Unofficial Dollarization and Market Integration: The Case of Latin America

Kathryn Paige Boiles*

Undergraduate Honors Thesis in Economics

Washington and Lee University

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* Advised by Dr. Michael Anderson, Professor of Economics at Washington and Lee University.

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Abstract

This study examines the relationship between unofficial dollarization and goods market integration in the context of dollarizing Latin American nations and the United States. While a breadth of research focuses on the integrating effects of official currency union, no authors have yet attempted to examine the associated link between "unofficial" currency unions and market integration. Using disaggregate price data to measure market integration and deposit dollarization data as a proxy for unofficial dollarization, we find that Latin American nations with higher levels of unofficial dollarization experience stronger market integration with the United States. Though these high dollarizing countries are more integrated with the United States, we find that this group is no more integrated on the whole than its low dollarizing counterpart.

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I. Introduction

Sixty percent of United States currency, about 450 billion dollars, circulates outside of the United States (US Treasury 2006). Walk through any Latin American artisan market and one can find these dollars changing hands among locals and tourists alike. In some countries, one may see dollars circulating even more often than the domestic currency. This unofficial parallel exchange rate regime, more commonly known as unofficial dollarization or currency substitution, operates throughout much of the world, accounting for a large portion of US currency in circulation abroad.

A handful of authors have studied the origins and economic implications of unofficial dollarization (*Feige (2003), Yeyati and Ize (2006), Reinhart, Rogoff, Savastano (2000)*), but the majority of dollarization research focuses on official adoption of the United States dollar (ie. official dollarization). In these studies, authors repeatedly find that dollarized nations are more integrated with the other members of the currency union, namely the United States (*Penaloza (2005), Parsley and Wei (2002)*). While the relationship between official dollarization and market integration is robustly positive, no one has yet attempted to study the effect of unofficial currency arrangements, such as unofficial dollarization, on market integration. The widespread use of the dollar, even if it is not the official domestic currency, may reduce *effective* exchange rate volatility and transaction costs in the same way as official dollarization. If this is true, perhaps a foreign government need not create an institutional exchange rate regime with the United States in order to receive the benefit of increased market integration.

If higher levels of unofficial dollarization yield greater market integration, it will provide a completely new angle for unofficial dollarization research. The majority of existing research tends to focus only on the dangers that currency substitution poses for economic stability,

financial stability, and the effectiveness of monetary policy (*Feige (2003); Reinhart, Rogoff, and Savastano (2003); Yeyati (2006); Ize and Yeyati (2005)*). However, if my hypothesis proves true, i.e. unofficial dollarization *does* have a positive effect on market integration, then perhaps unofficial dollarization is not as bad as the literature suggests. We may even find that the integrating effects of unofficial dollarization outweigh the consequences.

Regardless of the size or direction of the empirical relationship, if any, between unofficial dollarization and integration, the results presented in this study will contribute to the understanding of the dangers or potential benefits of currency substitution for both the dollarized nation and the United States.

II. Literature Review

(i) Effects of Currency Union on Bilateral Trade Volumes

Over the past decade, a large body of research has emerged that focuses on various currency arrangements—currency boards, hard pegs, official dollarization etc—and their effects on bilateral market integration as measured by trade flows. Andrew Rose (2000) sparked the dialogue surrounding the integrating effects of currency unions with his cross-sectional study of bilateral trade volumes between countries with a currency union and those without. Rose found that membership in a currency union can increase bilateral trade among members by up to 300 percent. In 2002, Rose and Glick added to the discussion by introducing time-series data on trade volumes and currency union membership. In line with Rose's original findings (2000), these authors found that joining a currency union can double trade volumes, while abandoning a currency union can cut trade in half. In two separate works with co-authors Frankel (2000) and

Engel (2002), Rose discovered additional evidence supporting his theory that currency unions, are associated with four-fold increases in trade, significant increases in the per capita GDP of each country, and synchronization of business cycles between currency union members. In short, Rose repeatedly finds strong evidence that a single currency has strong trade-boosting, integrating effects.

In 2005, Michael Klein responded to the findings of Rose and his co-authors in his paper "Dollarization and Trade." In contrast to Rose's wide multinational studies, Klein's study focuses only on country pairs that include either the United States or a country that has a currency union with the United States (i.e. Ecuador or Panama). Moreover, he then narrows this dataset into a subsample country pairs that include the United States and all current and potential dollarization candidates. One would expect that a focus on the United States and its dollarizing counterparts would result in stronger trade-inducing effects because these dollarizing countries presumably have the most to gain from increased trade with the United States; however, Klein finds exactly the opposite. The magnitude of the coefficient on currency union drops and the variable becomes statistically insignificant when measured in a gravity model almost identical to that used in Rose's research. In short, Klein finds that currency union, especially between hopeful dollarizers and the United States, will do little (if anything at all) to boost bilateral trade.

(ii) Effects of Currency Union on Price Convergence[1]

As an alternative to using trade flows to measure integration, a handful of authors propose a measure of integration based on disaggregate price data. This method, which relies only on price data, provides a measure of market integration regardless of whether the two countries have a significant trade relationship. Parsley and Wei (2002) pioneered this price-based method of examining the relationship between currency union and integration. Using disaggregate price data from the Economist Intelligence Unit, these authors calculate an annual measure of price dispersion for each city pair. Because large price wedges are an inherent characteristic of disintegrated markets, we can inversely assume that as markets become more integrated, the price wedges will decline along with overall price dispersion (Goldberg and Verboven 2005). After controlling for a variety of different factors, including distance between cities, tariffs, exchange rate variability, etc., Parsley and Wei discover that institutionalized exchange rate regimes, e.g. currency boards or currency unions, contribute to more integrated markets (as measured by price convergence).

In a separate study using similar disaggregated price data, Peñaloza (2005) finds that the official dollarization process in Ecuador led to greater price integration both within Ecuador and between Ecuador and the United States. This study is particularly useful because the author focuses the specific integrating effects of dollarization, rather than currency unions in general.

[1] This brief review of relevant price dispersion studies barely touches upon the vast collection of work on price dispersion. While the literature on this topic is broad, there is a general consensus that large, persistent deviations from the Law of One Price occur throughout the world, however there remains significant controversy surrounding the specific reasons behind observed deviations and how they can be eliminated.

A final branch of authors, examines how currency union and market integration policies in the European Union have affected actual market integration as measured by price convergence (*Rogers (2007), Faber and Stokman (2009), Crucini, Telmer, and Zachariadis (2005), Engel and Rogers (2004), etc.*). In these studies, authors focus on changes in integration within the entire *group* of European nations, rather than between European country pairs. This measure of group integration would not be possible using trade flows, and it will prove useful in a later section of my study where we explore integration within dollarizing Latin American country groups.

Because the theory behind the potential integrating effects of unofficial dollarization is based in part on pricing behavior in the dollarizing nation, this price-based method of measuring integration is more relevant to my specific study than measures based on trade volumes. As a result, this study will use a measure of price convergence to study bilateral changes in integration between the United States and Latin American nations over time. I will discuss my price-based measure of integration in further detail in the Theory and Model section of this paper.

(iii) Measuring Unofficial Dollarization

Literature surrounding unofficial dollarization and currency substitution is sparse and surprisingly undeveloped. The majority of underground currency arrangement research is theoretical, largely because uniform data on foreign currency in circulation does not exist or is unavailable. A handful of restricted data on dollars in circulation exists within the United States government, but even this data is based mainly on estimates.

Feige (2003) identifies four relevant approaches to measuring unofficial dollarization: an IMF dollarization index developed by Baliño, Bennet, and Borensztein (1999); a currency

substitution index, which measures the extent to which foreign currency substitutes local currency as medium of exchange; an asset substitution index, which measures the extent to which foreign monetary assets substitute domestic monetary assets; and finally, the comprehensive unofficial dollarization index that encompasses the first three measures.[2] Because of data restrictions, the latter three measures are unavailable for this study; however, there remains the possibility of using IMF dollarization index figures from Baliño, Bennet, and Borensztein (1999). Feige notes that the IMF index far underestimates the level of dollarization in an economy, yet follows the same trend over time as his more comprehensive unofficial dollarization index.

Another notable dollarization index can be found in Reinhart, Rogoff, and Savastano's 2003 paper cleverly entitled "Addicted to Dollars." These authors create a composite index that ranges from zero to thirty based on three components of dollarization (each measure on a scale of zero to ten). This index is particularly insightful because it combines the IMF index, a measure of external debt as a ratio of Gross National Product, and a ratio of total government debt that is linked to foreign currency. While this composite index may provide the most complete measure of unofficial dollarization, the data are unavailable for public use.

