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Price Dispersion and the Effectiveness of Integration Efforts

Abstract:

Using a specifically developed measure I find evidence that NAFTA, MERCOSUR, and EU membership are significantly correlated with decreased price dispersion. This suggests that these agreements have increased market integration beyond what can be explained by decreases in tariffs rates and foreign exchange volatility. Moreover I find that APEC, though seemingly less substantial, is also correlated with decreased price dispersion. This suggests that additional factors, including perhaps the development of trading networks, are important to increasing global market integration.

Part I

I) Introduction

Many believe that economic, political, and technological changes are reducing the costs of international trade and significantly increasing global integration. Empirical evidence, however, suggests that this is not the case. Persistent deviations from purchasing power parity exist, and the vast majority of trade is still conducted within nations' borders. This prevents producers from fully benefitting from comparative advantages, resulting in what is estimated at several trillion dollars of deadweight loss worldwide per year[1].

Moreover, empirical evidence suggests that free trade and growth are inexorably linked. In fact, Frankel and Romer have shown that "the relation between the geographic component of trade and income suggests that a rise of one percentage point in the ratio of trade to GDP increases income per person by at least one-half percent."[2] The most obvious attempts to better integrate international markets are free trade agreements and currency arrangements. It is important, therefore, to properly assess the effect of these agreements. Parsley and Wei (2002) shows that price-based measures indicate a positive effect on integration from a variety of both free trade and currency agreements[3]. Although Parsley and Wei develop a sophisticated dispersion measure, their analysis does not consider annual trends.

By measuring price dispersion annually, I am able to differentiate between levels of integration before and after important integration efforts. Moreover, I am able to show how quickly integration efforts have a measurable effect on the region. In this way, I find evidence that NAFTA, the EU, and MERCOSUR have led to significant price convergence in their

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[1] Hufbauer, G (2002)
[2] Frankel and Romer (1999)
[3] Furthermore, they find the size of potential benefits differ greatly. Reducing nominal exchange variability results in significant market integration, but hard pegs appear more effective. Also, they find that the largest integration comes from a mixture of both political and economic integration (page 13).

adopting countries. Moreover, the price convergence occurring during these agreements goes beyond what can be explained by absence of tariffs and foreign exchange volatility. Lastly, I attempt a very different specification for my price dispersion measure and find that results are quite similar. This suggests that my findings are fairly robust to changes in specification.

II) Literature Review:

Due to the forces of arbitrage, the Law of One Price (LOP) states that the price of any good should be the same in two different places. If two prices were found to be unequal, a business savvy individual could buy low and sell high, reaping profits. Although in theory world prices should be equal for identical goods, failures of LOP abound; often, substantial price differences for the same good can be found even within walking distance. LOP thus fails in the strictest sense. Price dispersion measures, or measures of how similar prices are, prove a useful tool for estimating integration. One would expect arbitrage to close price gaps quickly between two well-integrated locations, while larger gaps may persist between two locations that trade only with difficulty. For instance, one would expect New York and Dallas to have lower levels of price dispersion than locations such as Baghdad and Tokyo. By measuring the degree of arbitrage between two locations, LOP can provide insight into relative levels of economic integration.

One of the earliest statistical investigations of price dispersion, Engel and Roger (1996), has served as the benchmark. This work focuses on two measurable trade obstacles: distance and international borders. Distance serves as a proxy for transportation costs, risk, and disparity between nontradable inputs such as labor and rent. International borders work to prevent arbitrage by introducing artificial obstacles such as tariffs, non-tariff barriers, exchange rate

volatility, etc[4]. Using highly aggregated price indices, both distance and border effects prove to be significant between the United States and Canada. Surprisingly, however, the border effect dominates. Even though the border between the United States and Canada is highly permeable, it acts as an obstacle equivalent in magnitude to 75,000 miles. Interestingly, Engel and Roger find no measurable improvement in price dispersion between the two nations after the introduction of the Canada - US Free Trade Agreement[5].

A more formal investigation into the effects of international integration efforts can be found in Parsley & Wei's 2002 working paper "Currency Arrangements and Good Market Integration: A Price-Base Approach." They find both exchange rate variability and trade barriers to be correlated with higher levels of price dispersion. Moreover, they find that integration levels are much higher for nations adopting a hard peg than what can be explained by theoretically reducing exchange rate volatility to zero. Similarly, their research suggests that membership in a free trade agreement causes much more integration than would occur from simply reducing average tariff rates to zero. That is, agreements like NAFTA and the EU may lead to more convergence than can be explained by tariff and exchange rate changes alone.

Using the highly disaggregated price data of the EIU *Cost of Living Survey*, I expand upon these works to more explicitly measure the effects of international agreements on price convergence. While Parsley and Wei succeed in showing that price dispersion can properly measure integration efforts, they do not consider annual dispersion trends. Considering annual trends allows one to observe precisely when evidence of integration appears in the data. Although one would expect lower levels of price dispersion for NAFTA countries, the agreement

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[4] The many obstacles to arbitrage are discussed at length in Rogoff (1996) "The Purchasing Power Parity Puzzle"
[5] In a similar work Ceglowski (2003) finds Canada's provincial border s equivalent to 1,300 miles. Moreover, Asplund and Friberg (2001) find significant price dispersion for identical goods with prices listed in several currencies in duty free shops.

itself cannot be deemed the cause unless dispersion decreases in the appropriate years. Moreover, I consider a wider array of agreements, and find that even less successful agreements such as MERCOSUR may help increase market integration in the region. Lastly, I propose a modification to the Parsley and Wei dispersion measure but find that it produces very similar results suggesting my results are robust to specification changes.

III) Data

My observations come from the EIU *Cost of Living* survey, which offers annual observations of highly disaggregated price data. This data includes observations for a total of over 160 distinct goods (1 pound of apples, 1 day rental of economy car, etc) in 122 cities, from 77 countries annually from 1990 to 2003. I remove from the dataset all observations related to both Africa and the Middle East, which have a high percentage of missing observations. Moreover, I do not include observations related to nontradable goodswhich are not easily arbitraged and would not be quickly influenced by the integration efforts on which I focus[6]. After eliminating this data, I convert all prices from their local currency to US dollars using the EIU's provided spot exchange rate. With this data, my dependent variable measures annual levels of price dispersion between each two cities and is developed as follows.

Unfortunately, measures of price dispersion abound and have mostly been developed atheoretically. In fact, theoretical flaws have been identified for most of the commonly applied types of price dispersion measures[7]. This encourages a thorough theoretical investigation of the comparative merits of different measures of price dispersion. In fact, one forthcoming work

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[6] Because the distinction between tradable and nontradable goods can be subtle, I will use the designations found in Anderson and Smith (2004)

Anderson and Van Wincoop (2004) provides a very detailed explanation of the different types of dispersion measures and finds all to be fundamentally flawed for a variety of reasons.

suggests that applying different dispersion measures may yield significantly different results in both descriptive time series and regression analysis[8]. In order to prevent furthering the proliferation of price dispersion measures, I will employ the existing measures which seem best suited for this purpose.

Most price dispersion measures are, at their most basic level, a log ratio of prices between two locations, with prices expressed in some common currency. In order to keep all data points in the first quadrant, I will arrange all data such that the larger priced city will by denoted i. I refer to this ratio as $Q_{ij,k,t}$.

$$1) \qquad Q_{ij,k,t} = \ln(USP_{i,k,t}/USP_{j,k,t}) \text{ [9]}$$

A log price ratio shows how large a gap is between two prices for a given city, good, and time[10]. Although some measure market integration by averaging the log price differences, this is likely not the best approach. In their article "Trade Costs" Anderson and Van Wincoop compare dispersion measures to actual trade cost estimates and find that "average price dispersion measures are not very informative about trade costs, [but] the variation of price dispersion across location pairs and goods is." Similarly, Parsley and Wei say of measuring trade costs with average price dispersion measures:

> "This would not be appropriate. Intuitively, (only) once the price differential goes outside of a band, arbitrage actively becomes profitable and is likely to bring prices back inside the band. Within the band however, any realization of the price differential is possible." (Parsley and Wei, 2002, page 8)

Because current research suggests that average price dispersion measures are not as effective as measures using variation of price dispersion, I will focus on such a measure.

