78.11
China	99.28
German	97.72
United Kingdom	93.21
South Korea	98.47
Taiwan	99.08
France	94.02
Malaysia	98.94
Italy	92.71
Venezuala	98.09
Saudi Arabia	99.45
Singapore	93.92
Brazil	96.42
Thailand	96.80
Ireland	60.93
Nigeria	99.87
Indonesia	97.97