With options for dollarization indices quickly dwindling, I turn to another realm of unofficial dollarization research—deposit dollarization. Because deposit dollarization research is a subset of currency substitution research, there are many overlapping concepts and most importantly, overlapping data between the two research areas. Deposit dollarization authors (*Honohan (2008), Honig (2009) De Nicoló, et al.(2004), Broda and Levy-Yeyati (2006), Ozsoz (2009))* study the proportion of foreign-currency bank deposits relative to total deposits, whereas currency substitution (ie unofficial dollarization) authors study the proportion of foreign

[2] Details on each of these indices can be found in the data appendix of this paper.

currency in circulation relative to total currency. These areas of research are inherently related, especially in terms of data. Recall that the IMF dollarization index used by Baliño, Bennet, and Borensztein (1999) is calculated as the ratio of foreign currency deposits to the broad money supply. This measure is *very* similar to the measure used by deposit dollarization authors, which is calculated as the ratio of foreign currency deposits to total deposits. In fact, the correlation coefficient between the deposit dollarization index figures and the IMF dollarization index figures is .92![3]

Because of the generosity of Patrick Honohan, Professor of Economics at Trinity College in Ireland, data are available for deposit dollarization (foreign currency deposits as a ratio of total deposits) for 135 countries from 1990 through 2006.[4] The dollarization of bank deposits is an admittedly rough proxy for overall unofficial dollarization; however, the data are highly correlated with the IMF dollarization index, which is in turn highly correlated with Feige's comprehensive dollarization index (Feige 2003). In general, the deposit dollarization measure underestimates the true level of dollars circulating (as it only takes into account bank deposits), so the effects of dollarization on integration may be understated in the regressions that follow.

[3] This correlation is based upon a handful of IMF dollarization index data published in Baliño, Bennet, and Borensztein (1999) and the deposit dollarization data provided by Hohonan.
[4] Honohan (2008) data is based on hand-collected data in De Nicoló, et al. (2005) and Levy-Yeyati (2007), individual IMF Country Reports, and Central Bank Websites. The data were generously provided by Honohan, without whom this project would not be possible.

(iv) Relating Unofficial Dollarization to Market Integration

To my knowledge, there is no published literature on the relationship between unofficial dollarization and market integration within the United States. The purpose of this paper is to explore this relationship from an empirical perspective. I will focus this study on Latin America where the dollar is the most frequently used foreign currency. Because of the prevalence of the dollar, I can assume that the majority of foreign currency deposits are denominated in USD. In addition, Ecuador is a fully dollarized Latin American nation on which I also have price data. This will provide a benchmark for the level of integration between the United States and an officially dollarized economy. Price convergence will serve as a proxy for overall market integration. My study will include dollarization and price data from nine Latin American cities[5] chosen based on availability of data and range of dependence on the dollar. While this study is the first of its kind, many of the methods and underlying theories are based on currency union and dollarization literature discussed above.

III. Theory and Model

This study focuses on the relationship between unofficial dollarization and goods market integration between the United States and a select group of Latin American countries. To explore the empirical side of this relationship, I will construct a basic model of price dispersion, which will inversely measure the level of goods market integration between the nations of interest. I choose to measure integration via price dispersion, rather than trade flows, because price data provides a measurement of integration regardless of whether the two countries being

[5] Argentina, Chile, Columbia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela.

studied have a trade relationship. Disaggregate price data come from the Economist Intelligence Unit's Cost of Living Survey. Covering over one hundred goods and cities, this dataset is the most comprehensive compilation of prices available. Intuitively, we can assume that as price dispersion across cities decreases, market integration increases.

My baseline model is as follows:

$$\begin{matrix} & (-) & (+) & (+) & (+) & (+) \\ \mathbf{DISP_{ij}} = & \mathbf{f(DOLLAR,} & \mathbf{GDPGap_{ij},} & \mathbf{XEVol,} & \mathbf{DIST_{ij},} & \mathbf{HYPER)} \end{matrix}$$

The following section summarizes the theory and calculations for each variable.

Price Dispersion ($DISP_{ij}$): In order to measure dispersion, I will follow the empirical approach used by Parsley and Wei (2002). These authors calculate price dispersion using the standard deviation of price differentials across all goods for each year and each city pair. The standard deviation represents the width of the "no-arbitrage band"[6] between two cities in each year. Conceptually, the "no arbitrage band" represents the upper and lower bounds within which prices can fluctuate without any significant arbitrage. If costs of arbitrage are high, perhaps because of high transaction costs between disintegrated economies, it becomes more difficult to arbitrage away price differences, so the band will increase. Conversely, the costs of arbitrage in highly integrated markets are minimal, so we would expect to observe a tighter band of no-arbitrage that centers more closely on the mean price. The mathematical representation of this measure is as follows:

[6] The idea of the "no-arbitrage band" stems from work by Obstfeld and Taylor (1997), Taylor (2001), and O'Connel and Wei (2002).

Let $P_{ij,k\,t}$ represent the natural log of the ratio of prices between each city pair *(ij)* for each good, *k,* in each year, *t.*

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

Because some high-priced goods may have larger price spreads than lower-priced goods, Parsley and Wei use a normalization technique to prevent these high-priced goods from disproportionately affecting price dispersion within the city pairs. Mathematically, we will let $\mathbf{P_{k,t}}$ represent the mean log price ratio across city pairs for each good, *k,* in each year, *t.*

(2) $\mathbf{P_{k,t}} = \text{mean}(P_{ij,k\,t})$

By subtracting the good and year specific mean of the price differential, as shown below, we obtain a more uniform distribution of price differentials.

(3) $\mathbf{P^*_{ij,k\,t}} = P_{ij,k\,t} - \mathbf{P_{k,t}}$

Finally, we calculate the standard deviation of the price differentials, which yields the city and year specific outer bounds of the "no-arbitrage band" as described in Parsley and Wei (2002).

(4) $\mathbf{DISP_{ij,\,t}} = \boldsymbol{\sigma}[\mathbf{P^*_{ij,k,t}}]$

This method produces a measure of dispersion for each United States-Latin American country pair in each of the 15 years in this study. As two nations become more integrated, prices will converge and the width of the no arbitrage band will shrink.

Unofficial Dollarization (DOLLAR): The level of unofficial dollarization will act as my focus variable. In this study, we will measure unofficial dollarization as the ratio of foreign currency deposits to total deposits in each Latin American nation.

Unofficial Dollarization = Foreign Currency Deposits / Total Bank Deposits[7]

We will assume that United States, with its close proximity to the Latin America, provides the majority of foreign currency in circulation. Because no research exists on the relationship between unofficial dollarization and market integration, I will base my theory upon assumptions of pricing behavior within a dollarized economy and the idea that unofficial dollarization acts as a loose form of monetary union.

First, we will assume that as a nation begins to experience an increase in dollar circulation, businesses will be motivated to price goods in both the domestic currency and United States dollars. Because the same good may be purchased in the same place with either currency, unofficial dollarization effectively eliminates transaction costs associated with third-party currency exchange. Lower transaction costs drive down arbitrage costs; therefore, we expect to see less divergence in real prices. More importantly, we expect to see less divergence between USD prices in the dollarized Latin American nation and USD prices in the United States because both nations are pricing in the exact same currency.

In a 2001 study, Asplund and Friberg examine this dual-pricing scenario in the context of a duty-free shop aboard a Scandinavian ferry line. When examining the real price of *identical* goods sold side-by-side (but priced in two currencies), these authors find that price wedges still persist, but they are much smaller than price wedges between goods sold in different locations. For our purposes, we can think of an unofficially dollarized economy as a large-scale duty-free shop similar to the Birka Line from Asplund and Friberg's study. For example, in an unofficially dollarized economy, one can buy identical goods in the same location with the option of paying

[7] Dr. Patrick Honohan of Trinity University (Ireland) provided all necessary data for this dollarization measure.

in dollars or domestic currency, just as a tourist could pay for the same souvenir in either Swedish kroner or Finnish marka in the duty-free shop aboard the Birka Line. If an unofficially dollarized economy is, in fact, similar to the Birka Line's duty-free shop, then we expect to observe smaller price wedges (i.e. less price dispersion) in an unofficially dollarized economy as opposed to a non-dollarized economy where goods are only priced in the domestic currency.