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[8] Anderson and Smith. Forthcoming.

[9] In data discussions, I will use standard abbreviations as follows:
t = year, k = good, i / j = city, ij = city pair, m = month, * = average

[10] This price ratio alone is often used to measures price dispersion. Anderson & Smith (2004) applies the average of log price ratios to show that the border effect is found globally. Bergin & Glick (2007) use a slightly more nuanced aggregation of log price differences to observe global price dispersion trends. For reasons explained later, this would not be suitable for my purposes.

The two most common measures using variation of price dispersion appear in Parsley and Wei (2002) and Parsley and Wei (2001). The measure in Parsley and Wei 2001 uses standard deviations across time of changes in price dispersion for each good and city pair. Contrastingly, Parsley and Wei 2002 measures integration with the standard deviation of price dispersion across goods for each city pair and year. Because I aim to observe time differences between different city pairs, only the latter measures would be appropriate[11]. Unfortunately, this method is complicated by the difference in average price dispersion for different goods. The different magnitude of prices will not affect the standard deviation because the base measure is log ratios. However, as Parsley and Wei note, "the magnitude of deviation from the law-of-one-price may depend on the type of product." For example, it would not be reasonable to compare the deviation of car prices to that of rice because these two goods are not as easy to arbitrage. For this reason, like Parsley & Wei, I will demean all price ratios with respect to good type.

$$2) \qquad Q_{ij,k,t}-Q_{k,t}^* \text{ where } Q_{k,t}^* = avg_{k,t}(Q_{ij,k,t})$$

I will then measure the deviation of demeaned price ratio across goods annually for each year. Parsley and Wei measure the band of arbitrage in a variety of ways and find that range, interquartile range, and standard deviation all offer similar results. With this in mind, I will use only the standard deviation. Thus, my price dispersion measure will be an annual observation for each city pair of the standard deviation across goods of demeaned log price ratios.

$$3) \qquad PD_{ij,t} = SD_k\,(Q_{ij,k,t} - Q_{k,t}^*) \qquad [12]$$

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[11] In theory, one could also look at deviation across location or time, but these would collapse the data in an undesired dimension. That is, by collapsing across year, I would be unable to observe any annual trends. Collapsing across location would be similarly undesirable. For this reason, the dispersion measures used by Parsley and Wei (2001), Engel and Roger (1996), and many others would be inappropriate.

[12] Price dispersion is unique for city pairs (ij) and time (t). It is a standard deviation across goods (k) of the difference between log price ration (Qij) and average log price ration (Qij*).

To give this variable some perspective, I will now provide some summary statistics. In my sample, this price dispersion ranges from a low of 0.15 found in Madrid-Barcelona 1990 to a high of 2.15 found in Belgrade-Tunis 1993. As one would expect, the least dispersion is found between two cities spaced very near one another and within the same nation. Similarly, the most dispersion is found between two underdeveloped cities located in different nations. For all observations, dispersion has an average of 0.54 and standard deviation of 0.2. City pairs within the United States show much lower dispersion; they range from 0.18 to 0.64, with an average of 0.35 and a standard deviation of 0.09. For city pairs belonging to the European Union as of 1990, dispersion ranges from 0.15 to 0.69 and has an average of 0.39 and standard deviation of 0.08. Figure 0.1 shows that the annual averages in $PD_{ij,t}$ differ only slightly from year to year.

I will also consider an array of explanatory variables. I will use greater-circle distance to measure the space between each two city pairs. I will also consider tariff rates. Although there is no question that non-tariff barriers to trade create significant obstacles to arbitrage, calculating a precise measures for NTBs would be very difficult. For this reason I will use only tariff levels to measure anti-trade policy. Unfortunately, the best available tariff data comes from the WTO's average annual external tariff rates for each nation [13]. Because only each nation's averages are available, there is no way to truly gauge the trade barrier between any two cities. While this measure of tariff levels is not perfect, it will provide some measure of each nation's openness to trade and is the best available.

To better approximate tariffs between two cities engaging in free trade, Parsley and Wei set tariffs to zero for all same-country city pairs, as well as pairs within one of four major regional trade groups. In order to better approximate international tariff rates, I consider the

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[13] The WTO's tariff data is available at http://iaf.wto.org/English/Welcome.asp

entire list of WTO accepted regional trade agreements[14]. With this list, I have set to zero all city pairs considered by Parsley and Wei, as well as all other city pairs belonging to a listed RTA after its entry into force. With this paired tariff data, I create my tariff measure T_{ij} as the sum of tariffs in cities i and j.

$$4) \qquad T_{ij,t} = T_i + T_j$$

Again, Parsley and Wei consider several other specifications of this tariff variable, including sum and mean, but find the effect of tariffs unchanged. For this reason, I will only consider the sum.

Also, I include a measure of exchange rate volatility. Monthly exchange rates to SDR are available from the IMFs "International Financial Statistics" database [15]. By dividing pairs of exchange rates to SDR, I construct bilateral exchange rates for each of my city pairs (the following process can be ignored for same-currency city pairs where exchange volatility is set to zero).

$$5) \qquad FX_{ij,t} = SDR_i/SDR_j$$

With this, I generate monthly change in exchange rate

$$6) \qquad DeltaFX_{ij,t} = FX_{ij,t} - FX_{ij,t-1}$$

Although Parsley and Wei (2002) measured exchange volatility as the standard deviation of monthly changes in exchange rates each year, this seems improper. As with goods, the average exchange rates vary quite a bit among the different city pairs. In fact, the average monthly change in bilateral exchange rate ranges from 0 to 452,630. Standard deviations would thus be systematically higher for city pairs where foreign exchange rates have a larger magnitude. To reduce this effect, I instead measure exchange rate volatility by the coefficient of variation of monthly changes in bilateral exchange rate. My measures of foreign exchange volatility is thus

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[14] WTOs regional trade agreements is available at http://www.wto.org/english/tratop_e/region_e/eif_e.xls
[15] International Financial Statistics: http://www.imfstatistics.org/imf/

the standard deviation of monthly changes in bilateral exchange rate over a one year period, divided by the annual average monthly change for that year.

$$6) \qquad FXvol_{ij,t} = (SD\ (DeltaFX_{ij,m})) / DeltaFX_{ij,m}*$$

Nontradable inputs such as labor and rent will be controlled for by city fixed effects, but I will also control more explicitly for these inputs using proxy variables. Although annual wage data are available for many nations, it is not present in the EIU data with sufficient frequency and will not allow for any comparison among same-country pairs. Moreover, little disaggregate income data is available at the city level. For this reason, although babysitter wages are not an ideal measure, this is the only low skilled labor data sufficiently available at the city level. Although this is an imperfect measures of wages, one would imagine wages for a babysitter to be associated with that of other low-skilled laborers. Similarly, although there are data for office building rent and factory space per square foot, it is absent from the majority of the dataset. For this reason, I will use instead monthly rent for a one-bedroom apartment. Again, although this is an imperfect proxy for building/land costs, one would expect an association between input related rents and apartment prices[16].

$$7) \qquad L_{ij,t} = (BBY_{i,t}/BBY_{j,t})$$

$$8) \qquad R_{ij,t} = \ln(APT_{i,t}/APT_{j,t})$$

[16] Where $BBY_{j,t}$ and $BBY_{i,t}$ are the cities' babysitter wages and $APT_{i,t}$and $APT_{j,t}$ are apartment rent prices.

