Market Entry and Trade Weighted Import Costs

Benjamin Bridgman*

Bureau of Economic Analysis

April 2010

Abstract

Trade costs have fallen surprisingly little given the large increase in international trade in the last 50 years. This paper examines whether trade costs are properly measured. I show theoretically that trade weighted measures will underestimate the changes in trade costs when there are fixed market entry costs and quality differences. Newly traded goods enter at higher trade costs than previously traded ones. Lower import costs shift trade to low quality goods with higher measured trade costs. U.S. import costs fall twice as fast as trade weighted measures from 1974 to 2004 when the impacts of shifting and new goods are removed. Once the biases are removed, typical estimates of trade elasticities can explain increasing trade.

JEL classification: F1.

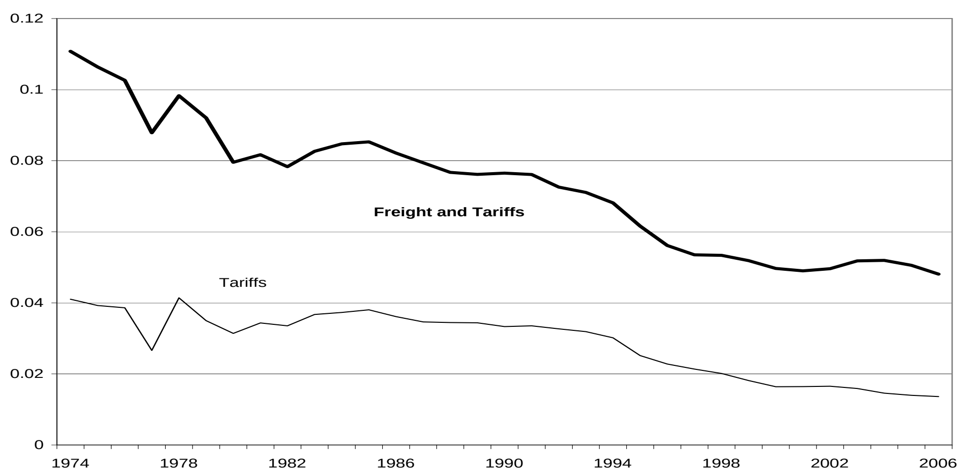
Keywords: Trade costs; Tariffs; Transportation costs.

*I thank Erik Swanson and Chris Zwicker for their research assistance. The views expressed in this paper are solely those of the author and not necessarily those of the U.S. Bureau of Economic Analysis or the U.S. Department of Commerce. Address: U.S. Department of Commerce, Bureau of Economic Analysis, Washington, DC 20230. email: Benjamin.Bridgman@bea.gov. Tel. (202) 606-9991. Fax (202) 606-5366.

1 Introduction

Global trade has grown significantly since World War Two. A classic explanation of this growth, found in Krugman (1995) among others, is that it is due to falling barriers to trade. However, the classic story has difficulty working quantitatively. Trade costs do not seem to fall fast enough to explain the amount of trade growth observed given conventional elasticities (Hummels 2007, Yi 2003). Until the recent recession, trade continued to grow during the 2000s despite, as shown in Figure 1, little decline in trade costs.

Figure 1: Trade Weighted U.S. Import Costs, 1974-2006



The relatively small decline in trade costs is puzzling. Freight costs especially show very little decline despite international transportation having undergone revolutionary change since the late 1960s. Ports and ocean shipping have experienced enormous productivity growth due to the adoption of containerization and bulk handling. Rather than being unloaded manually over the course of days, modern container and bulk ships can be unloaded in a few hours (Levinson 2006). One explanation is freight rates have not fallen much due to improved transportation quality. Shipments are faster and subject to less damage, pilferage and loss (Harrigan 2009, Hummels & Schaur 2009). Another explanation is that market power in international shipping have kept rates high (Hummels, Lugovskyy & Skiba 2009).

This paper examines the basic question of whether trade costs are properly measured. Import costs are made up of thousands of product level freight and tariff lines that need to be aggregated. Trade weighting, the most common form of aggregation, suffers from a well known bias: Goods with the highest trade costs get the lowest weighting or may not be counted at all (Anderson & van Wincoop 2004).

If there are fixed costs of trading, there will be additional biases. Such fixed costs appear to be important. Beginning Melitz (2003) and Eaton & Kortum (2002), a large trade theory literature emphasizing such fixed costs has developed which has successfully explained a number of trade facts. These facts include trade growth along the extensive margin and the presence of "zeros," potential trade flows that do not occur. One implication of fixed costs is the Alchian-Allen hypothesis, which posits that the presence of fixed costs in trade causes higher quality goods to be traded (Alchian & Allen 1964). Hummels & Skiba (2004) and Manova & Zhang (2009) find support for this hypothesis in U.S. and Chinese data.

Using a version of the heterogeneous firms trade model developed in Baldwin & Harrigan (2008), I show theoretically that fixed market entry costs can bias trade weighted measures in two ways. First, as fixed costs fall, goods with high variable trade costs will start to be traded. The influx of relatively high trade cost goods will dampen trade weighted measures. Second, the *ad valorem* equivalent of trade costs that charged on a specific (per unit) basis will vary with the quality of goods. Only high quality, high value per unit goods are traded when fixed costs are high. When specific costs fall, the average quality of goods also falls. Lower quality goods that were not traded before are traded and trade shifts to lower quality goods among those goods that had been traded. Since these goods have the highest *ad valorem* trade costs, trade weighted measures will underestimate the decline in trade costs.

I examine the quantitative impact of extensive margin trade growth and intensive margin shifting on the measurement of trade costs and find that trade costs fell twice as fast as trade weighted measures. New goods enter with higher trade costs than old ones, a gap that has been growing. In 2004, new goods were twice as costly to trade as old goods. Even among old goods, there has been a substantial shift *toward* goods that are costly to trade. To account for shifts among previously traded goods in U.S. imports, I compute index number measures of U.S. import costs. Import costs of previously traded goods would have fallen twice as fast had trade not shifted to high cost goods. This finding is the opposite of the usual intuition that importers shift to lower trade cost goods.

The data are consistent with falling trade costs allowing lower quality goods to be shipped. New goods cost about the same to ship and face similar tariffs. However, they are more expensive to trade since they have lower unit value than old goods. This finding is consistent with freight costs being fixed per physical unit and lower trade costs allowing lower quality goods to be shipped. This explanation helps square the significant improvements in transportation technology with relatively small declines in measured transportation costs.

If decline in trade costs has been underestimated, trade elasticity do not have to be unrealistically high. An elasticity around 6 can explain long term trade growth, rather than 12. This elasticity is much closer to typical estimates. For example, Ruhl (2005) finds an elasticity of 6.4.

Market entry costs have implications for the measurement of other prices. Berman, Martin & Mayer (2009) find a similar dampening effect for the pass-through of exchange rate fluctuations. Devaluations lead to high cost firms entering the export market, causing delivered prices to fall less than the amount of the devaluation. This paper finds that such shifts are important, suggesting the import price indices may be vulnerable to shifts in goods quality.