Second, we will assume that as the level of dollars increases in an unofficially dollarized economy, the arrangement approximates currency union with the United States. While the unofficially dollarized nation officially retains control over domestic monetary policy, the monetary policy decisions of the United States will still have a large effect on the dollarizing economy because of the sheer number of dollars that circulate unofficially throughout the nation. This de facto submission to United States monetary policy is characteristic of a hard peg or official dollarization. There is also the glaring fact that an unofficially dollarized nation *uses dollars* in everyday transactions, which illustrates yet another characteristic of official dollarization or a hard peg arrangement.

As discussed in the literature review, a strong area of economic literature surrounds the effects of monetary union on market integration (*Rogers (2007), Parsley and Wei (2002), Engel and Rose (2002), Rose(2000), Faber and Stokman (2009)).* While some cite lower transaction costs, others reference less uncertainty about future exchange; however, on the whole, there exists no uniform consensus on the theory behind the market integration and monetary union. Nonetheless, the repeated strength of this positive empirical relationship suggests a positive relationship between unofficial dollarization, a form of currency union, and market integration.

Distance ($DIST_{ij}$): Included in almost all integration models, distance acts as a proxy for transportation costs that are associated with price differences across identical goods. In this

study, distances are calculated as the great circle distance between Houston, Texas and each Latin American city.[8] Because transportation costs will rise as distance increases, distance should be positively associated with price dispersion.

Control for Balassa-Samuelson Effects (GDPGap): This variable accounts for price differences that may be attributed to the Balassa-Samuelson effect. In the most basic sense, the Balassa-Samuelson effect explains why countries with high productivity and high income often have higher priced goods than countries where productivity and income are low.[9] Because the United States and Latin America have drastically different productivity levels, Balassa-Samuelson effects may have a strong influence on price dispersion between the two areas.

For this study, we will use the difference in Gross Domestic Product to measure the productivity gap within country pairs. The idea to include the GDP differential in a model of goods market integration stems from work by *Crucini, et al (2005).* These authors found that larger gaps in GDP within country pairs are strongly correlated with higher price dispersion. In addition, Peñaloza (2005) finds evidence of Balassa-Samuelson effects at work when studying integration between dollarized Latin American countries and the United States. This strong evidence in favor of the Balassa-Samuelson effect suggests that my variable, GDPGap, will be positively associated with price dispersion.

Before running the first regression, I took a preliminary look into the relationship between GDPGap and price dispersion. The two-way scatter plot is presented below:

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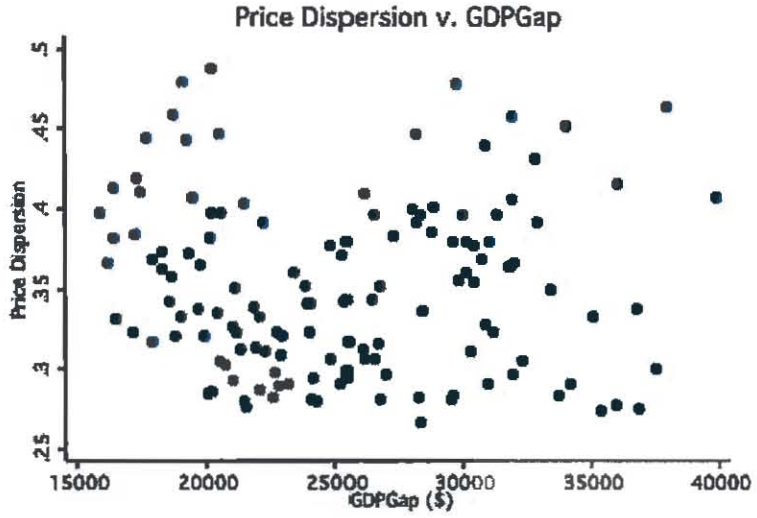
[8] Individual Latin American cities are listed in the data appendix.

[9] According to Balassa-Samuelson, the prices of non-tradeable goods (or goods with non-tradeable inputs) are directly related to productivity levels and wages in the tradeable sector. We can assume that virtually all goods in the study have some level of non-tradeable inputs.

Figure 1: **Price Dispersion v. GDPGap:**
Evidence for a "U-shaped" relationship



This plot suggests that the GDP differential may have a non-linear relationship with price dispersion. In fact, it appears that the data follow a "U-shape", where dispersion first decreases with early stages of unofficial dollarization, remains constant, then increases as a nation experiences higher levels of unofficial dollarization. This quick look into the behavior of the GDPGap leads me to include a squared term with a positive expected sign, as the "U-shape" appears to open upward.

Exchange Rate Volatility (XEVol): Nominal exchange rate volatility is yet another source of price differences and can be found in many models of price dispersion (*Parsley and Wei (2002), Goldberg and Verboven (2001), Faber and Stokman (2009), Goldberg and Knetter(1997), Parsley and Wei (2001)).* According to Purchasing Power Parity, prices should not be affected by exchange rates in the long run; however, in the short run before prices can adjust, we may observe sizeable price differences that stem from fluctuations in the exchange rate. This is especially true in the case of dollarizing Latin American nations where exchange rates are inherently volatile. In this study, we measure exchange rate volatility in each year as

the standard deviation of normalized monthly exchange rates, and we expect greater exchange rate volatility to be associated with an increase in price dispersion.

Control for Hyperinflationary Periods (HYPER): Taken directly from Parsley and Wei (2002), this variable accounts for hyperinflationary periods in Latin America. In this paper, we classify a hyperinflationary year as one in which inflation exceeded fifty percent.[10] We expect dispersion to be greater during these periods of abnormally high prices.

[10] Hyperinflationary periods include Argentina (1990-91), Uruguay (1990-93), Colombia (1994-97), Paraguay (1990-94), Peru (1990-92).

IV. Empirical Approach

To account for non-linear relationships in the explanatory variables, I used a right hand natural logarithmic transformation. This model will also allowed for easier interpretation of the point estimates on independent variables. In addition, I added in a squared term for the GDPGap as the data suggests there may be "U-shaped" relationship between the GDPGap and price dispersion.[11] My empirical specification is as follows:

$$DISP_{ij,k,t} = \beta_0 + \beta_1 * \ln(DOLLAR) + \beta_2 * \ln(GDPGap) + \beta_3 * (\ln GDPGap)^2 + \beta_4 * \ln(XEVol) + \beta_5 * \ln(DIST_{ij}) + \beta_6(HYPER) + City\ FEs + Year\ Fes$$

Summary of Baseline Variables				
Name	**Variable**	Exp. Sign	**Brief Description**	**Source**
$DISP_{ij}$	Price Dispersion		Dependent Variable measuring bilateral market integration via the level of price dispersion between nation pairs	EIU 2009
DOLLAR	Dollarization Index	-	Proxy for the level of unofficial dollarization in each Latin American country, measured as the ratio of foreign currency deposits to total deposits	Honohan (2008)
GDPGap	GDPGap	+	Control for Balassa-Samuelson effects, calculated as the absolute difference between US and Latin American GDP figures	WDBI CD-ROM 2008
XEVol	Exchange Rate Volatility	+	Standard deviation of normalized monthly exchange rates (1994-2006)	OANDA[12]
$DIST_{ij}$	Bilateral Distance	+	Great circle distance between cities in each city pair	
HYPER	Hyperinflation Period Indicator	+	Hyperinflation indicator, activated for years in which inflation exceeded 50% in the relevant Latin American nations	EIU 2009

[11] In the table A2 of the results appendix, I present results for an earlier version of this model that did not include the squared GDP term.

[12] OANDA exchange rate data is available at www.oanda.com. While the IMF International Financial Statistics database is the most accepted source of exchange rate data, this database did not include monthly exchange rate data for all of the Latin American nations in my study.

In section seven of this paper I discuss other specifications of this model that include additional variables and alternate functional forms. The results are robust over all other specifications and are generally unaffected by the addition of supplemental explanatory variables.

V. Results

The following are the results from my baseline model calculated across all goods. Robust standard errors are reported in parentheses. All results are significant at less than one percent.[13]

$$\mathbf{DISP_{ij,k,t}} = \boldsymbol{\beta_0} \underset{(.000)}{\mathbf{-\ .012}}\mathbf{*(lnDOLLAR)} \underset{(.020)}{\mathbf{-\ .481}}\mathbf{*(lnGDPGap)} + \underset{(.005)}{\mathbf{.180}}\mathbf{*(lnGDPGap)^2} +$$

$$\underset{(.000)}{\mathbf{.011}}\mathbf{*(lnXEVol)} + \underset{(.000)}{\mathbf{.023}}\mathbf{*(lnDIST_{ij})} + \underset{(.004)}{\mathbf{.093}}\mathbf{*(HYPER)} + \mathbf{City\ FEs + Year\ Fes}$$

Results are consistent across all goods and subsets of tradeable and non-tradeable goods. In addition, this specification of the model has adjusted r-square of .81, which suggests the model successfully accounts for the major determinants of price dispersion between Latin America and the United States.