IV) Empirical Models:

I will use the price dispersion measure described above to identify changes following the introduction of a major integration effort. To follow annual trends in the effect of each agreement I create interaction terms for each year and agreement[17]. But first, it is important to establish a baseline for comparison. Using my full dataset, I will first estimate the effect of internal US trade on price dispersion using yearly interaction terms. That is, the effect of US in 1990 will be the fixed effect "US", while the years 2001-2002 will be measured by the sum US + USx(Year). Using this I regress my price dispersion measure, PD, against the explanatory variables explained above.

9a) $PD_{ij,t} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 \text{Border} + \beta_3 \text{US} + \beta_4 1991*\text{US} + \ldots + \beta_{15} 2003*\text{US} + \beta_{16} \text{AvgTariff} + \beta_{17} \text{FXVol} + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,t}$

With the US trends established for comparison, I will create similar interaction terms for NAFTA, the EU, and MERCOSUR. These dummies will indicate the member nations for the agreement, regardless of year, so that we can trend the changes in price dispersion as the agreement enters into force. In each agreement, the annual effect in 1990 will be measured by the fixed effect alone while the effect in years 1991-2003 will be measured by the sum of both the fixed effect and an annual effect. That is, the effect of NAFTA in 1990 would be measured by dummy variable NAFTA, and in all other years the total effect would be measured by NAFTA + 1991*Year . This will be applied similarly for EU and MERCOSUR. This regression

[17] NAFTA for all years will consist of Mexico, United States, and Canada. The EU, for all years, will consist of the original countries of the European Monetary Union : Austria, Belgium, Netherlands, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Portugal, and Spain. Similarly, MERCOSUR will consist of only its original members, namely Argentina, Brazil, Paraguay, Uruguay, and Venezuela.

will look at the influence of integration efforts on price dispersion, controlled for foreign exchange volatility, average tariff, distance, and the appropriate expansion dummies.

9b) $PD_{ij,t} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 EU + \beta_3 NAFTA + \beta_4 MERCOSUR + \beta_5 1991 * EU + ... + \beta_{18} 2003 * EU + \beta_{19} 1991 * NAFTA + ... + \beta_{32} 2003 * NAFTA + \beta_{33} 1991 * MERCOSUR + ... + \beta_{46} 2003 * MERCOSUR + \beta_{47} AvgTariff + \beta_{48} FXVol + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,t}$

Most integration efforts also allow, to a lesser extent, freer movement of nontradable inputs like labor and capital. The city-specific fixed effects included in my equations absorb all city specific causes of variation, including rent and labor costs. Next, however, I will control more directly for labor and rent rather than leaving it to the fixed effects. To measure the differences in labor and rent costs, I will use a simple log ratio of babysitter wages and apartment rent prices as described above. The regression below consider the effect of selected integration efforts with the addition of explicit control for labor and rent costs.

10) $PD_{ij,t} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 Border + \beta_3 EU + \beta_4 NAFTA + \beta_5 MERCOSUR + \beta_6 1991 * EU + ... + \beta_{18} 2003 * EU + \beta_{19} 1991 * NAFTA + ... + \beta_{32} 2003 * NAFTA + \beta_{33} 1991 * MERCOSUR + ... + \beta_{46} 2003 * MERCOSUR + \beta_{47} AvgTariff + \beta_{48} FXVol + \beta_{49} L_{ij} + \beta_{50} R_{ij} + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,t}$

V) Results

Looking at the results from my first regression (9a), most of the explanatory variables take the expected sign[18]. Distance, foreign exchange volatility, and border effects are all positive and statistically significant at 95% during this period. The effect of average tariffs, however, is not significantly different from zero. Graphing the effect of US "membership" on price dispersion is illustrative. First, in all years, prices between city pairs within the US have significantly less dispersion than those found worldwide. This suggests that for all years US markets are better integrated than those found elsewhere in the world, as suggested by Parsley and Wei. Also, importantly, the effect of the United States is fairly stable. Although there are yearly fluctuations in the precise estimated effect, it remains between -.006 and -0.12 for all years. This means that any large yearly changes in the other regions are distinct from what is seen in an area with fairly constant integration levels such as the United States.

In the second regression (9b), the explanatory variables have very similar effects. Again, distance, foreign exchange volatility, and border effects are all positive and statistically significant during this period. Also again, the effect of average tariffs is not significantly different from zero. Looking at the effect of each year on price dispersion allows us to create a baseline trend in price dispersion from 1990 to 2003 (see Appendix A). It is worth noting that this baseline effect of each year on price dispersion follows a clear U-shape. This pattern of convergence from 1990-1996 and divergence from 1997-2002 is consistent with the findings of other authors[19]. Although this U-shaped pattern itself leaves many questions, I will not address

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[18] Full results from this regression, and those that follow, are available upon request. Also, when discussing "significant" or "insignificant" I will use 95% confidence unless otherwise stated.

[19] A close investigation of this effect is found in Bergin and Glick (2006) "Global Price Dispersion...". They find that the divergence trend may be attributed to rising costs of oil and thus transportation.

that at this time and instead turn to the trends in price convergence for my areas of integration effort.

Next, consider the effect of different regions in each year. Note, since the effect in each year comes from both the fixed effect and interaction terms, all significance will be determined with an F-Test. First, North American cities show the effect of NAFTA to be insignificantly different from zero from 1990-1994, but falling steadily from 1994 to 2003. This would suggest that there has been a noticeable increase in the effect of NAFTA on price convergence since its signing in 1994. More specifically, the net effect of NAFTA changes from insignificant before 1994 to significantly negative after 1996. This suggests that NAFTA has led to a measurable increase in price convergence, beyond what can be explained by decreases in tariffs or exchange rate volatility alone.

Also, there appears to be a fall in dispersion for MERCOSUR. Being a member of MERCOSUR has a positive effect on price dispersion before 1993. After 1993, however, this effect falls dramatically from over 0.15 to around -0.05. The two treaties responsible for creating MERCOSUR were the Treaty of Asunción and the Treaty of Ouro Preto, of 1991 and 1994 respectively. While the magnitude of MERCOSUR's effect is much larger than that of NAFTA and the EU, its influence is not statistically significant from zero for any year. However, the change in effect between 1993 and 1994 is significant. For this reason, it appears there was a significant decrease in price dispersion in the appropriate region after the adoption of MERCOSUR. This suggests that the during the adoption of this agreement, prices throughout the region became more similar, suggesting increased market integration after the beginning of the MERCOSUR agreement.

The trend for nations adopting the European Common Currency is interesting as well. While global dispersion follows a definite U - shape, the effect of EU membership in those years is almost exactly opposite. During the entire time period, EU membership has a significantly negative effect on price dispersion. The reduction in this negative influence between 1993 and 1999 is, however, unexpected. Although this trend is surprising, Derlacz finds the same rise and fall in European price dispersion using a different measure[20]. One possible explanation would be unintended side effects from efforts to convert to a common currency. In 1993, the Maastricht Treaty was signed, promising a monetary union by 1999. During this period, member nations were required to very carefully control exchange rates, which likely agitated local prices. In this way, efforts to control exchange rates rigidly in preparation for a common currency may have a negative effect on price convergence. Interestingly, although EU price dispersion falls during the later years, it does not become significantly lower than the price dispersion seen before 1993. Nevertheless, the EU maintains a positive effect on price convergence throughout this period, suggesting that EU membership has continued to encourage integration.

In the second regression, including labor and rent effects, again most explanatory variables take the expected sign. Border, distance, and tariffs here appear significantly positive, while foreign exchange volatility appears positive but is not statistically significant. Both labor and rent appear positive as well, as one would expect; disparity between input costs should lead to varying price wedges in final products. The baseline trend appears much the same, but shifted slightly lower than before. Similarly, the same trends are visible in NAFTA, MERCOSUR, and the EU. This suggests that the integration efforts of NAFTA the EU, and MERCOSUR have led to a noticeable improvement in price convergence in the appropriate years, even after controlling for foreign exchange volatility, tariff rates, as well as rent and labor input costs.