This paper is part of a literature suggesting alternative measures trade costs. (See Cipollina & Salvatici (2007) for a survey.) One approaches is to use an alternative set of weights. These include using production shares and world trade shares. Anderson & van Wincoop (2004) weight each commodity classification category. All of these suffer from being arbitrary. Equal weighting will depend on the classification system used. Countries often change their classifications, sometimes from year to year. While there has been harmonization recently, different countries use different systems. The measure can be dominated by a few very high cost but rarely traded goods. The literature generally either considers tariffs or freight costs independently, while this paper examines both.

More theoretically grounded indices have been created to measure welfare: The Trade Restrictiveness Index (TRI) proposed in Anderson & Neary (1996) and a market access equivalent (Merchantalist Trade Restrictiveness Index or MTRI) proposed in Anderson & Neary (2003). They have been analyzed and extended in number of follow up papers (Bach & Martin 2001, Bach & Martin 2005). The TRI is a marked improvement over the previous methods, but can be sensitive the selection of modeling (O'Rourke 1997). They are also much more data intensive.

Oksanen & Williams (1979) uses price index theory to measure protection. They only propose a theoretical pairwise comparison of tariffs, while this paper empirically applies these methods to time series data for the United States.

Another model based approach has been to use a gravity equations to back out trade barriers using distance and other proxies. For a recent examples, see Estevadeordal, Frantz & Taylor (2003), Novy (2006) and Jacks (2006). This approach only provides an aggregate estimate of all trade barriers and does not allow for an examination of different sources of barriers.

2 Model

I use a variant of the Quality Heterogeneous Firm Trade (QHFT) model developed in Baldwin & Harrigan (2008) and similar to that of Gervais (2008) to demonstrate the biases of trade weighting. The QHFT matches a number of empirical facts. Importantly for our purposes, it generates "zeros" or potential bilateral trade flows without any trade.

2.1 Households

There are J countries. The preferences of the representative household in each country is given by:

$$U = (\sum_{i\in\Omega_j}(c_j(i)q(i))^{1-\frac{1}{\sigma}}di)^{\frac{1}{1-\frac{1}{\sigma}}} \tag{2.1}$$

where $c_j(i)$ is units consumed of variety i in country j and Ω_j is the set of available varieties. The preference parameters $q(i)$ are the quality of the variety and $\sigma > 1$. The household is endowed with L_j units of labor.

2.2 Goods Production

Consumption goods are produced using labor. The wage is w_j. Output of a variety is $y(i) = \frac{L(i)}{a(i)}$. A firm with unit cost a produces a good of quality q according to:

$$q(i) = a(i)^{1+\theta} \tag{2.2}$$

where $\theta > 0$. Under the assumption that $\theta > 0$, the consumer's valuation of quality increases faster than marginal cost so profit increases in marginal cost. Baldwin & Harrigan (2008) argue that the data support this assumption.

2.3 Transportation Sector

There is a transportation technology that uses labor to export goods. The unit labor requirement is F^s. It costs the firm a market entry fixed cost of F^f units of labor to export to a market.

In addition, there is an *ad valorem* tariff τ. The revenue raised is thrown into the ocean.

2.4 Equilibrium

Each household chooses $c(i) \in \Omega_j$ to maximize Equation 2.1 subject to $\sum_{i\in\Omega_j} p_j(i)c_j(i)$. The solution to this problem generates a demand function $c_j(p_d(i))$.

Transportation firms take prices as given and solve:

$$\max_{c_d} p_d c_d - p_o c_d - w_o F^s_{od} c_d \tag{2.3}$$

Each firm is a monopolistic competitor that set prices to maximize profits. It can set different prices for each market. The optimal mill price in origin country o for a good exported to destination country d is the solution to:

$$\max_{p_o} p_o c_d(p_o) - w_o a c_d(p_o) - F^f w_o \tag{2.4}$$

The firm will only export if profits are positive.

2.5 Solution

For goods that are available in a market, expenditure in destination country d is given by:

$$p_d(i) c_d(i) = [\frac{p_d(i)}{q(i)}]^{1-\sigma} B_d \tag{2.5}$$

where $B_d = \frac{w_d L_d}{P_d^{1-\sigma}}$ is the real income and $P_d = (\int p(i)^{1-\sigma} di)^{\frac{1}{1-\sigma}}$ is the quality adjusted price index of destination country d.

The mill price for good i in the country of origin o is $p_o(i) = \frac{w_o}{\sigma-1}[a(i)\sigma + \frac{F^s_{o,d}}{1+\tau_{o,d}}]$ and the delivered price is $p_d(i) = \frac{w_o \sigma}{\sigma-1}[a(i)(1+\tau_{o,d}) + F^s_{o,d}]$.

The goods that are available are determined by the whether it is profitable to sell to the market. A good will be exported from origin country o to destination country d if

$$(\frac{a_o^{1+\theta}}{a_o + F^s_{od}})^{\sigma-1} (\frac{\sigma-1}{w_o})^{\sigma-1} \frac{B_d}{(1+\tau_{od})\sigma^\sigma} \geq F^f w_o. \tag{2.6}$$

3 Model Results

This section shows the biases of trade-weighted measures in the presence of fixed costs of trade. In terms of the theory, all τ represents all *ad valorem* charges and F^s represents specific (per unit) costs. I interpret the empirical equivalent of τ to be tariffs and F^s to be freight costs since that generally represents the current U.S. experience. This assumption is not true in all cases and historically the opposite was true (Crucini 1994).

The empirical equivalent of the entry cost F^f is still an area of active research. The typical method is to back out the costs using a structural model rather than using data directly (Sanghamitra Das & Tybout 2007, Ruhl & Willis 2009). This research has emphasized non-transportation costs, such as information (marketing) costs (Arkolakis 2009). Since they are not included in the customs data that is the basis of the empirical work, I exclude them in the theoretical analysis of trade weighted import costs.

The *ad valorem* equivalent trade costs of a good are given by:

$$\frac{\sum_{i\in\Omega}\tau_{o,d}p_o(i)c_j(i)+w_oF^s_{o,d}c_j(i)}{\sum_{i\in\Omega}p_o(i)c_j(i)} \tag{3.1}$$

Imports are valued at mill prices since U.S. tariffs are charged on price in the country of origin. The results hold if imports are valued on a delivered price (CIF) basis.

Taking each cost individually, it is clear that the *ad valorem* tariff component is unaffected by the quality of the good: $\frac{\tau pc}{pc}=\tau$. However, changes in goods quality do affect freight costs. For specific freight charges F^s_{od}, the *ad valorem* equivalent cost is $\frac{w_oF^sc}{pc}=\frac{w_oF^s}{p}$. Since higher quality goods have higher prices, higher quality goods have lower *ad valorem* equivalent specific freight costs.

In the results that follow, I will concentrate on the response of trade of different varieties of a good in a single bilateral trade relationship. Therefore, I assume the changes are small enough to not affect the aggregate prices: Wages w and the aggregate price level P_d are constant.

3.1 Extensive Margin

The decision to enter an export market depends on the market entry fixed cost F^f and the variable costs τ and F^s. Reductions in either type of cost can lead to trade growth along the extensive margin. In both cases, trade weighting will tend to underestimate changes in trade costs.