Before jumping into analysis on the point estimates of each independent variable, it may be helpful to take a look at the behavior of our dependent variable: the width of the no-arbitrage band. The width of the band varies between .26 and .49 depending on the year and US-Latin American country pair, and a normal variation in the width of the band is about .05 (one standard

[13] Complete baseline results along with descriptive statistics are presented in table A1 of the results appendix.

deviation of the price dispersion measure). As we analyze the coefficients on each of the independent variables, we will determine economic significance based on the size of each point estimate relative to this "normally observed" deviation in the no-arbitrage band.

We first turn to the coefficient on our focus variable: unofficial dollarization. When multiplying the point estimate on the dollarization index by its standard deviation, which we assume to be a commonly observed variation, we find that higher levels of unofficial dollarization can reduce price dispersion by about .024 (-.012*2.0 = -.024). While this effect seems negligible, it actually represents about a one-half standard deviation reduction of the no-arbitrage band. Because market integration (as measured in this model by price dispersion) is a very complex variable influenced by a host of nation-specific characteristics, this one-half standard deviation movement appears much more significant.

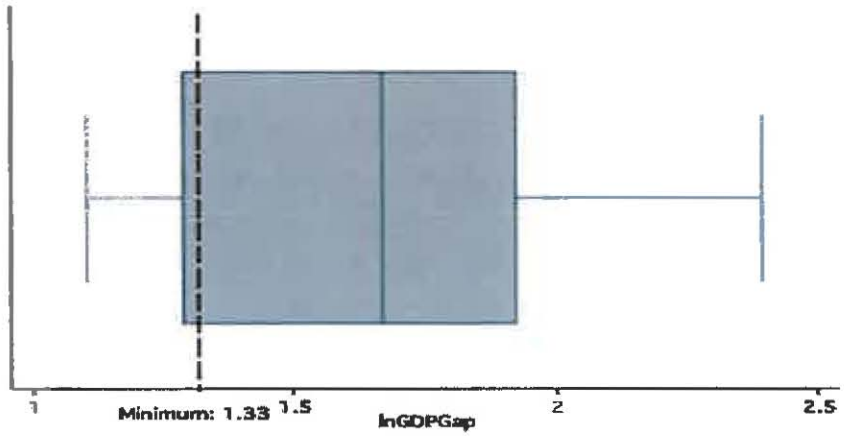
The integrating effect of unofficial dollarization becomes even more apparent when we look at integration between the United States and a country that has very little dollarization (e.g. Venezuela, with a mean dollarization index of .125%) versus a country that is officially dollarized (e.g. Ecuador). By moving from low Venezuelan levels of dollarization to very high Ecuadorian levels of dollarization, a nation could theoretically observe greater than one standard deviation reduction in the average width of the no-arbitrage band. These results suggest that unofficial dollarization *does*, in fact, have integrating effects for Latin American nations and the United States.

We will now move to the variable measuring the gross domestic product differential, GDPGap. When we first inspected the GDPGap and squared GDPGap variables, theory suggested that the signs would be positive. However, the regression yields a negative coefficient on GDPGap. Because of this troubling sign, we investigated the range of the data, and found

that the absolute minimum of the squared regression line occurs before the data begins; therefore, the only relevant part of the curve is the positively sloping portion where the data actually lie.

***Figure 2*: Box Plot for ln(GDPGap)**

As illustrated below, the majority of the data for lnGDPGap lie above the absolute minimum of the squared regression line (Minimum = 1.33).



In order to find the total effect of the GDPGap, we must partially differentiate our dependent variable with respect to the GDPGap.

$$Y = \beta_0 + \beta_2*(\ln GDPGap) + \beta_3*(\ln GDPGap)^2 \qquad (1)$$

$$dY/d(\ln GDPGap) = \beta_2 + 2(\beta_3)(\ln GDPGap) \qquad (2)$$

Next, we simply fill in the values for β_2 and β_3 and choose a reasonable value for the GDPGap. For comparison, we will use two values for the GDPGap: the mean of the natural log of the GDPGap (Eq 3) and the maximum value of the natural log of the GDPGap (Eq. 4).

$$dY/d(GDPGap) = -.48 + 2(.18)(1.64) = \mathbf{.11} \qquad (3)$$

$$dY/d(GDPGap) = -.48 + 2(.18)(2.39) = \mathbf{.38} \qquad (4)$$

After plugging these values into the equation, we find that the GDP differential is associated with an increase in the width of the no-arbitrage band of .11 to .38 (i.e. between *two* and *eight* standard deviations increase from the mean width of the arbitrage band). This finding is highly significant, both economically and statistically. It provides strong evidence for the Balassa-Samuelson theory and suggests that the key to integration may lie in closing the productivity gap (and thus the GDPGap) between nations.[14]

Finally, all control variables are statistically significant and display the expected positive relationship with price dispersion.

VI. Alternative Specifications and Tests for Robustness

In this section, I will discuss checks for robustness and explore alternate specifications of my baseline model. In short, the baseline results above hold strong throughout a variety of tests for robustness, and all explanatory variables remain significant and maintain their relationship to price dispersion when additional variables are added to the model.

(i) Robustness Checks

First, my results hold for all goods and for subsets of tradeables and non-tradeables, which suggests that dollarization may have integrating effects in all sectors.[15] As a second check for robustness, I ran the same baseline regressions without the semi-log transformation. While the overall fit of the model declines (R^2 declines by .03 from .81 to .78), all explanatory variables

[14] Crucini, et al (2005) also finds very strong evidence in favor of Balassa-Samuelson effects within a model of price dispersion.

[15] These results across good categories are presented in table A1 of the results appendix.

maintain their expected signs and significance.[16] Finally, I experimented with a variety of additional variables that control for protective measures and inflation. As before, the addition of these variables did not alter the point estimates or statistical significance of the core variables presented in my baseline model.

(ii) Additional Variables

As I explored alternate forms of my baseline model, I came across two more potential explanatory variables, namely controls for protective barriers and inflation. In this subsection, I will discuss the theory behind these additional controls and how they affect my results.

The first of these are controls for protective barriers in either Latin America or the United States. There are a variety of ways to account for protective barriers, but here I will only discuss tariffs and openness indices. Intuitively, one would expect tariffs to play a large role in determining price dispersion between nations. For example, if the United States places high tariffs on avocados from Mexico, a primary supplier of avocados, we would generally expect to see higher priced avocados in the United States. Because the theory underlying the relationship between tariffs and prices is quite strong, many authors have included tariff measures as an explanatory variable in price dispersion models (*Parsley and Wei (2002), Bergin and Glick (2007), Anderson and Van Wincoop (2004), Engel and Rogers (1996), etc).* However, the data underlying these controls is suspect. Until recently, tariff data has been inconsistent and difficult to find. For example, tariff data in the UN World Development Indicators is missing more than 50% of the time, and many of its observations in later publications contradict data presented in earlier volumes (WBDI 2008). Needless to say, this dataset is not reliable.

[16] The coefficient on distance changes signs, but the point estimate is effectively zero, so this negative sign becomes irrelevant. Results for this model are presented in table A2 of the results appendix.

Accurate tariff data are not only difficult to find, but the theory behind calculating tariff measures is surprisingly loose. One way to control for tariffs involves generating a variable that takes on the average tariff value by city pair and good (*Parsley and Wei (2002)*). This approach inaccurately measures the desired effect of tariff barriers because it fails to take into account the nation that is actually applying the tariff to each good, whether it be country *i*, country *j*, or a third party. Additional authors use the *sum* of tariff rates between the two nations in each city pair (*Bergin and Glick (2007), Parsley and Wei (2001)*), but this method suffers from the same aforementioned specification error.

In spite of these difficulties with tariff data, I will attempt to tease out the effects of tariff barriers on price dispersion. My data comes from the UNCTAD[17] World International Trade Statistics database, which includes tariff data from TRAINS.[18] This database is the most comprehensive, publicly accessible tariff database in the world. While I realize that the sum of tariff rates is not the most accurate measure of good-specific tariff barriers, I believe that it is the best possible option at my disposal. The modified results are presented in Figure 3 on the following page.