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[20] Wolszczak-Derlacz (2004) "The Impact of the European Monetary Union on Price Convergence"

Interestingly, in this specification NAFTA does not show a significant effect on price dispersion until much later: 2000 instead of 1996 as in the previous model. This would suggest that some of NAFTA's early convergence effect may have been due to increasingly similar input prices. It is important, however, that both specifications show NAFTA having an insignificant effect before 1993 and a negative effect on price dispersion by 2000. Moreover, both show the majority of price convergence increases during the same period of time (1998-2000). Although controlling for input prices prevents NAFTA from becoming significant until much later, both models suggest NAFTA membership was correlated for much unexplained price convergence beginning in the mid to late 1990s.

VI) An Alternate Specification

Although the dispersion measure applied in this paper yields appealing results in the regions and years of study, it seems strange to assign equal weight to the price dispersion of all goods. For instance, it would be much more alarming to see large price gaps in products such as rice and heating oil than in products such as premium wine, electric toasters, or lipstick. It may be beneficial, therefore, to weight goods differently based on their importance to the typical household. For this reason, I will now attempt to create a measure similar to that used above, but considering different weights for each good.

Although the tastes of "typical household" will certainly vary from nation to nation and city to city, I will assign this crude weighting system, if only as a means of comparison. I assign weights to all goods according to the percentages dictated in the "Relative importance of components in the Consumer Price Indexes: U.S. city average, December 2008[21]." Using this

[21] CPI composition data is available ftp://ftp.bls.gov/pub/special.requests/cpi/cpiri2008.txt

data, I created weights for each of the goods according to those found in the relevant CPI categories.

For some goods, categories and assigned weights were obvious: bananas and apples, for instance appear as specific items in both my data and the CPI basket. Other products, however, required some modifications. While my dataset features a variety of lamb products, for example, they are not present specifically in the CPI basket, falling instead within the "other meats" category. To estimate the weight of lamb and other meats without specific CPI weights, I divided the value for "other meats" among all EIU meats not appearing elsewhere. I continued in this manner until all of the goods in my dataset were appropriately weighted. After creating my best approximation of the CPI weights, I inflated the weight for each good so that the weights of all the goods in my dataset sum to one (some CPI specified goods are absent from my data). With these weights, I altered equation 3 by taking the weighted standard deviation across goods.

$$11) \qquad PD2_{ij,t} = SDW_k \, (Q_{ij,k,t} - Q_{k,t}^*)$$

Using this different dispersion measure, I repeated regression 10 using this new dispersion measure.

$$12) \quad PD2_{ij,t} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 \text{Border} + \beta_3 EU + \beta_4 NAFTA + \beta_5 MERCOSUR + \beta_6 1991^* EU + ... + \beta_{18} 2003^* EU + \beta_{19} 1991^* NAFTA + ... + \beta_{32} 2003^* NAFTA + \beta_{33} 1991 * MERCOSUR + ... + \beta_{46} 2003 * MERCOSUR + \beta_{47} AvgTariff + \beta_{48} FXVol + \beta_{49} L_{ij} + \beta_{50} R_{ij} + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,t}$$

VII) Results:

Looking at figure 3.1, it is apparent that these results closely mirror those of earlier regressions. MERCOSUR shows a high dispersive effect in early years, but falls quickly during

the early 1990s. EU remains low for all years, but increases and decreases during the transition to common currency. Similarly, NAFTA's contribution to price convergence becomes stronger in the 1990s after free trade begins. The great similarity found in these results, using a very different definition of price dispersion, suggest that the findings in this paper are robust.

Several differences, however, are apparent. Although the NAFTA trend appears to begin low in the 1990s in all regressions, it is much lower in this specification. In fact, NAFTA's effect on price convergence during 1991 and 1992 is statistically significant. Strangely, its effect trends towards zero while the agreement comes into force, falling only much later. In fact, NAFTA does not become statistically significant again until 1998. Also, MERCOSUR shows the same general trend in early years, its original effect is much larger. Although in previous specifications, all measures remained below 1.5, in early years MERCOSUR's future members have such price dissimilarity that the measure stays above 6 for both 1990 and 1991. Also, although all trends show a fall in dispersion from 1991 to 1993, this new specification shows much more stability in later years. This gives more support for MERCOSUR's continued effectiveness than previous estimates. In short, although this measure gives very similar results, the presence of noticeable differences suggests that additional considerations, such as product weights, may be an important consideration in future research.

VIII) Conclusions

Using a dispersion measure adapted to show yearly trends in price dispersion, I find evidence that integration efforts NAFTA, EU, and MERCOSUR are significantly correlated with price convergence. Also, these findings are robust to significant change in the dispersion measure, shown by weighting the effect of goods according to the goods' composition used in the

US CPI basket. Importantly, both NAFTA and MERCOSUR show significant changes in their effect on price dispersion soon after these agreements became effective. This can be interpreted in two ways. First, decreases in price dispersion suggest that these integration efforts have succeeded in increasing arbitrage between nations. Second, the price dispersion measures may be an effective means of measuring and tracking the effects of world integration efforts.

Moreover, the price convergence I find is more than can be explained by changes in tariffs, foreign exchange volatility, or input prices. This suggests that forces beyond trade policy play an important role in world market integration. In Part 2, I further investigate this phenomenon by using the methods applied above to trend the effects of a less significant group, APEC. Also, the trend for the those countries joining the European Monetary Union is unexpected, but similar to other findings in the literature. This suggests that strictly controlled exchange rates to prepare for transition towards a common currency may cause unintended price disruption. Interestingly, in my model there is little difference in EU's price dispersion in 1993 and 2002 (before and after currency union). In this way, the ill effects seen during the introduction of the currency union do not appear to pay off during the year sampled. The effect of the EU since 2003 would be very informative regarding the effect of this union as the Euro has become more accepted.

Many questions, however, remain. The three agreements this paper focuses on were selected because they entered into force during the years of my data. That said, investigating a wider sample of integration efforts would be informative. This would provide some evidence relating to which types of agreements were most effective, and help inform future integration efforts. Also, although the agreements studied in this work all showed a significant convergence effect and no evidence of trade diversion, this may not be the case in other regions. For this

reason, expanding the study to include other agreements may show greater diversity in the effectiveness of free trade efforts.

Finally, although research suggests that measures utilizing deviation in price gaps rather than averages, much further work is necessary to establish the best method of extracting trade information from price data. When using a measure similar to that of Parsley and Wei 2002, it is theoretically appealing to weight goods by trade volume or consumption. Such an approach would benefit from additional research on its behavior in comparison to the original measure. Also, unfortunately, current research finds reasons to question the results from all current dispersion measures. Without a valid standard and little theoretical foundation, it is difficult to objectively evaluate results found using price dispersion measures. This is a significant obstacle that should be addressed by future researchers.

Part II

I) Introduction

In Part I, by measuring price dispersion annually, I am able to differentiate levels of integration both before and after important integration efforts. Moreover, I am able to show how quickly integration efforts have a measurable effect on the adoption region. In this way, I find evidence that NAFTA, the EU, and MERCOSUR have led to significant price convergence in their adopting countries. Moreover, the price convergence occurring during these agreements goes beyond what can be explained by absence of tariffs and foreign exchange volatility. In addition, this finding prove fairly robust after several revisions to the original specification.