When the fixed cost F^f declines, goods whose variable trade costs τ and F^s had been too high before will now be traded. Therefore, the costs of newly traded goods will tend to be systematically higher, even if the underlying (variable) trade costs have not changed.

Consider the following example. Consider two goods $c_{o,d}(1)$ and $c_{o,d}(2)$ such that have the same quality $(a(1) = a(2))$. Let $F^s_{o,d}(1) = F^s_{o,d}$. Suppose $\tau_1 < \tau_2$ such that for fixed cost F^f_t good 2 is not traded and is traded for F^f_{t+1}. Trivially, trade weighted tariffs in period t are τ_1. It is easy to show trade weighted tariffs in period $t+1$ are greater than in period t: $\frac{\sum_{1,2} \tau_i p_o(i) c_{o,d,t+1}(i)}{\sum_{1,2} p_o(i) c_{o,d,t+1}(i)} > \tau_1$ since $\sum_{1,2} \tau_i p_o(i) c_{o,d,t+1}(i) > \tau_1 p_o(i) c_{o,d,t+1}(i)$.

Trade weighted tariffs increased despite the fact that tariffs did not change. Perniciously, measured trade costs increase when the entry cost falls and decrease when the entry costs rise. This result relies in part on the fact that an import cost is excluded from the measure of import costs. However, the (measured) specific cost F^s leads to a similar effect due to shifts in quality. The specific charge means that high quality, high value per unit goods are traded. When new goods enter, they tend to be lower quality goods with higher *ad valorem* equivalent freight costs.

To begin the formal analysis, note that the Alchian-Allen hypothesis holds for this model: The average quality of exports is increasing in trade costs. Define cutoff quality $\overline{q}_{od}$ as the quality level that sets Equation 2.6 at equality.

Proposition 3.1. *The cutoff quality $\overline{q}_{od}$ is increasing in trade costs F^s_{od}, τ_{od} and F^f.*

Proof. Profit is increasing in a. Since quality is increasing in a, equation 2.6 implies that the quality of imported goods is increasing in trade costs F^s_{od}, τ_{od} and F^f. □

Profit is declining in F^s_{od} and τ_{od}, so high trade costs mean that only the most profitable, high quality goods will be traded. High fixed cost F^f means there is a high profit threshold, which also means that only high quality goods will be exported. If the fixed cost falls, lower quality goods become profitable to sell and the average quality of traded goods falls.

If lower quality goods enter, trade weighting the fixed cost will underestimate the fall in trade costs. Consider the following example. Suppose the origin country produces a high and low quality version of a good: $q_o(H) > q_o(L)$. Initially, the fixed cost F_{od} is such that only the high quality good in exported. Trivially, trade weighted costs are given by F_{od}. Suppose that the fixed cost falls to $F'_{od} < F_{od}$, holding all other parameters fixed, and the low quality good is traded. Trade weighted costs are now $\frac{F'_{od} w_o}{s_H P_H + (1-s_H) P_L}$ where $P_d(H) > P_d(L)$ are the prices in the destination country and $s_H = \frac{c(H)}{c(H)+c(L)}$ is the share of high quality units consumed. Define $\mu = \frac{P_H}{P_L} > 1$. The traded weighted cost change is given by:

$$\frac{\frac{F'_{od}}{s_H P_H + (1-s_H) P_L}}{F_{od}} = \frac{\mu F'_{od}}{(s_H \mu + (1 - s_H)) F_{od}} > \frac{F'_{od}}{F_{od}} \tag{3.2}$$

Therefore, trade weighting will underestimate the decline in F_{od}. While the per unit cost is the same for both the high and low quality good, the *ad valorem* cost is higher for the low quality good. The falling cost observed on the high quality good is counteracted by the increase in trade in low quality goods. If the price gap between the goods is big enough ($\mu > \frac{F'_{od}}{F_{od}}$), theoretically the effect could be strong enough that a decline in F_{od} causes an increase in trade weighted costs.

This intuition is formalized in the following proposition.

Proposition 3.2. *Suppose* $F^s_{o,d,t+1} < F^s_{o,d,t}$. *Then*

$$w_o F^s_{o,d,t+1} \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)} < w_o F^s_{o,d,t+1} \frac{\sum_{\Omega_{t+1}} c_{t+1}(i)}{\sum_{\Omega_{t+1}} p_{o,t+1}(i) c_{t+1}(i)}$$

.

Proof. Suppose

$$F^s_{o,d,t+1} \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)} < F^s_{o,d,t+1} \frac{\sum_{\Omega_{t+1}} c_{t+1}(i)}{\sum_{\Omega_{t+1}} p_{o,t+1}(i) c_{t+1}(i)}$$

Cross multiplying, we have:

$$\frac{\sum_{\Omega_{t+1}} c_{t+1}}{\sum_{\Omega_t} c_{t+1}(i)} < \frac{\sum_{\Omega_{t+1}} p_{o,t+1}(i) c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)}$$

Let $\Omega'_{t+1} = \Omega_{t+1} - \Omega_t$, the new goods traded in period $t+1$.

$$\frac{\sum_{\Omega'_{t+1}} c_{t+1}}{\sum_{\Omega_t} c_{t+1}(i)} < \frac{\sum_{\Omega'_{t+1}} p_{o,t+1}(i) c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)}$$

Cross-multiplying:

$$\frac{\sum_{\Omega'_{t+1}} c_{t+1}}{\sum_{\Omega'_{t+1}} p_{o,t+1}(i) c_{t+1}(i)} < \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)}$$

Let $\overline{p}$ be the price of the lowest quality good in Ω'_{t+1}.

$$\frac{\sum_{\Omega'_{t+1}} \overline{p} c_{t+1}}{\sum_{\Omega'_{t+1}} p_{o,t+1}(i) c_{t+1}(i)} < \frac{\sum_{\Omega_t} \overline{p} c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)}$$

By construction, $\overline{p} \geq p(i)$ for all $i \in \Omega'_{t+1}$. Therefore, the right hand side is greater than one. By proposition 3.1, $\overline{p} < p(i)$ for all $i \in \Omega_t$. Therefore,

$$\frac{\sum_{\Omega'_{t+1}} \overline{p} c_{t+1}}{\sum_{\Omega'_{t+1}} p_{o,t+1}(i) c_{t+1}(i)} < 1 < \frac{\sum_{\Omega_t} \overline{p} c_{t+1}(i)}{\sum_{\Omega_t} p_{o,t+1}(i) c_{t+1}(i)}$$

□

The effect works in both directions: An increase in trade costs will also be underestimated. Higher trade costs will cause low quality, high trade cost goods to exit the trade market. The remaining goods are those with relatively low trade cost. Therefore, trade weighting will mute the rise in trade cost.

3.2 Intensive Margin

Changes in trade costs also lead to shifts in the relative trade among the goods that are consistently traded as well as their prices. These shifts also affect the measurement of trade costs. Changes in the specific trade cost F^s have a stronger impact on the trade of low quality goods than high quality goods, as shown in Lemma 3.3.