As evident in the results, the tariff control has an economically insignificant point estimate.[19] This observed relationship is likely a result of my tariff measure's inability to account for the good-specific nation that actually applies the tariff. Nevertheless, the complete lack of a relationship between tariffs and dispersion is rather surprising. As a potential remedy, I

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[17] United Nations Conference on Trade and Development

[18] The TRAINS (Trade Analysis and Information System) database is "a comprehensive computerized information system at the HS-based tariff line level covering tariff, para-tariff and non-tariff measures as well as import flows by origin for more than 140 countries." (Source: UNCTAD)

[19] The point estimate of the tariff variable falls from .002 to .001 when we take into account the standard deviation of the tariff variable (.55).

substituted tariff data with trade openness indices that more extensively account for non-tariff barriers (NTBs) and protectionist policies (*Faber and Stokman (2009)*). As a nation relaxes tariffs, NTBs, and protectionist policies, the trade openness index increases (i.e. an "open" country like the United States has a high openness index). Because higher indices are associated with greater protective barriers, we expect a negative relationship between the openness indices and price dispersion. I used two measures of trade restrictiveness: one from the Fraser Institute's Economic Freedom Network and the other from the Heritage Foundation's Index of Economic Freedom. As before, the control for protective barriers will take on the sum of the openness indices from each city in the pair. Though the point estimates on both indices carry an unexpected sign, these estimates fall close to zero when we take into account a "normally observed" movement in the respective trade indices.[20]

Figure 3*: Comparing Point Estimates for Protective Controls

Point Estimates for Protective Barrier Controls

Tariff	Heritage Index	Fraser Index
0.0023	**0.097**	**0.066**
(4.10E-04)	(0.0075)	(0.0076)

Descriptive Statistics

	Mean	Standard Deviation	Observations
lnTariff	3.02108	0.5471061	13488
lnHIndex	4.938807	0.0854358	22950
lnFIndex	2.664661	0.0732006	22950

*All results are significant at greater than one percent. Robust standard errors are listed in parentheses. Full results available in the table A4 of the results appendix.

In the final alternative specification, I replaced the control variable for hyperinflationary periods with a general control for inflation. This variable accounts for small changes in inflation as well as severe periods of hyperinflation. Higher inflation is generally associated with greater

[20] The point estimate on FIndex (Fraser Institute's Index) falls from .07 to .005 when taking into account the standard deviation on FIndex (.07). Similarly, the point estimate on HIndex (Hertiage Foundation's Index) falls from .10 to .008.

price dispersion (i.e. less market integration). Figure 4 below presents an excerpt of these results. The inclusion of a general inflation variable did not drastically change the point estimates on my baseline variables, however, the coefficient on dollarization dropped slightly, along with the overall fit of my model. Because the hyperinflation indicator variable was more economically significant than the general inflation control, I chose to keep the hyperinflation indicator in my baseline model.

***Figure 4*: Comparing Inflation Controls**

	Inflation Controls	
	Hyperinflation Indicator	General Inflation Control
lnDollar	**-0.012**	**-0.0094**
	(2.70E-04)	(4.00E-04)
Hyper	**0.093**	
	(0.0036)	
lnInflation		**0.0076**
		(3.50E-04)
Adjusted R^2	**.81**	**.78**

	Descriptive Statistics	
	Mean	Standard Deviation
lnInflation	2.437884	1.198648

*All results are significant at greater than one percent.
Robust standard errors are listed in parentheses. Full results listed in table A5 of the results appendix.

VII. Integration Among Dollarizing Nations

The observed price convergence between the United States and dollarizing nations suggests that unofficial dollarization has bilateral integrating effects as levels of dollarization increase. As discussed in the theory section, this phenomenon may be a result of both decreased economic "friction," as both countries price in the same currency, and/or the semblance of monetary union that arises with unofficial dollarization.

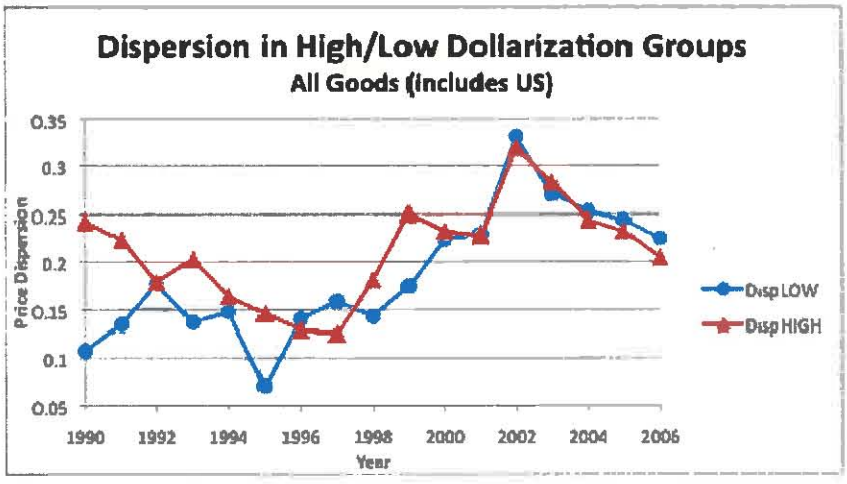
If this theory holds true, then perhaps it is the case that nations with high levels of unofficial dollarization are more integrated with each other than those nations with relatively few dollars in circulation. Because these nations are part of an "unofficial currency union" with the United States, prices in high dollarizing nations should converge around the United States price, thus revealing relatively tight price integration among the group of high dollarizers. In addition, nations with high levels of dollarization have an incentive to price items in both dollars and the domestic currency. As discussed in the theory section, this dual pricing scenario should reduce price wedges between USD and domestic currency. As a result, we should see greater convergence to the USD price within the high dollarization group. On the other hand, nations with low dollarization do not have an incentive to price items in both dollars and domestic currency. Without the dollar driving price convergence, we expect prices to be more dispersed across all non-dollarized nations.

Because this idea is not the central topic of this study and the theory behind it is admittedly weak, I take a more descriptive, less empirically intensive approach to examining this phenomenon. Following the work of Rogers (2007)[21], I construct an annual measure of price

[21] Rogers's measure of price dispersion is explained in greater detail in the final section of the data appendix.

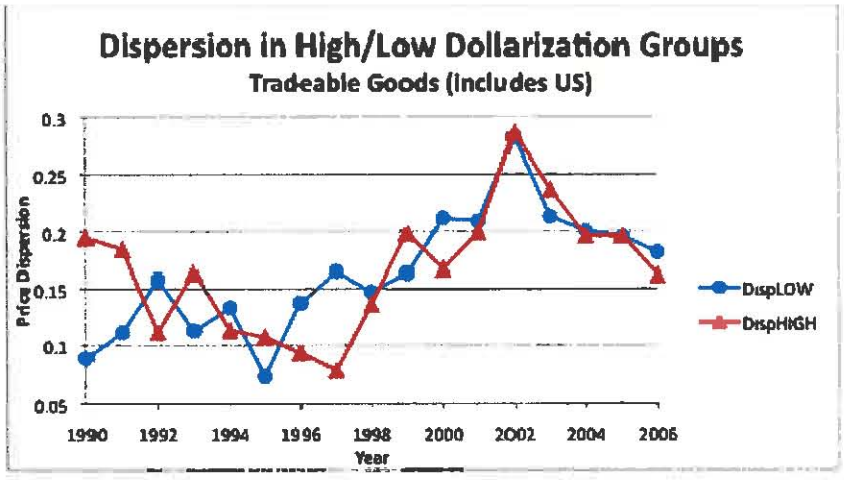
dispersion to track changes in market integration within high dollarization and low dollarization nation-groups. Because my purpose is primarily exploratory, I omit controls for distance, protective barriers, exchange rate volatility, and Balassa-Samuelson effects as in my previous model of bilateral integration.