The unexplained decrease in price dispersion associated with EU, NAFTA, and MERCOSUR suggests that integration, measured by price convergence, cannot be explained by tariff reduction and exchange rate stability alone. Perhaps nations with a history of cooperation are able to exchange goods with more ease than those without historic ties, allowing for greater integration. In fact, Rauch has found that the intricacies of trading networks play an important role in international trade

> Uninformativeness of prices prevents "globally scanning" traders from ... matching international buyers and sellers of differentiated products. Instead connections between sellers and buyers are made through a search process that because of its costliness does not proceed until the best match is achieved. This search is strongly conditioned by proximity and preexisting "ties" and results in trading networks rather than "markets" ."(Rauch, 1996).

In short, international trade agreements may lead to additional price convergence by increasing communication, and aiding the development of new and larger "trading networks."

For this reason, I will now consider the role of Asia-Pacific Economic Cooperation (APEC). APEC, beginning in 1989, was formed to encourage an increase in trade for its

member countries. Since 1989, it has grown from 12 to 21 member nations[22]. Despite its intentions, the organization itself has led to little formal improvements in international trade. Unlike the EU, NAFTA, and MERCOSUR, APEC membership does not require any specific changes to tariff or foreign exchange policy. Moreover, while APEC nations have negotiated some tariff reductions, the average tariff between APEC members remained at 8% in 2000[23].

Surprisingly, I find that APEC is also correlated with an unexplainable price convergence trend much like that of the other agreements. Moreover, there is a noticeable decrease in price dispersion for new APEC members as they join the agreement. Lastly, to further probe these findings, I introduce an alternate measure of price dispersion and find that APEC's effect is consistent. This reduction in price dispersion suggests an increase in market integration is associated with APEC membership and that other, less concrete factors, have a measurable effect on international trade practice. Since this cannot be attributed to firm tariff or foreign exchange policy, this further supports Rauch's finding that the development of "trading networks" plays an important role in global integration efforts.

II) Literature Review:

Please see Part I

III) Data

For full data discussion, please see Part I.

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[22] APEC's original member nations include Australia, Brunei, Canada, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand, and the United States. In 1991, China was added. In 1993 Mexico and Papa New Guinea joined. Chile became a member in 1998. APEC grew to 21 members with the addition of Peru, Russia, and Vietnam in 1998. I define my APEC variable in this way, adding new members as they join with the exception of Brunei which is not covered by my data.

[23] "APEC's Progress on Tariffs", http://www.scribd.com/doc/3288094/APEC-Progress-on-tariffs

In addition to the variables used in Part I, I will also consider evidence from an alternate dispersion measure, Parsley and Wei (2002). Because APEC has existed for the entire duration of my dataset, I can consider evidence from an alternate measure using standard deviations across time (but ignoring annual trends). Again, we will begin with log ratios as the base unit.

$$1)\ Q_{ij,k,t} = \ln(USP_{i,k,t}/USP_{j,k,t})$$

To create this measure, Parsley and Wei first calculate the annual change in log price ratio for each year, good, and city pair.

$$2)\ \Delta Q_{ij,k,t} = Q_{ij,k,t} - Q_{ij,k,t-1}$$

The measure of dispersion, unique for each good and city pair, is then the standard deviation across time of $\Delta Q_{ij,k,t}$.

$$3)\ PD2_{ij,k} = SD_t\ (\Delta Q_{ij,k,t})$$

$PD2_{ij,k}$ is in short, the standard deviation across time of changes in log ratio of price for each good and city pair.

IV) Empirical Models

First, I will add APEC and the yearly interaction variables to the original model specified in Part I.

$$4)\ PD_{ij,t} = \beta_0 + \beta_1 \ln(Distance) + \beta_2\ Border + \beta_3 EU + \beta_4 NAFTA + \beta_5 MERCOSUR + \beta_6 1991{*}\ EU + ... + \beta_{18}\ 2003{*}EU + \beta_{19}\ 1991{*}NAFTA + ... + \beta_{32}\ 2003{*}NAFTA + \beta_{33}\ 1991\ *\ MERCOSUR + ... + \beta_{46}\ 2003\ *\ MERCOSUR + \beta_{47} + \beta_{47}\ APEC + \beta_{48} APEC\ *\ 1991\ ... + \beta_{61}\ APEC\ *\ 2003 + \beta_{62} AvgTariff + \beta_{63}\ FXVol + \beta_{64} L_{ij} + \beta_{65} R_{ij} + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,\,t}$$

While this will provide evidence of APEC's influence since 1990, since APEC began in 1989, it is impossible to see if there was a decline leading to the agreements inception as with EU, NAFTA, and MERCOSUR. We should, in addition, look at the price dispersion levels for a country not joining APEC until a later date. In order to isolate the effects of APEC, I will drop all data not containing city pairs within APEC according to its 2003 membership. Within this APEC subset of the data I will then investigate the trends in price dispersion for "APECalt" - city pairs containing either Mexico or Papa New Guinea, which both joined APEC in 1993[24]. If APEC membership is entirely unimportant, there should be no changes in price dispersion for this group between 1990 and 2003.

5) $PD_{ij,t} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 \text{APECalt} + \beta_3 \text{APECalt} * 1991 \ldots + \beta_{15} \text{APECalt} * 2003 + \beta_{16} \text{AvgTariff} + \beta_{17} \text{FXVol} + \beta_{18} L_{ij} + \beta_{19} R_{ij} + \textit{time dummies} + \textit{city dummies} + \varepsilon_{ij,t}$

Lastly, because APEC has existed for a long span of years, we can consider evidence from the alternate dispersion. Returning to the full dataset, we will now create a similar regression to those above, but with PD2 as the dependent variable. However, unlike the previous measures this collapses the data across time rather than goods. For this reason, now we will have good dummies instead of time dummies, and no yearly interaction terms are necessary. Also, EU, NAFTA, and MERCOSUR appear in the regression only to control for any potential effect of these areas. The actual significance of these variables, however, will be unimportant. These

[24] The only other years of significant APEC expansion were 1991 and 1997. An event from 1991 would be too early to show significant trends in my data, and 1997 which featured the introduction of Russia which was dropped from this dataset for a variety of reasons discussed in Part I.

dummies control for the region regardless of year, and these regional agreements came into effect in the middle of the years sampled. I will, instead, focus only on the effect of APEC in this model.

6) $PD2_{ij,k} = \beta_0 + \beta_1 \ln(\text{Distance}) + \beta_2 EU + \beta_3 NAFTA + \beta_4 MERCOSUR + \beta_{62} AvgTariff + \beta_{63} FXVol + \beta_{64} L_{ij} + \beta_{65} R_{ij} + \textit{good dummies} + \textit{city dummies} + \varepsilon_{ij,t}$

VI) Results

In the first regression tariff, distance, and border appear positive and significant. Foreign exchange appears positive, but insignificant. The trend line appears as the U-shape once again, and the integration areas from Part I appear as before (Please see Appendix B). Looking at the trends in APEC's effect on price dispersion, it appears that members of this seemingly insignificant organization experience a reduced level of price dispersion. Moreover, the effect of APEC, in each year, is significantly negative as measure by an F-Test of APEC and the yearly interaction. Although the level of unexplainable convergence has diminished since 1990, it is positive for all years sampled except 1998. This suggests that APEC membership is correlated with reduced price dispersion for its member nations.

Looking at the results from the second regression, again much is as expected. The effects of border, distance, and input proxies are significantly positive. Moreover, although the effect of tariffs and foreign exchange is negligible, the effect of these two variables was fairly inconsistent in previous models. More important, however, is the apparent effect of becoming an APEC member.

For all years 1990-2003, Mexico and Papa New Guinea experience a lower level of price dispersion than other within-APEC pairs. Computing an F-Test on the combined effect of APECalt and each yearly interaction term shows that this negative influence is significant in all years. This suggests that the prices of Mexico and Papa New Guinea are more similar to the prices in other APEC nations, controlled for a variety of factors. Moreover, the level of price dispersion for pairs including Mexico or Papa New Guinea decreases significantly between 1992 and 1994. Again by F-Test, there is a significant difference in the apparent effect of APECalt membership between these two years. This means that there was a significant change in price dispersion for these two countries after becoming APEC members. It is difficult to describe the magnitude of this effect since the dispersion measure does not have meaningful units; however, it is worth noting that the effect nearly triples between 1990 and 1994. Accession to APEC is correlated with significant changes to price dispersion, implying that the negative effect of APEC on price dispersion cannot easily be explained by such factors as historic trading partnerships, or perhaps cultural similarity between nations.