Lemma 3.3. *Suppose $F^s_{o,d,t+1} < F^s_{o,d,t}$. If good L is lower quality than good H ($a(L) < a(H)$) then $\frac{c_{t+1}(L)-c_t(L)}{c_t(L)} > \frac{c_{t+1}(H)-c_t(H)}{c_t(H)}$.*

Proof. If $\frac{c_{t+1}(L)-c_t(L)}{c_t(L)} > \frac{c_{t+1}(H)-c_t(H)}{c_t(H)}$, then $\frac{c_{t+1}(L)}{c_t(L)} > \frac{c_{t+1}(H)}{c_t(H)}$. Substituting in the solution for $c(i)$, we have:

$$[\frac{a(L)(1+\tau) + F^s_{o,d,t+1}}{a(L)(1+\tau) + F^s_{o,d,t}}]^{-\sigma} \geq [\frac{a(H)(1+\tau) + F^s_{o,d,t+1}}{a(H)(1+\tau) + F^s_{o,d,t}}]^{-\sigma}$$

Rearranging, $(a(L)(1+\tau)+F^s_{o,d,t})(a(H)(1+\tau)+F^s_{o,d,t+1}) \geq (a(H)(1+\tau)+F^s_{o,d,t})(a(L)(1+\tau) + F^s_{o,d,t+1})$ This expression yields: $(a(H) - a(L))F^s_{o,d,t} \geq (a(H) - a(L))F^s_{o,d,t+1}$. Since $a(L) < a(H)$, we have$F^s_{o,d,t} \geq F^s_{o,d,t+1}$, the maintained assumption. □

The *ad valorem* equivalent for specific costs are higher for low quality goods. Fixed costs have a smaller proportional effect on the final price of high quality goods, since the cost is spread over higher expenditures than low quality goods. Therefore, changes in freight costs affect demand for high quality goods less.

When the specific freight cost falls, the relative consumption of low quality goods increases. This shift dampens trade weighted freight costs. Since more trade is in low quality goods that have high *ad valorem* equivalent freight costs, the trade weighted measure falls less than the true cost, as shown in Proposition 3.4.

Proposition 3.4. *If* $F^s_{o,d,t+1} < F^s_{o,d,t}$, *then*

$$\frac{\sum_{\Omega_t} p_t(i)c_t(i)}{\sum_{\Omega_t} c_t(i)} \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{t+1}(i)c_{t+1}(i)} \frac{F^s_{o,d,t+1}}{F^s_{o,d,t}} > \frac{F^s_{o,d,t+1}}{F^s_{o,d,t}}$$

Proof. See appendix. □

Higher tariffs have the opposite effect. High tariffs reduce the importance of freight costs F^s on final price, increasing the relative trade of low quality goods. (This result was found in Hummels & Skiba (2004).) While falling tariffs have the opposite effect by increasing average quality, this shift does not have an effect on their measurement since *ad valorem* tariffs are the same regardless of quality.

There can be cross effects between the two types of trade costs. Falling tariffs will shift trade toward higher quality goods, which would reduce the *ad valorem* equivalent value of freight costs. This effect will cause trade weighting to overestimate the fall in freight costs. The is a countervailing force since falling tariffs will also induce entry of lower quality goods along the extensive margin.

4 Quantitative Results

This section examines the quantitative impact of fixed costs of trading on the measurement of trade costs for U.S. data. The data comes from the U.S. Bureau of the Census, as compiled by Hummels (2007)[1]. The data begin in 1974, the year that the United

[1]U.S. Import data described in Feenstra (1996) and Feenstra, Romalis & Schott (1996): Five digit SITC Revision 2 classification-country of origin pairs.

States began to collect import data both on a FOB and CIF basis[2]. Total trade cost are freight and tariffs and are weighted by the nominal share of total trade. Freight costs are the CIF/FOB ratio and tariffs are calculated duty over FOB imports for consumption.

A good is defined as a product-source country pair, where a product is a five digit SITC Revision 2 classification. This is the finest product classification that spans the data. The classification of imports has changed several times over the years. From 1974 to 1988, imports are classified using the Tariff Schedule of the United States Annotated (TSUSA). In 1989, data began to be collected under the Harmonized Schedule (HS). For comparability across the two time periods, I use the five digit SITC classification. The disadvantage of this system is that it is more aggregated. I check the robustness of the results using the finest level of data available for the two subperiods.

4.1 Extensive Margin

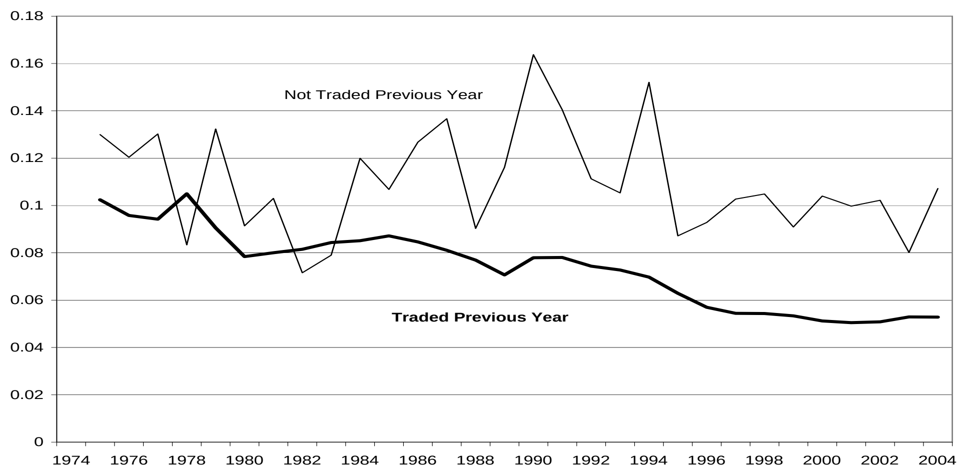
The extensive margin is an important source of trade growth globally (Evenett & Venables 2002). The period considered shows a significant increase in import relationships. In 1974, 29,486 goods were imported. In 2004, almost twice as many - 58,196 - were imported. A number of new countries were created during this period, increasing the possible goods (product-country pairs) that could be imported. The increase in goods traded was steady over the period, so it is not driven by this fact. There is evidence that falling trade barriers are an important source of growth along the extensive margin. For example, Kehoe & Ruhl (2003) show that the extensive margin is an important source of trade growth after major reforms, such as NAFTA, reduce trade barriers.

The model predicts that new goods should have higher trade costs compared to goods that are already traded. The data support this prediction. Figure 2 shows trade weighted import costs split into goods that were imported in the previous year and those that were not. New goods tend enter at higher trade cost than established goods, a tendency that has strengthened over time.

The evidence is consistent with fixed per unit freight costs. As top panel of Figure 3 shows, the cost to ship a ton of goods does not differ much between new and

[2]The United States actually collects a similar concept to FOB, Free Along Side or FAS. This is the value at the port of exit rather than on the vessel at the port of exit.

Figure 2: Tariffs and Freight by New and Old Goods 1975-2004



old goods. The tariffs faced by each good also does not differ much, as can be seen in middle panel of Figure 3. Rather, it is due to the lower unit value of new goods, as can be seen in bottom panel of Figure 3. The data are consistent with fixed costs of trading and productive firms being the most able to produce high quality (high unit value) goods. The lower unit value to new goods may indicate that they are of lower quality than previously traded goods.