I classify Latin American nations into two categories—"high dollarizers" and "low dollarizers"—based on data presented in Baliño, Benett, and Borensztein (1999), Honohan (2008), and Ize and Yeyati (2005). The high dollarizers include nations that are classified as such by at least two of the aforementioned authors or have a deposit dollarization index of greater than forty percent.[22] In addition, I include the United States in the high dollarization group because our premise of stronger integration is based on the assumption (1) that high dollarization countries are part of an unofficial currency union with the United States and (2) that the prices in the high dollarization nations will converge to the USD price. Using Rogers's method, I calculate the dispersion measure separately across all goods and for the both groups in each year. I discover the following trends of dispersion over time:

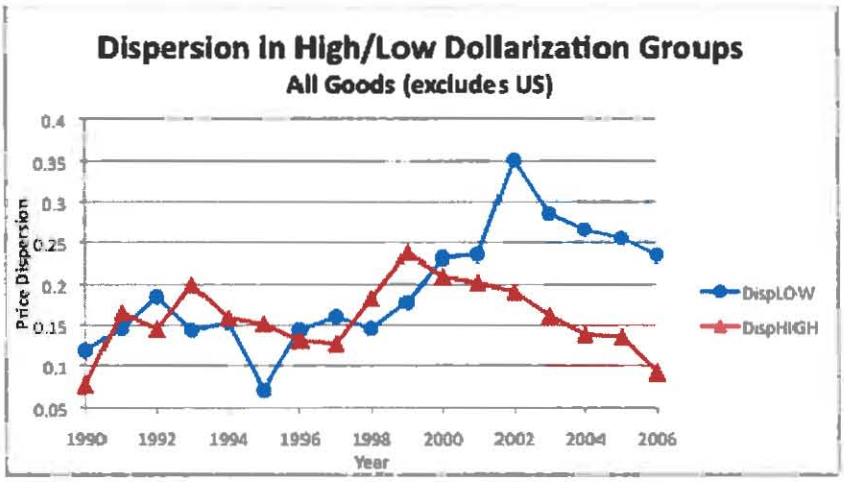


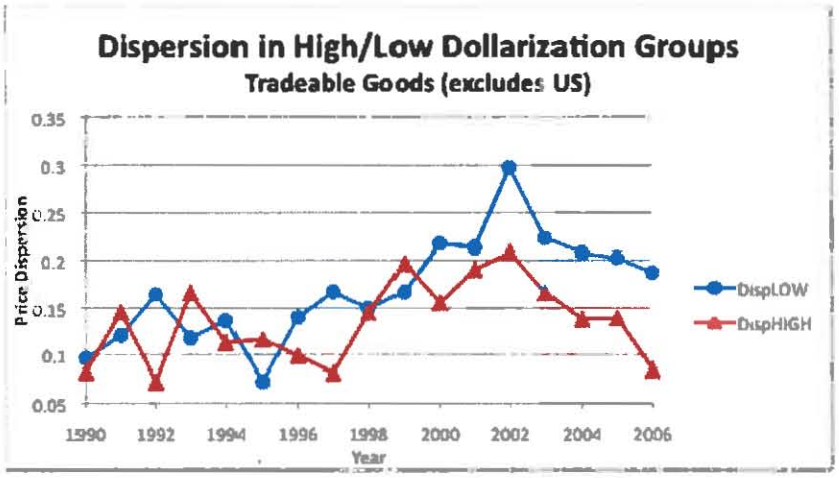
[22] Nations may be classified as high dollarizers in some years and low dollarizers in others. The exact classification of nations and years may be found in the section three of the data appendix.

On the whole, these results are inconclusive. The nation-group with lowest dispersion (i.e. strongest integration) alternates frequently and follows no obvious pattern. We observe that high dollarization group has more dispersed prices in the majority of years (ten out of 17 total years), which discredits my hypothesis that high dollarizers are more integrated than low dollarizers. In an effort to discover more conclusive results, I calculated Rogers's measure a second time using only tradeable goods.



Once again, our results fail to provide conclusive evidence on the group-integrating effects of high dollarization. As a final alternative, I recalculated the dispersion measure for the high dollarization group without including the United States. Because the model does not control for distance, the disproportionate distance of the United States from the other Latin American countries may significantly affect dispersion within the high dollarization group. The following results exclude the United States.





While these results are largely inconclusive, a pattern emerges after 2000. The high dollarization group becomes steadily more integrated and begins to diverge from the low dollarization group.[23] This pattern of behavior fits with my hypothesis of stronger integration within the high dollarizing nations; however, the lack of a consistent relationship in years prior to 2000 bars me from making a sound comparison between overall integration levels in each group. The unexpected trends discovered in this section may be driven by a few underlying characteristics of unofficial dollarization and/or inherent problems with my simplistic model.

[23] Ecuador became officially dollarized in early 2000. Perhaps this event is related to the change in dispersion patterns.

We will begin by assuming that these results are an accurate depiction of reality. In this case, the integrating effects of high dollarization may be diluted by the relative economic instability characteristic of many high dollarizing nations. Craig and Waller (2004) and De Nicolo, et al. (2005) find that unofficial dollarization (namely deposit dollarization) often occurs as a result of risk, exchange rate instability, and/or uncertainty about the future. During these periods of economic instability, nations often turn to the dollar as a means of preserving wealth. Thus, the high dollarizing nation group is self selected (i.e. endogenous), making comparison between low and high dollarizers difficult. As an illustrative example, imagine a Latin American nation suffers from an economic "illness"—be it currency instability, economic volatility, etc. As a potential treatment for this "illness," these nations begin using USD in hopes of stabilizing the nation and preserving wealth. We would expect that nations "treated" with USD circulation (i.e. high unofficial dollarizers) would be "healthier" (i.e. more integrated) than those who did not receive the treatment; however, in our results, we find that these treated nations are not any better off (or even worse off) than their non-treated (i.e. undollarized) counterparts. However this result is not surprising as the "treated" nations are the very same nations who were "sick" in the beginning. If high levels of dollarization are in fact a result of instability, then it comes as no surprise that high dollarizers are less integrated than we originally hypothesized.

Second, my results may be skewed by the small sample size of only twelve nations (eleven Latin American nations and the United States). If my categorization of high/low dollarizers does not accurately reflect reality, then my small sample would allow this misclassification to significantly distort the dispersion measure for the entire group. Moreover, the model lacks controls for important factors that affect price dispersion (namely distance between countries within the high/low dollarizing subgroups, nominal exchange rate volatility,

hyperinflation, etc.), so we must be cautious in making comparisons between country groups with significant unobserved heterogeneity.

Finally, the primary function of the dispersion measure used in this section (Rogers 2007) is to examine trends over time within country groups, rather than to compare integration levels between country groups. Because of the exploratory purpose of this study, I will not attempt to tease out the many economic factors that influence my results; but rather, it may be more informative to take a brief look into overall dispersion trends in this study as compared to those from Rogers's 2007 study.

Though Rogers (2007) focuses on price dispersion in Europe, his study covers a similar time period to my study and includes data on dispersion in the United States, both of which may be useful for comparison with my results. Rogers's results across tradeables and non-tradeables are presented below.

***Figure 5*: Dispersion Trends from Rogers (2007) – Tradeable Goods**

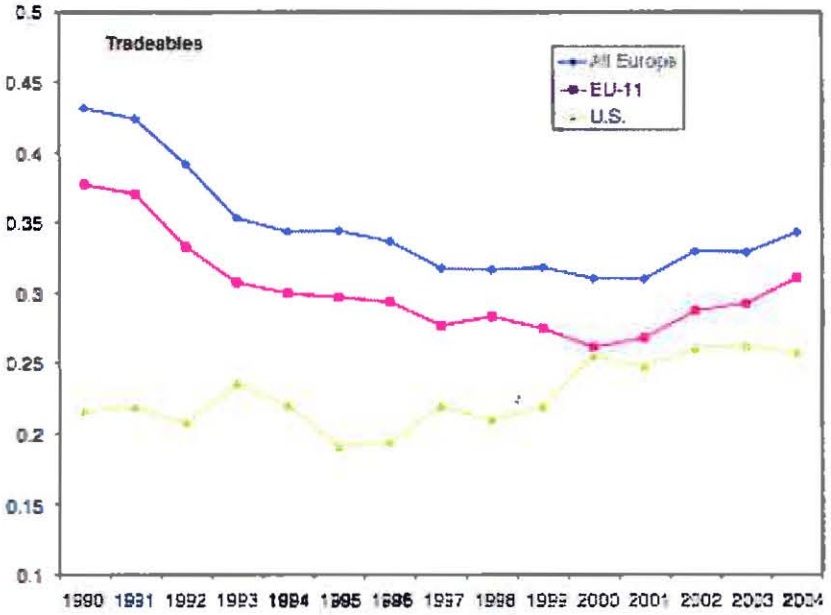
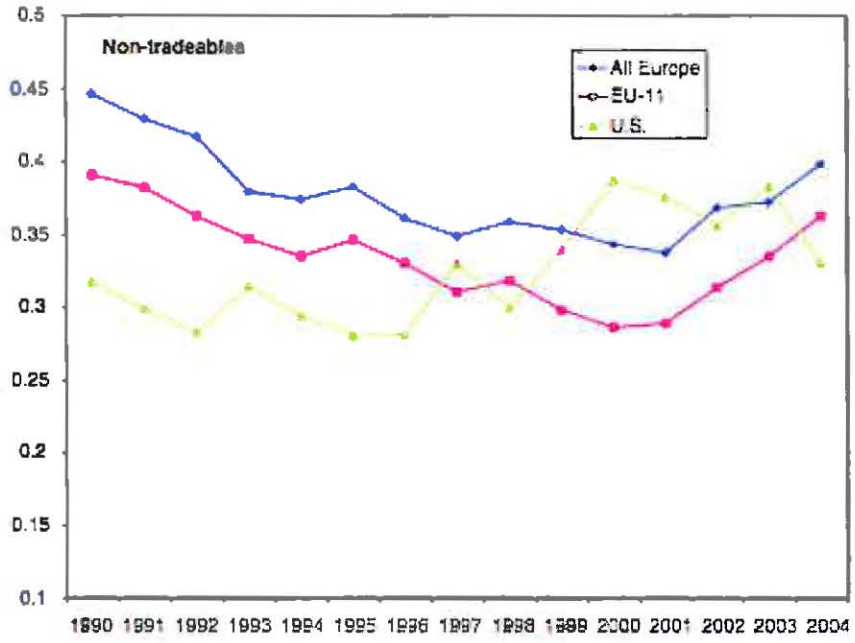