Lastly, consider the results from model 3. This uses the alternate price dispersion measure, which was also praised by Anderson and Van Wincoop. In this regression, distance, border, tariff, and inputs all take the expected sign. Foreign exchange becomes unexpectedly negative but is insignificant. It is interesting to see that the EU and MERCOSUR are correlated with reduced price dispersion, while NAFTA appears insignificant. It is important to remember, however, that these trade areas were introduced in the middle of the years sampled. Since these dummies reflect the area of the agreement regardless of the year, these trends are unimportant. More importantly, APEC membership is correlated with reduced price dispersion. This supports

the findings of the previous two regressions and suggests that APEC is a significant and effective integration effort.

VII) Conclusions

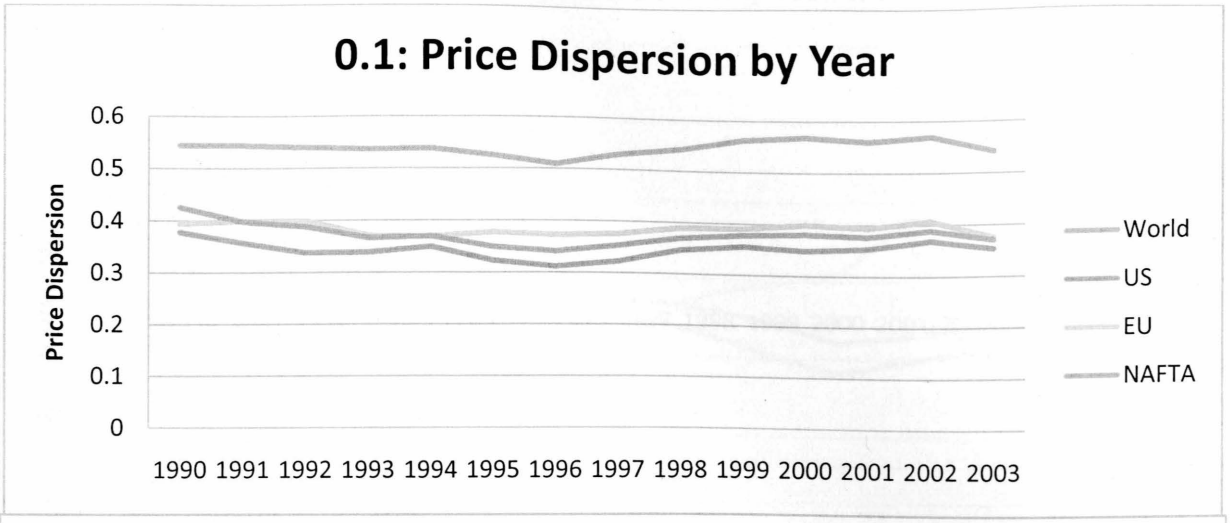
In the first section, I applied the Parsley and Wei 2002 price dispersion measure and found a variety of integration efforts correlated with decreased price dispersion. Moreover, this finding was robust to a variety of changes to specification suggesting that price-based measures of trade costs may provide useful information for judging FTAs and currency arrangements. Furthermore, I found that the decrease in price dispersion after such agreements was larger than what could be explained by changes to tariff or foreign exchange policy. This suggests that global integration efforts may be heavily influenced by other forces including perhaps, as Rauch suggests, the importance of developing new trading networks.

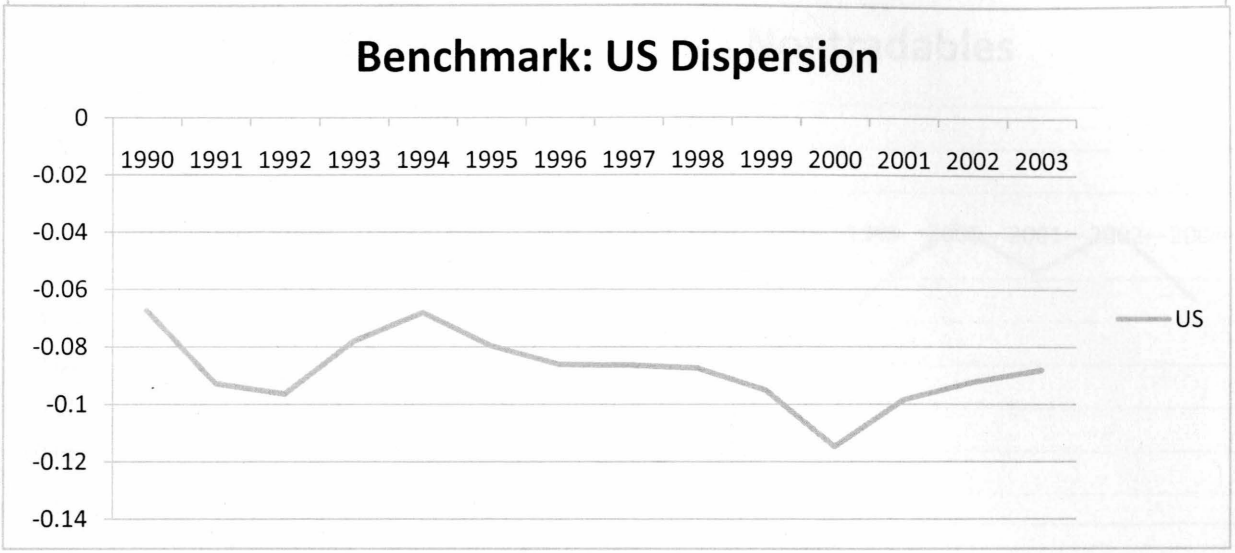
While one would expect reduced price dispersion following the beginning of significant trade agreements, it seemed less likely that looser international arrangements such as APEC would have a noticeable effect. However, applying methods similar to those of Part I, I found that APEC correlated with lower levels of price dispersion from 1990-2003. Moreover, I found that the price dispersion between APEC and newer entrants fell as these nations became part of the agreement. This suggests that APEC's significance cannot easily be explained by historic trading partnerships or cultural similarity. The correlation between APEC and reduced price dispersion is further supported using a completely different specification of the price dispersion variable.

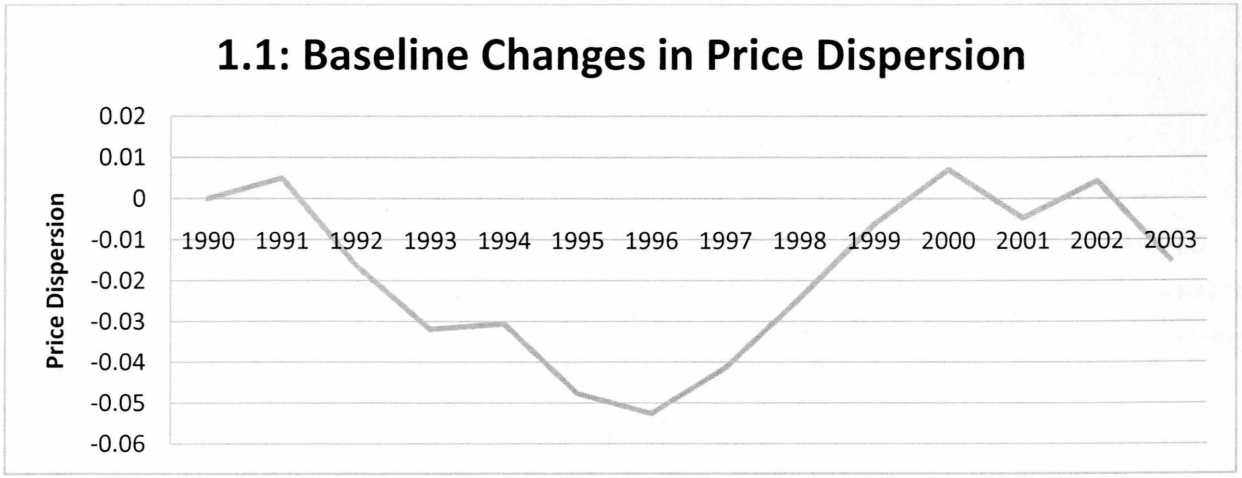
In short, the creation of new trading networks provided by APEC seems correlated with increased integration. This provides interesting evidence of the nature of international trading