Further evidence of specific freight rates comes from oil products during the 1970s. As seen in Figure 4, the large run-up in oil prices in the 1970s coincides with a large decline in *ad valorem* freight rates. However, the freight rate per ton shows a significant increase. Additional evidence of fixed trade cost can be found in Hummels & Skiba (2004) and Alessandria, Kaboski & Midrigan (2008).

The presence of specific trade costs can lead to shifts to low trade cost goods for counterintuitive reasons. For inelastic goods such as oil, an increase in prices will lead to an increase in nominal import share despite the real quantity imported falling: the effect

Figure 3: Trade Weighted Import Costs of New and Old Goods 1975-2004

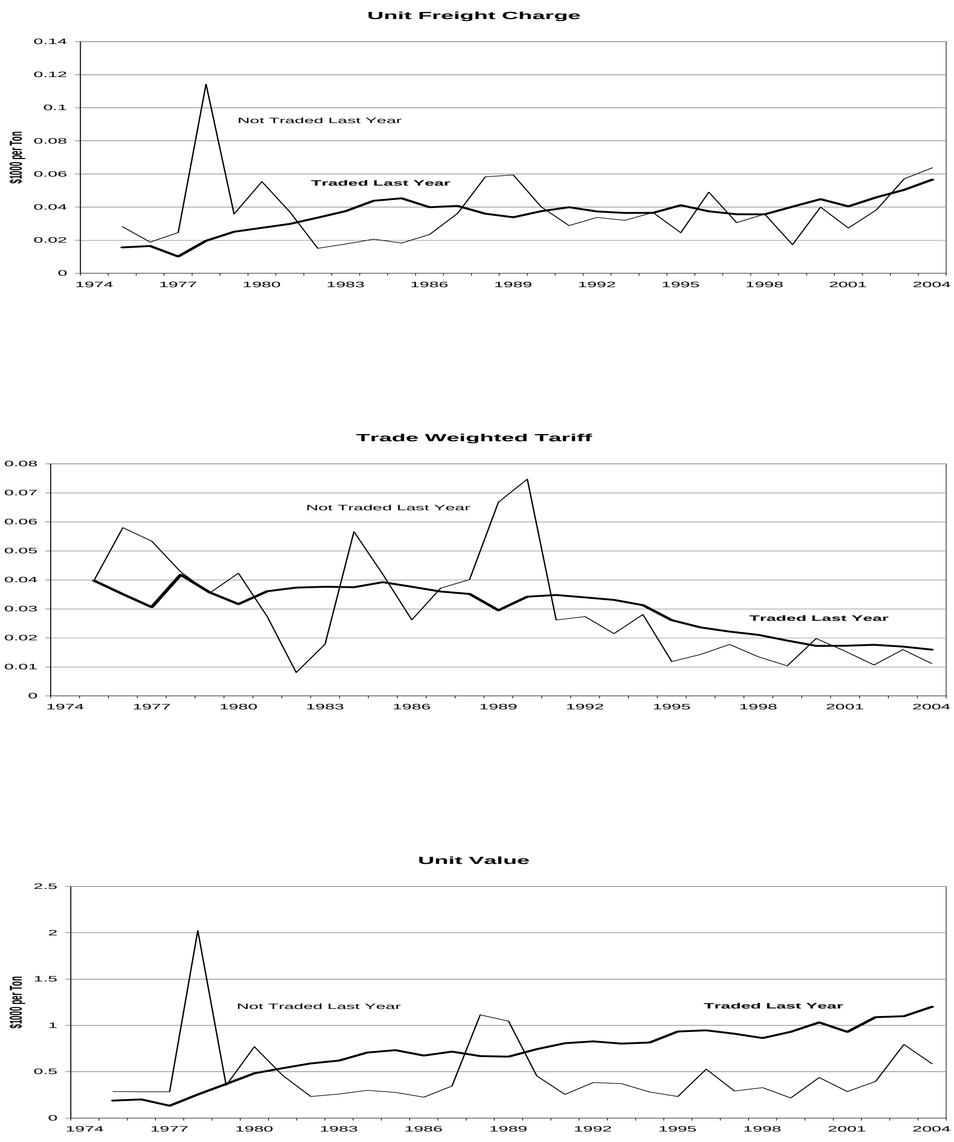
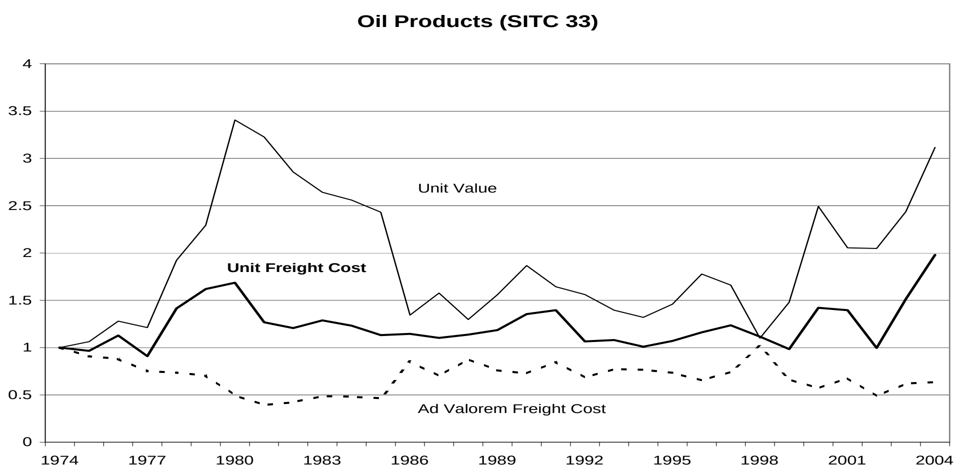


Figure 4: Oil Prices and Freight Rates 1974-2004



of the price increase dominates that of falling quantity. At the same time, *ad valorem* trade costs fall. Therefore, it will appear with trade weighting that lower trade costs led to a shift to a lower cost good when, in fact, real trade in that good fell.

4.2 Intensive Margin

To control for shifts among goods that were already traded, I use indices drawn from the price measurement literature. These measures have been created to explicitly deal with the problems of changes in trade composition[3].

Import share of good j is given by $\omega_j = \frac{p_t(j)m_t(j)}{\sum_t(j)p_t^{FOB}(j)m_t(j)}$ where $m_t(j)$ is imports and $p_t^{FOB}(j)$ the world (FOB) price of good j. Trade costs are the sum of *ad valorem* tariffs $\tau_t(j)$ and freight $f_t(j) = \frac{p_t^{CIF}(j)}{p_t^{FOB}(j)} - 1$.

I calculate three forms of trade cost indices. The Laspeyres index I^L weights

[3]See Feenstra (2004) for a discussion of price indices in international economics.

prices using the base period quantities.

$$I_t^L = \frac{\sum_j (\tau_t(j) + f_t(j))\omega_0(j)}{\sum_j (\tau_0(j) + f_0(j))\omega_0(j)} \tag{4.1}$$

The Paasche index I^P weights prices using current quantities.

$$I_t^P = \frac{\sum_j (\tau_t(j) + f_t(j))\omega_t(j)}{\sum_j (\tau_0(j) + f_0(j))\omega_t(j)} \tag{4.2}$$

The Fisher index I^F is the geometric mean of the two indices.

$$I_t^F = \sqrt{I_t^P * I_t^L} \tag{4.3}$$

I use chain weighting, where the base year in period t is the previous period $t-1$. This method is used in the GDP accounts.