Figure 6: **Dispersion Trends from Rogers (2007) – Non-Tradeable Goods**



Dispersion trends in Europe show no obvious correlation with dispersion trends in Latin America, suggesting that price behavior in Latin America is not related to any global event. However, we notice that dispersion trends in the United States follow as similar patter to those in Latin America. Most notably, we observe low and steady dispersion levels in both the United States and Latin America until around 1998, when dispersion rises rapidly to a peak in 2000. The synchronized movement in dispersion levels suggests that an underlying multi-national event or economic circumstance may have influenced price dispersion throughout North and South America. Rogers provides no explanation of the driving forces behind his results for the United States, so we can only speculate that these trends stem from unobserved changes in trade liberalization, labor costs, etc., some of which may be specific to both the United States and Latin America. While it is not within the scope of this exploratory study, these observed trends

merit a more extensive analysis on factors that could drive price dispersion throughout the entire North and South American regions.

VIII. Conclusions and Policy Implications

When examining goods market integration between Latin American nations and the United States, we found that increases in unofficial dollarization in Latin America were associated with significant increases in bilateral integration. We used Parsley and Wei's (2002) measure of price dispersion—the width of the no-arbitrage band—as a proxy for market integration. We found that a one percent increase in the unofficial dollarization index is associated with one-quarter standard deviation decrease in the width of the band of no-arbitrage. When considering that dollarization levels often vary by two percent or more, we could easily observe one-half standard deviation decreases in dispersion. Because market integration (as measured in this model by price dispersion) is an incredibly complex variable, this one-half standard deviation increase in integration is highly significant.

These results provide an excellent base for future research in the relatively undeveloped field of unofficial dollarization research. In the future, attention should be paid to finding a more accurate measure of currency substitution and unofficial dollarization. In this study, a deposit dollarization index acts as a proxy for unofficial dollarization; however, this measure does not account for dollars in circulation outside of the banking system. As a result, the levels of dollarization are severely understated, and the final results may not fully capture the integrating effects of unofficial dollarization.

In the latter portion of this paper, we took an exploratory look at integration within dollarizing Latin American country groups. First, we separated eleven Latin American nations

into two groups, those with low dollarization and those with high dollarization. We then calculated the level of integration within each group using a group price dispersion measure taken from Rogers (2007). While we expected the high dollarization group to be more integrated, the results failed to provide a sound basis for comparing integration between the dollarization groups. These puzzling results could be attributed to small sample size or lack of controls for heterogeneity within the groups, but if they are an accurate reflection of reality, then it may be the case that high levels of unofficial dollarization are signaling economic instability. When analyzing dispersion trends over time, we notice that the Latin American nations in this study follow dispersion patterns similar to those of the United States as presented in Rogers's 2007 analysis of price conversion. This intriguing synchronization of dispersion trends merits further analysis that is beyond the capacity of this descriptive study.

Finally, we explored the implications of the results presented in this paper for Latin American dollarization policy. Virtually all unofficial dollarization research focuses on the negative effects that unofficial dollarization can have on monetary policy and exchange rate stability (*Feige (2002,2003); Reinhart, Rogoff, and Savastano (2003); Levy-Yeyati (2006); Levy-Yeyati and Ize (2005)*). Because widespread circulation of dollars can distort money supply measures and wreak havoc on economic stability, many authors suggest pursuing de-dollarization policies. However, my results suggest that unofficial dollarization may provide benefits in the form of stronger bilateral integration with the United States.

But why would a Latin American nation even be concerned with bilateral integration with the United States? In the most basic sense, disintegration signals inefficiency, and where there is economic efficiency, there are unrealized economic gains. Hufbauer, Wada, and Warren (2002) find that the benefits of market integration, as measured by price convergence, can

amount to about eighteen percent of the GDP of many low-income nations. In other words, a developing nation could experience economic gains of almost twenty percent of GDP as a result of stronger integration with the rest of the world. If unofficial dollarization does, in fact, increase integration, then the economic benefit of unofficial dollarization could be quite significant.

Despite the findings presented in this study, one cannot conclude that Latin America should embrace unofficial dollarization as a means of increasing economic prosperity. The gains from stronger integration may be severely outweighed by the costs of unofficial dollarization (ie. monetary policy instability, exchange rate instability, uncertainty, etc). While this study was not intended to provide policy suggestions for Latin America, the results offer an interesting new viewpoint for unofficial dollarization research. Perhaps Latin America nations should embrace the phenomenon of unofficial dollarization. After all, it may strengthen economic relations with the United States and provide a few unforeseen economic benefits of integration along the way!

XI. Results Appendix

A1: Baseline Regression Results

All point estimates are significant at less than one percent. Robust standard errors are listed in parentheses. Refer to the descriptive statistics for economic interpretation of the point estimates.

Variable	All Goods	Tradeables	Non-Tradeables
lnDOLLAR	**-0.012**	**-0.0129**	**-0.0126**
	(2.70E-04)	(3.00E-04)	(7.20E-04)
lnGDPGap	**-0.481**	**-0.325**	**-0.747**
	(0.0193)	(0.0188)	(0.0458)
$(\ln GDPGap)^2$	**0.18**	**0.175**	**0.192**
	(0.005)	(0.0047)	(0.0122)
lnXEVol	**0.0112**	**0.0101**	**0.0119**
	(6.20E-04)	(7.50E-04)	(0.0018)
$\ln DIST_{ij}$	**0.0229**	**0.00982**	**0.0398**
	(7.90E-04)	(7.90E-04)	(0.0026)
HYPER	**0.0931**	**0.0512**	**0.12**
	(0.0036)	(0.0027)	(0.0085)
_cons	**0.522**	**0.376**	**0.789**
	(0.0168)	(0.0172)	(0.0368)
City FEs	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes
n	12450	8798	12450
Adjusted R^2	0.81	0.81	0.78
MSE	0.0204	0.0205	0.0225

Descriptive Statistics for Logged Variables:

Variable	Obs	Mean	Std. Dev.	Min	Max
DISP	22800	0.35	0.05	0.26	0.49
lnDollar	18900	2.60	2.02	-2.30	4.61
lnDistance	22950	7.98	0.58	6.63	8.55
lnGDPij	20400	1.64	0.36	1.10	2.39
$(\ln GDPij)^2$	20400	2.81	1.22	1.22	5.72
lnXEVol	16950	4.93	3.20	0.00	10.17

Table A2: Baseline Model without GDPGap Squared Term

All point estimates are significant at less than one percent. Robust standard errors are listed in paretheses. Refer to the descriptive statistics for economic interpretation of the point estimates.

Variable	Baseline Model	Without GDP^2
lnDOLLAR	**-0.012** (2.70E-04)	**-0.00661** (2.30E-04)
lnGDPGap	**-0.481** (0.0193)	**0.18** (0.0046)
$(lnGDPGap)^2$	**0.18** (0.005)	
lnXEVol	**0.0112** (6.20E-04)	**0.0069** (7.20E-04)
$lnDIST_{ii}$	**0.0229** (7.90E-04)	**0.0131** (8.20E-04)
HYPER	**0.0931** (0.0036)	**0.0927** (0.005)
cons	**0.522** (0.0168)	**0.0359** (0.0067)
City FEs	Yes	Yes
Time FEs	Yes	Yes
n	12450	12450
Adjusted R^2	0.814	0.775
MSE	0.0204	0.0225

While all the signs and statistical significance of variables remain robust to through deletion of the GDPGap squared term, the coefficient on unofficial dollarization drops by fifty percent. However, the baseline model has a better overall fit as measured by the adjusted r-square.