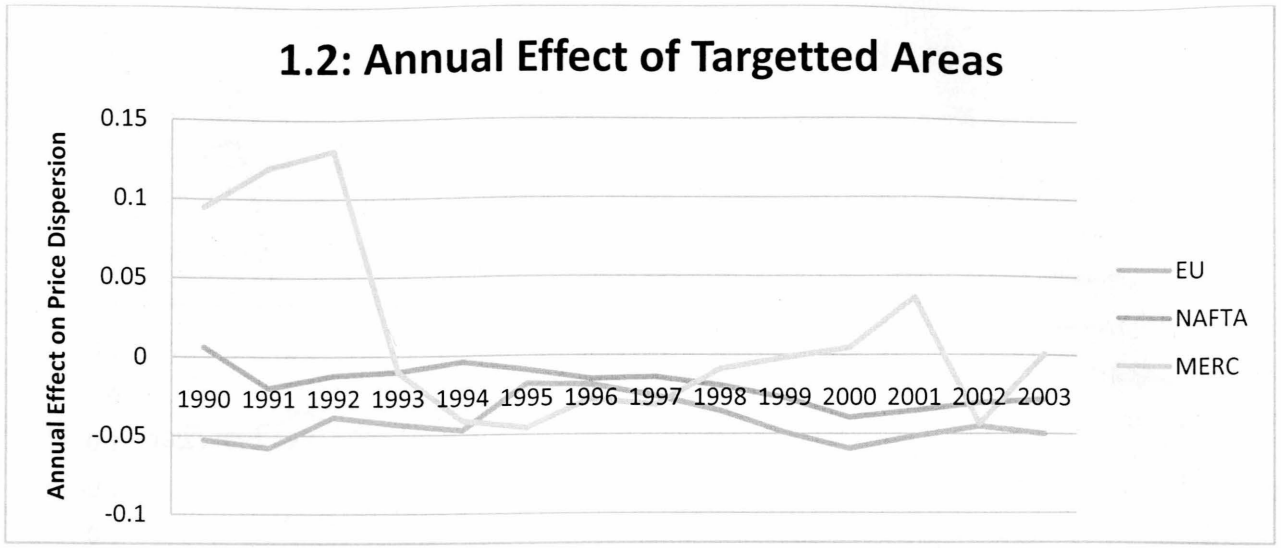
networks. While one would expect significant changes to trading networks after firm agreements as seen in Part 1, this is surprising with APEC. The decreased price dispersion associated with APEC suggests that trading networks may develop from merely the appearance of increased international cooperation. These networks could develop anticipating the possibility of more substantial future international cooperation. Or perhaps, establishing a loose framework such as APEC makes business within other member nations seem less risky; nations' leaders have agreed to meet and thus provide open communication channels in the event of unfair business practice. Because suing a business in another country can be extremely difficult, companies are likely to do business only in countries where international integration efforts may thwart misbehavior. Whatever the cause may be, evidence of increased levels of integration in the APEC area suggests that integration cannot be explained by changes in tariff and foreign exchange policy alone. Because important trading networks may develop in absence of significant changes to trade policy, less firm cooperative agreements like APEC may be an important element of future global integration efforts.