The indices allow us to examine the impact of shifting on the measurement of trade costs. The Laspeyres index shows changes in trade costs using the base year's import shares. Therefore, it allows us to examine what trade costs would have been if there had been no change in composition.

The Paasche index tracks the mirror case: What would trade costs have been in the base period using current trade weights. This measure tracks the change in trade costs of currently traded goods.

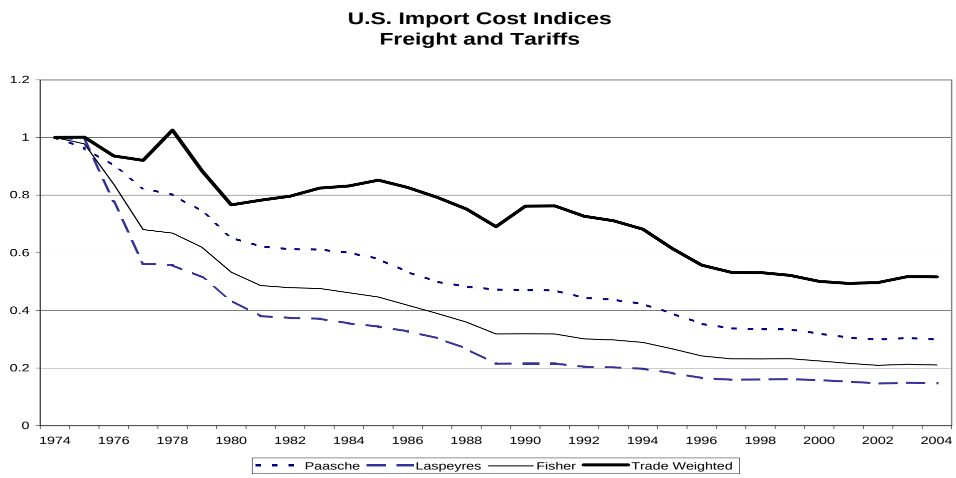
The Fisher is the geometric average of these two effects. A Fisher price index is used to deflate nominal imports in the National Income and Product Accounts.

These measures do not include new goods. If a good was not traded in the previous period, it is dropped from the index. The indices can only diagnose composition changes among previously traded goods.

Unlike the model based methods, patterns of substitution are derived directly from the data. These measures have the advantage of not imposing much structure on the data. We do not need to make a stand on preferences or technology. They allow us to examine the change in trade costs holding trade shares constant without needing to know why trade shares changed. They are also relatively easy to implement.

Figure 5 shows the three trade cost indices and trade weighted U.S. import costs. The pattern of the decline is similar across the four measures, but all three indices fall

Figure 5: U.S. Import Cost Indices, 1974-2004



faster than the trade weighted measure. Trade weighted import costs fall almost 50 percent while the indices fall by more than 70 percent.

Trade is shifting *toward* relatively expensive goods to ship. The Laspeyres index falls 85 percent, significantly more than the 70 percent drop in the Paasche index. Shifting to the previous pattern of trade would drop trade costs of continuing goods in half. This finding is surprising given that the concern with trade weighted measures is that cost may be hidden by shifts away from high cost goods.

The trade weighted measures still fall significantly less than the index measures, even taking into account the shift to costlier to import goods. Total trade weighted costs are 20 percentage points higher than the Paasche index. The remaining gap reflects the entry of new goods. As noted above, the indices miss an important part of the change in composition of trade since it does not include import cost changes of newly imported goods. Since there is no observed import cost in the previous year, they are dropped from the indices. Therefore, these indices only measure import cost changes of continuing goods.

These patterns hold up if we examine the types of import costs separately. Figure 6 shows separate freight and tariffs indices respectively. The composition effect appears to be strongest in tariffs. Trade weighted tariffs do not fall much until the mid-1990s while the index measures fall consistently through the period. The Fisher index more closely matches the trade weighted index for freight. Freight costs fall from their oil shock highs and remain relatively flat afterward. (See Bridgman (2008) for a discussion of the role of oil prices in transportation costs.)

These indices are useful for examining how much trade weighting obscures changes in import costs, they are not as useful for examining some related issues without imposing additional structure. They are only measure changes in trade costs, not the correct "height" of trade barriers. They are not necessarily measures of welfare or trade expansion. While it is intuitive to think that falling trade costs should lead to trade growth and welfare gains, the link between the two is surprisingly complex. In fact, changes in trade costs that improve market access may reduce welfare (Anderson & Neary 2007).

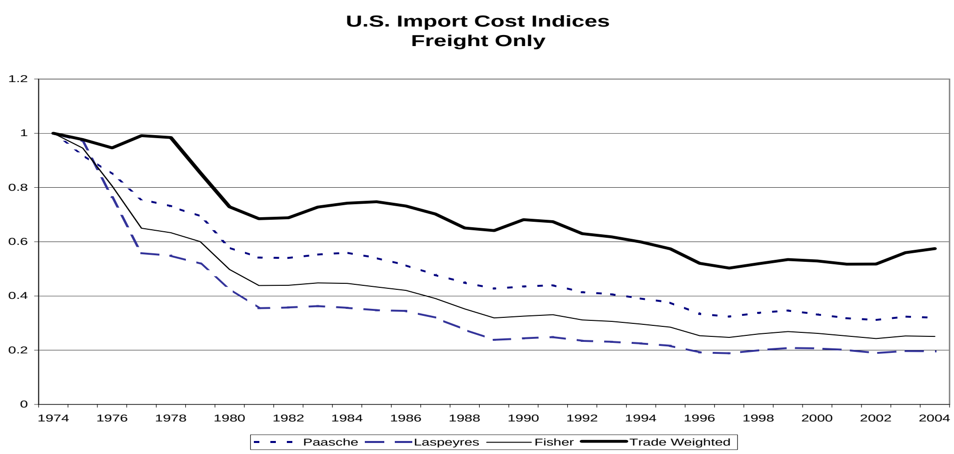
4.3 Implications

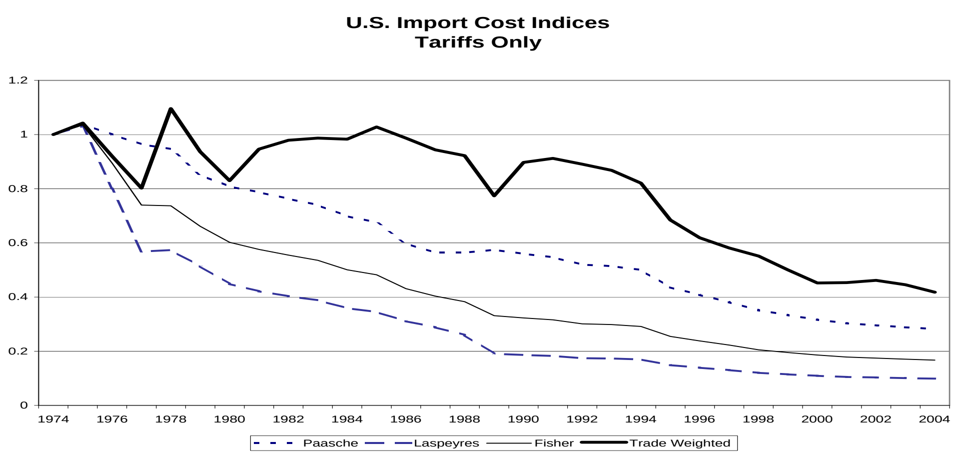
The data results are suggestive that trade cost declines are significantly understated by trade-weighted measures. For goods that we have direct measures, the continuing goods, trade costs fall much further than the trade weighted measure. The Laspeyres index of import cost falls 70 percent more than the trade-weighted version.