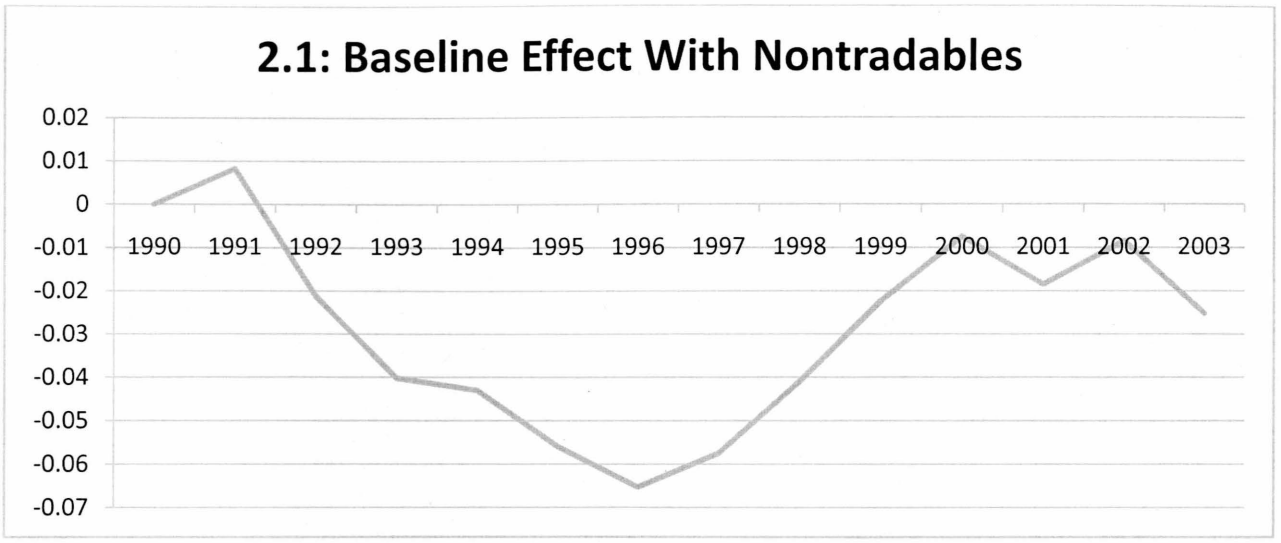
Appendix A: Charts and Graphs, Part I

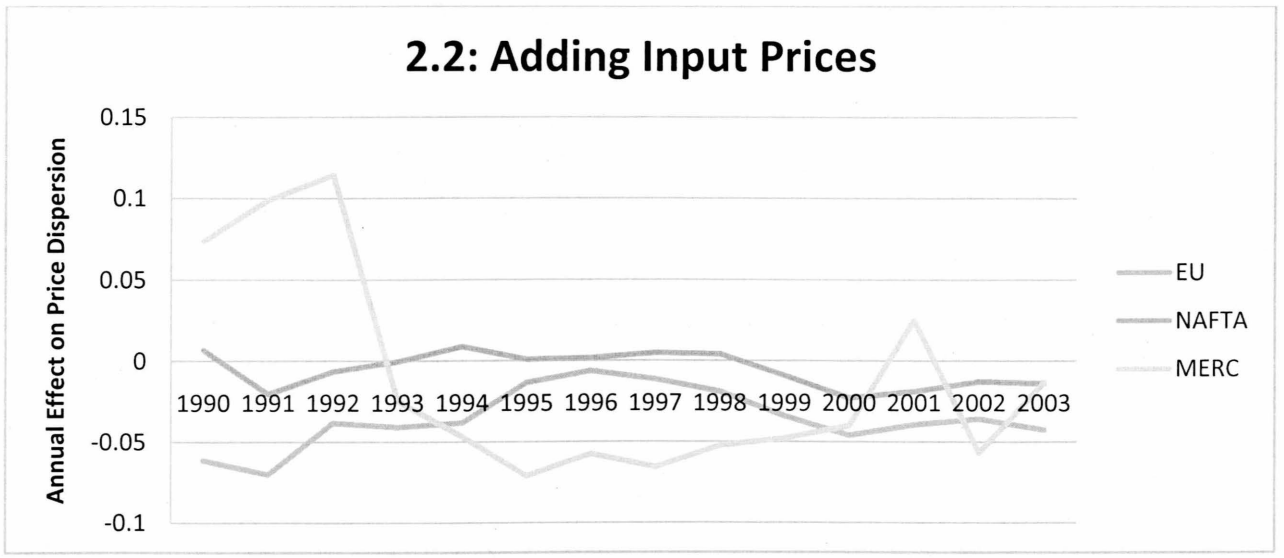






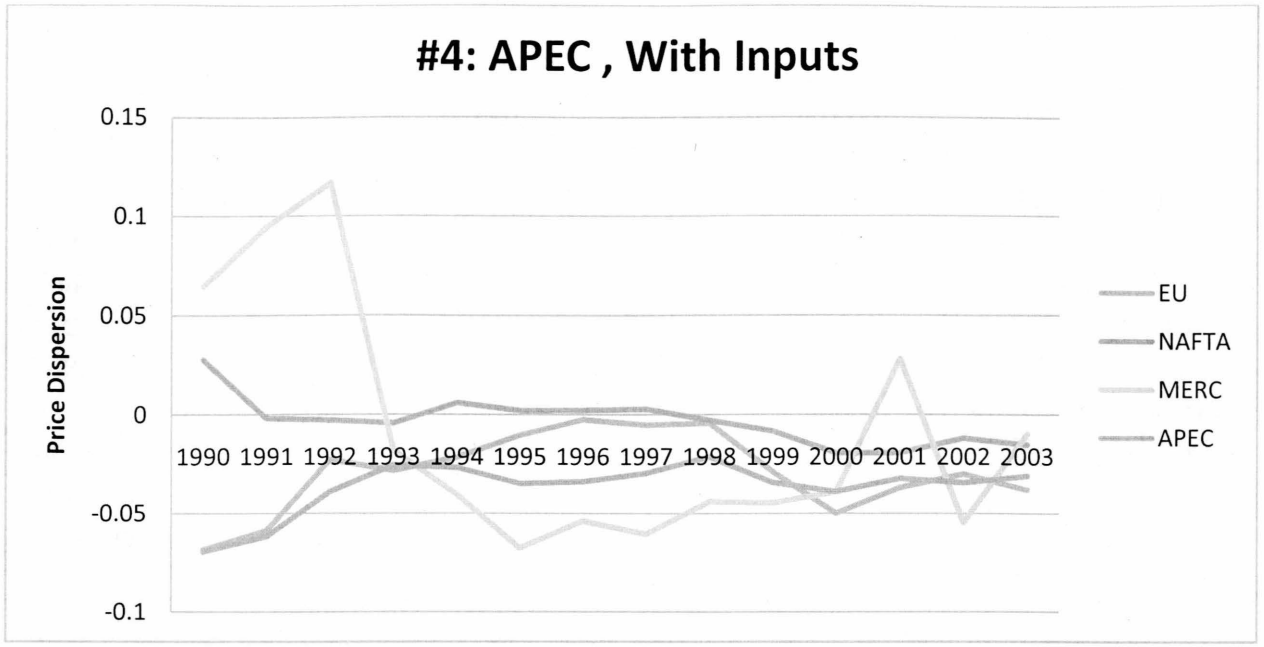

1.2: Annual Effect of Targetted Areas
Annual Effect on Price Dispersion
0.15
0.1
0.05
0
-0.05
-0.1
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
EU
NAFTA
MERC

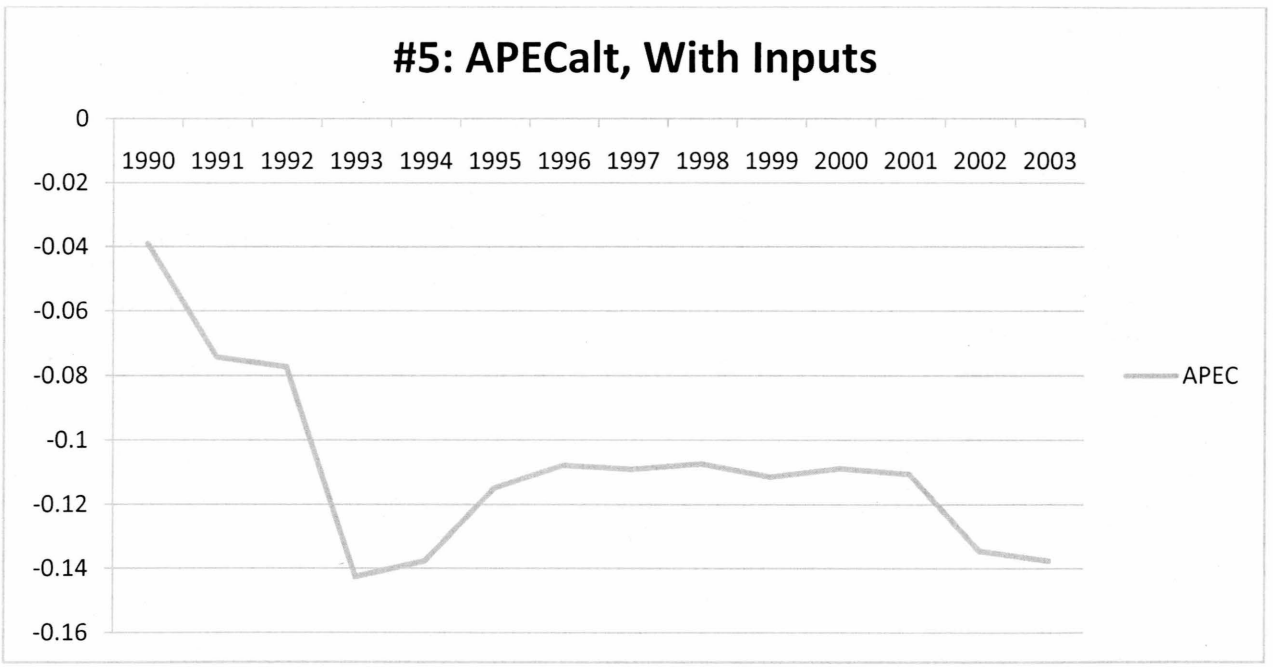

2.1: Baseline Effect With Nontradables
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003


2.2: Adding Input Prices
Annual Effect on Price Dispersion
0.15
0.1
0.05
0
-0.05
-0.1
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
EU
NAFTA
MERC


3.1: With Goods Weighted
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003
EU
NAFTA
MERC

Appendix B: Charts and Graphs, Part II





Equation #6: APEC, PD2

Variable	β	SD	T	P	95% L	95% U
FXvol	-0.0008	0.0009	-0.8900	0.3730	-0.0027	0.0010
Tij	0.0003	0.0001	4.3200	0.0000	0.0002	0.0005
Lij	0.0012	0.0003	3.6300	0.0000	0.0005	0.0018
Rij	0.0011	0.0004	2.7200	0.0060	0.0003	0.0019
lndist	0.0084	0.0006	15.2700	0.0000	0.0074	0.0095
border	0.0160	0.0023	6.8500	0.0000	0.0114	0.0206
APEC	-0.0642	0.0175	-3.6700	0.0000	-0.0985	-0.0299
MERC	-0.0538	0.0130	-4.1300	0.0000	-0.0794	-0.0283
EU	-0.0197	0.0018	-10.930	0.0000	-0.0232	-0.0162
NAFTA	-0.0044	0.0024	-1.8300	0.0670	-0.0092	0.0003

R-squared = 0.3073

Observations = 194113

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