We cannot observe the change in trade costs of newly traded goods since they were not traded, (the "new goods problem" in price index theory). Therefore, we cannot say with certainty whether new goods were traded due to an overall trend downward in trade costs or an idiosyncratic changes.

Under the assumption that trade cost changes are indicative of all goods, trade weighted measures miss half of the fall in trade costs. Yi (2003) states that a 15 percentage point drop in trade barriers needs to explain a 210 percent increase in trade. A trade elasticity of 15 is required to obtain this result in standard trade models, which is significantly higher than most empirical estimates. If trade barriers are understated by half, they fell by 30 percentage points and trade elasticity only needs to be 6.3. Notably,

Figure 6: U.S. Import Cost Indices by Component





this estimate is close to the 6.4 elasticity found by Ruhl (2005) for permanent changes in trade costs and is similar to other estimates of the elasticity. While this calculation is a back of the envelope estimate, it suggests that quality shifts are an important piece of the puzzle in explaining the trade elasticity puzzle.

4.4 Robustness

Generally speaking, the only way a truly new good can enter is if a country begins to export in an SITC category it did not previously. The SITC codes are complete classification, even if some of those categories are miscellaneous categories. A new invention would be placed in a pre-existing code. However, the SITC is an international classification, so not all goods need be imported into the United States even if they exist.

I also redid the analysis using the finest levels of classification available. The results were somewhat stronger. For example, the Fisher index falls 70 percent from 1974 to 1988 compared to 62 percent using the SITC classification. Disaggregating the classifications increases the scope for new goods and shifts across classifications. Blonigen & Soderbery (2009) examine automobile trade using a finer classification system than the HS codes and find that substantial entry and exit of goods are missed. Therefore the results may substantially underestimate the impact of new goods on the measurement of trade costs.

I also did the analysis defining a good as only an SITC code without country detail. The qualitative results are similar, but the magnitude of the decline is muted. The total trade costs Fisher index falls only 66 percent from 1974 to 2004 versus 79 percent with country detail.

The more aggregated version removes some of the margin for the extensive margin to matter. If a new country enters the market with a good that is already imported from another country, the initial trade cost for the new country is included whereas it is excluded in the baseline case. As seen above, new sources of imports tend to enter at costs above those of existing traders. Therefore, falling trade costs will tend to be muted. Even without the country detail, trade costs do fall significantly. The decline is not driven by new countries.

5 Conclusion

This paper explores the effects of composition change on aggregate measures of trade costs. For earlier data, composition changes tend to overstate the fall in trade costs as imports shift to goods that cost less to trade. Since the 1970s, there has been a counterintuitive shift toward high trade cost goods as falling trade costs have made low value goods more economical to trade. This tendency has the opposite effect of muting falling import costs in trade weighted measures.

The results also highlight a new good problem in measuring trade costs. The expansion of trade along the extensive margin means that there are a large number of goods for which we cannot directly measure the change in trade costs. The evidence is consistent with new goods having similar per unit import costs, but having lower unit values.

6 Appendix: Omitted Proofs

Proof for Proposition 3.4:

Proof. Expanding terms:

$$\frac{\sum_{\Omega_t} p_t(i)c_t(i)}{\sum_{\Omega_t} c_t(i)} \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{t+1}(i)c_{t+1}(i)} = \frac{\sum_{\Omega_t} p_t(i)c_t(i)}{\sum_{\Omega_t} p_{t+1}(i)c_t(i)} \frac{\sum_{\Omega_t} p_{t+1}(i)c_t(i)}{\sum_{\Omega_t} c_t(i)} \frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{t+1}(i)c_{t+1}(i)}$$

Since $F^s_{o,d,t+1} < F^s_{o,d,t}$, $p_t(i) > p_{t+1}(i)$ for all i. Therefore, the first term on the RHS is greater than one.

Define $c_{t+1}(i) = c_t(i) + \Delta c(i)$. The remaining two terms are greater than one if:

$$\frac{\sum_{\Omega_t} c_{t+1}(i)}{\sum_{\Omega_t} p_{t+1}(i)c_{t+1}(i)} < \frac{\sum_{\Omega_t} c_t(i)}{\sum_{\Omega_t} p_{t+1}(i)c_t(i)}$$

Cross-multiplying:

$$\frac{\sum_{\Omega_t} c_t(i) + \Delta c(i)}{\sum_{\Omega_t} c_t(i)} > \frac{\sum_{\Omega_t} p_{t+1}(i)(c_t(i) + \Delta c(i))}{\sum_{\Omega_t} p_{t+1}(i)c_t(i)}$$

$$\frac{\sum_{\Omega_t} \Delta c(i)}{\sum_{\Omega_t} c_t(i)} > \frac{\sum_{\Omega_t} p_{t+1}(i)(\Delta c(i))}{\sum_{\Omega_t} p_{t+1}(i)c_t(i)}$$

$$\sum_{\Omega_t} \Delta c(i) \sum_{\Omega_t} p_{t+1}(i)c_t(i) > \sum_{\Omega_t} c_t(i) \sum_{\Omega_t} p_{t+1}(i)(\Delta c(i))$$

This statement is true for an arbitrary number of varieties N. We establish the result by induction. For $N = 2$, where $a(H) > a(L)$.

$$\begin{aligned}(\Delta c(H) + \Delta c(L))(p_{t+1}(H)c_t(H) + p_{t+1}(L)c_t(L)) \\ > (c_t(H) + c_t(L))(p_{t+1}(H)\Delta c(H) + p_{t+1}(L)\Delta c(L))\end{aligned}$$

Expanding and collecting terms:

$$(p_{t+1}(H) - p_{t+1}(L))c_t(H)\Delta c(L) > (p_{t+1}(H) - p_{t+1}(L))c_t(L)\Delta c(H)$$

$$\frac{\Delta c(L)}{c_t(L)} > \frac{\Delta c(H)}{c_t(H)}$$

By Lemma 3.3, this statement is true, establishing the result.

Suppose the statement is true for N. Then for it to be true for $N+1$ where $a(i) < a(i')$ for $i < i'$, the following inequality must hold for the additional terms:

$$\begin{aligned} c_t(1)p_{t+1}(N+1)\Delta c(N+1) + ... + c_t(N)p_{t+1}(N+1)\Delta c(N+1) \\ + \Delta c(N+1)c_t(1)p_{t+1}(1) + ... + \Delta c(N+1)c_t(N)p_{t+1}(N) \\ \geq c_t(1)p_{t+1}(1)\Delta c(1) + ... + c_t(N)p_{t+1}(N+1)\Delta c(N+1) + \\ \Delta c(1)c_t(N+1)p_{t+1}(1) + ... + \Delta c(N)c_t(N+1)p_{t+1}(N) \end{aligned}$$

Collecting terms:

$$\begin{aligned} \sum_{i=1}^{N} p_{t+1}(N+1)c_t(N+1)\Delta c(i) - p_{t+1}(i)c(N+1)\Delta c(i) \\ - p_{t+1}(N+1)c_t(i)\Delta c(N+1) + p_{t+1}(i)c_t(i)\Delta c(N+1) \geq 0 \end{aligned}$$

$$\sum_{i=1}^{N} p_{t+1}(N+1)(c_t(N+1)\Delta c(i) - c(i)\Delta c(N+1)) - p_{t+1}(i)(c_t(N+1)\Delta c(i) - c_t(i)\Delta c(N+1)) \geq 0$$

Since $p_{t+1}(N+1) > p_{t+1}(i)$, the statement is true if $c_t(N+1)\Delta c(i) \geq c_t(i)\Delta c(N+1)$. By Lemma 3.3, this statement is true, establishing the result.

□

References

Alchian, Armen & William R. Allen (1964), *University Economics*, Wadsworth, Belmont CA.

Alessandria, George, Joseph Kaboski & Virgiliu Midrigan (2008), Inventories, lumpy trade and large devaluations, Working Paper 13790, NBER.

Anderson, James E. & Eric van Wincoop (2004), 'Trade costs', *Journal of Economic Literature* **42**(3), 691–751.

Anderson, James E. & J. Peter Neary (1996), 'A new approach to evaluating trade policy', *Review of Economic Studies* **63**, 107–125.

Anderson, James E. & J. Peter Neary (2003), 'The merchantalist index of trade policy', *International Economic Review* **44**(2), 627–649.

Anderson, James E. & J. Peter Neary (2007), 'A new approach to evaluating trade policy', *Journal of International Economics* **71**, 187–205.

Arkolakis, Costas (2009), Market access costs and the new consumers margin in international trade, Working Paper 14214, NBER.

Bach, Christian F. & Will Martin (2001), 'Would the right tariff aggregator of policy analysis please stand up?', *Journal of Policy Analysis* **23**(4), 621–635.

Bach, Christian F. & Will Martin (2005), Keeping the devil in the details: A feasible approach to aggregating trade distortions, mimeo, World Bank.

Baldwin, Richard & James Harrigan (2008), Zeros, quality and space: Trade theory and trade evidence, Working Paper 13214, NBER.

Berman, Nicholas, Phillippe Martin & Thierry Mayer (2009), How do different exporters react to exchange rate changes?: Theory, empirics and aggregate implications, Discussion Paper 7493, CEPR.

Blonigen, Bruce & Anson Soderbery (2009), Measuring the benefits of product variety with an accurate variety set, Working Paper 14956, NBER.

Bridgman, Benjamin (2008), 'Energy prices and the expansion of world trade', *Review of Economic Dynamics* **11**(4), 904–916.

Cipollina, Maria & Luca Salvatici (2007), Measuring protection: Mission impossible?, Working Paper 06/07, TradeAG.

Crucini, Mario J. (1994), 'Sources of variation in real tariff rates: The United States, 1900-1940', *American Economic Review* **84**(3), 732–743.

Eaton, Jonathan & Samuel Kortum (2002), 'Technology, geography, and trade', *Econometrica* **70**(5), 1741–1779.

Estevadeordal, A., B. Frantz & Alan M. Taylor (2003), 'The rise and fall of world trade, 1870-1939', *Quarterly Journal of Economics* **118**(2).

Evenett, Simon J. & Anthony J. Venables (2002), Export growth in developing countries: Market entry and bilateral trade flows, Working paper, London School of Economics.

Feenstra, Robert C. (1996), U.S. imports, 1972-1994: Data and concordances, Working Paper 5515, NBER.

Feenstra, Robert C. (2004), *Advanced International Trade: Theory and Evidence*, Princeton University Press, Princeton.

Feenstra, Robert C., John Romalis & Peter K. Schott (1996), U.S. imports, exports and tariff data, 1989-2001, Working Paper 5515, NBER.

Gervais, Antoine (2008), Vertical product differentiation, endogenous technological choice and taste for quality in a trading economy, mimeo, University of Maryland.

Harrigan, James (2009), Airplanes and comparative advantage, mimeo, University of Virginia.

Hummels, David (2007), 'Transportation costs and international trade in the second era of globalization', *Journal of Economic Perspectives* **21**(3), 131–154.

Hummels, David & Alexandre Skiba (2004), 'Shipping the good apples out?: An empirical confirmation of the Alchian-Allen conjecture', *Journal of Political Economy* **112**(6), 1384–1402.

Hummels, David & Georg Schaur (2009), Hedging price volatility using fast transport, Working Paper 15154, NBER.

Hummels, David, Volodymyr Lugovskyy & Alexandre Skiba (2009), 'The trade reducing effects of market power in international shipping', *Journal of Development Economics* **89**(1), 84–97.

Jacks, David S. (2006), 'New results on the tariff growth paradox', *European Review of Economic History,* **10**, 205–230.

Kehoe, Timothy J. & Kim J. Ruhl (2003), 'How Important is the New Goods Margin in International Trade?', *Federal Reserve Bank of Minneapolis Staff Report* **324**.

Krugman, Paul (1995), 'Growing world trade: Causes and consequences', *Brookings Papers on Economic Activity* **1995**(1), 327–377.

Levinson, Marc (2006), *The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger*, Princeton University Press, Princeton.

Manova, Kalina & Zhiwei Zhang (2009), Export prices and heterogeneous firm models, mimeo, Stanford University.

Melitz, Marc J. (2003), 'The impact of trade on intra-industry reallocations and aggregate industry productivity', *Econometrica* **71**(6), 16951725.

Novy, Dennis (2006), Is the iceberg melting less quickly?: International trade costs after World War II, mimeo, Cambridge University.

Oksanen, Ernest & James R. Williams (1979), 'Measuring the rate of protection with index numbers', *Economics Letters* **4**, 65–68.

O'Rourke, Kevin H. (1997), 'Measuring protection: A cautionary tale', *Journal of Development Economics* **53**(1), 169–183.

Ruhl, Kim J. (2005), Solving the elasticity puzzle in international economics, mimeo, University of Texas.

Ruhl, Kim J. & Jonathan Willis (2009), New exporter dynamics, mimeo, New York University.

Sanghamitra Das, Mark J. Roberts & James R. Tybout (2007), 'Market entry costs, producer heterogeneity, and export dynamics', *Econometrica* **75**(3), 837873.

Yi, Kei-Mu (2003), 'Can vertical specialization explain the growth of world trade?', *Journal of Political Economy* **111**(3), 52–102.