A3: Baseline Regression without Log Transformations

All point estimates are significant at less than one percent. Robust standard errors are listed in parentheses.

Variable	Baseline Model	Without GDP^2
Dollar	**-0.00044**	**-0.00028**
	(2.50E-05)	(2.10E-05)
GDPGap	**7.40E-07**	**1.50E-05**
	(1.90E-06)	(4.60E-07)
$(GDPGap)^2$	**1.70E-10**	
	(2.30E-11)	
XEVol	**7.00E-06**	**6.50E-06**
	(2.20E-07)	(2.30E-07)
$DIST_{ij}$	**-1.50E-05**	**-1.50E-05**
	(1.90E-07)	(1.80E-07)
HYPER	**0.0712**	**0.0746**
	(0.0026)	(0.0026)
_cons	**0.155**	**-0.108**
	(0.0373)	(0.0146)
City FEs	Yes	Yes
Time FEs	Yes	Yes
n	12150	12150
Adjusted R^2	0.73	0.728
MSE	0.0254	0.0254

All results remain significant and retain their respective expected sign. The coefficient on distance becomes negative, but this is irrelevant as the point estimate is effectively zero.

Descriptive Statistics for Unlogged Variables:

Variable	Obs	Mean	Std. Dev.	Min	Max
DISP	22800	0.3467216	0.0525927	0.2638042	0.4872663
DIndex	18600	32.40323	29.83287	0	88.8
GDPij	20400	25397.78	5693.111	15849.8	39933.99
GDPij2	20400	6.77E+08	3.02E+08	2.51E+08	1.59E+09
Distance	22950	3352.556	1473.734	755	5150
XE	16950	2686.139	6167.827	0.99925	25998.8

A4: Controlling for Protective Barriers

This table reports regression results for with three variations of controls for protective barriers: (1) Tariff Barriers, (2) Heritage Foundation Openness Index, (3) Fraser Institute Openness Index. All point estimates are significant at less than one percent. Robust standard errors are listed in parentheses.

Variable	Tariff	Heritage Openness Index	Fraser Openness Index
lnDOLLAR	**-0.012** (3.20E-04)	**-0.013** (2.70E-04)	**-0.012** (2.50E-04)
lnGDPGap	**-0.48** (0.023)	**-0.45** (0.018)	**-0.46** (0.018)
$(\ln GDPGap)^2$	**0.18** (0.006)	**0.18** (0.0047)	**0.18** (0.0048)
lnXEVol	**0.011** (7.70E-04)	**0.012** (6.20E-04)	**0.011** (6.30E-04)
$\ln DIST_{ii}$	**0.022** -9.90E-04	**0.028** -8.60E-04	**0.025** -8.60E-04
HYPER	**0.092** (0.0047)	**0.093** (0.0034)	**0.093** (0.0034)
lnTariff	**0.0023** (4.10E-04)		
lnHOpen		**0.097** (0.0075)	
lnFOpen			**0.066** (0.0076)
cons	0.52 0.02	-0.018 0.042	0.3 0.027
City FEs	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes
n	8651	12450	12450
Adjusted R^2	0.82	0.82	0.82
MSE	0.02	0.02	0.02

Descriptive Statistics for Protective Barrier Controls:

Variable	Obs	Mean	Std. Dev.	Min	Max
lnTariff	13488	3.02108	0.5471061	-1.514128	4.913757
lnHOpen	22950	4.938807	0.0854358	4.394449	5.09375
lnFOpen	22950	2.664661	0.0732006	2.475785	2.781342

A5: Alternative Control for Inflation

This table reports results with the hyperinflation indicator variable (as in the baseline regression) alongside results using the general Inflation control. All point estimates are significant at less than one percent. Robust standard errors are listed in parentheses.

Variable	Baseline Model with Hyperinflation Dummy	General Inflation Variable
lnDOLLAR	**-0.012** (2.70E-04)	**-0.0094** (4.00E-04)
lnGDPGap	**-0.48** (0.019)	**-0.59** (0.029)
$(\ln GDPGap)^2$	**0.18** (0.005)	**0.18** (0.0068)
lnXEVol	**0.011** (6.20E-04)	**0.0066** (8.90E-04)
$\ln DIST_{ii}$	**0.023** (7.90E-04)	**0.024** (0.0011)
HYPER	**0.093** (0.0036)	
lnInflation		**0.0076** (3.50E-04)
cons	0.52 (0.017)	0.63 (0.023)
City FEs	Yes	Yes
Time FEs	Yes	Yes
N	12450	12000
Adjusted R^2	0.81	0.78
MSE	0.02	0.023

Descriptive Statistics for Inflation Control:

Variable	Obs	Mean	Std. Dev.	Min	Max
lnInflation	21150	2.437884	1.198648	-1.857899	6.015003

X. Data Appendix

(i) Measures of Unofficial Dollarization and Currency Substitution

Because of the difficulty in measuring foreign currency in circulation within an economy, literature surrounding unofficial dollarization and currency substitution is sparse and largely undeveloped. A few authors, most notably Edward Feige, have collected data from confidential databases to form the most accurate measures of unofficial dollarization available. Other authors have created indices measuring various aspects of unofficial dollarization; however, these indices often require data that is not public accessible. While I am unable to use any of these unofficial dollarization measures in my study, they are an important part of understanding the currency substitution phenomenon.

Feige (2003) identifies four possible approaches to measuring unofficial dollarization: (1) an IMF dollarization index developed by Baliño, Bennet, and Borensztein (1999); (2) a currency substitution index that measures the extent to which foreign currency substitutes local currency as medium of exchange; (3) an asset substitution index that measures the extent to which foreign denominated monetary assets substitute domestic monetary assets; and finally, (4) the comprehensive unofficial dollarization index. Each of these measures is calculated as follows:

(1) **IMF Dollarization Index** = *FCD / Broad Money Supply* (M3)
(2) **Currency Substitution Index** = *FCC* / [*FCC* + *LCC*]
(3) **Asset Substitution Index** = *FCD* / (*LCD* + *FCD* + *LTD)*
(4) **Unofficial Dollarization Index** = [*FCC* + *FCD*] / *Effective Broad Money Supply*

FCD: Foreign currency deposits in the domestic banking system
FCC: Foreign currency in circulation within the economy
LCC: Local (domestic) currency in circulation
LCD: Local currency deposits
LTD: Local currency time and savings deposits
Effective Broad Money Supply: Broad Money (M3) + FCC

Data on Broad Money Supply is readily available on the IMF's online International Financial Statistics Database (IFS); however, data on foreign currency deposits and foreign currency in circulation is much more difficult to obtain. Foreign currency deposits belongs to an internal IMF database and data on foreign currency in circulation does not exist in any official form. In order to calculate FCC, Feige (1994) uses a proxy measure based on the total amount of $100 bills issued by the Federal Reserve in New York and Los Angeles. While this seems like an incredibly rough proxy, Feige notes that it is consistently correlated with confidential Federal Reserve estimates of net currency flows abroad. In later currency substitution papers, Feige (2003) recalculates the unofficial dollarization index using FCC data compiled from CMIR[24] data used by the US Customs Service. In both cases, the figures are restricted to government use. While Feige notes that the IMF index far underestimates the level of dollarization in an economy, he does find that this IMF measure follows the same trend over time as the more comprehensive unofficial dollarization index.

Finally, I would like to discuss the deposit dollarization index, the proxy for unofficial dollarization used in this paper. These data were gathered and calculated by hand from the statistical appendices of IMF country reports, and are used in deposit dollarization studies by Honohan (2008), De Nicoló et. al. (2005), and Yeyati (2006). This measure is very similar to the IMF dollarization index because it is uses data foreign currency deposits; however, this index is calculated as the ratio of FCD to total deposits, rather than broad money supply. When I entered the IMF index data provided in Baliño, Bennet, and Borensztein (1999) along with the Deposit Dollarization data, I found that the two indices are *very* highly correlated.[25] Because the IMF index is highly correlated with Feige's comprehensive unofficial dollarization index (Feige

[24] Reports of International Transportation of Currency or Monetary Instruments (CMIR) must be filed when exporting/importing currency in excess of $10,000.
[25] The Pearson correlation coefficient for these two indices is .92.

2001), I feel confident that my proxy measures unofficial dollarization in the most accurate way possible given my data limitations.

(ii) Disaggregate Price Data

Disaggregate price data come from the 2009 update of the Economist Intelligence Unit (EIU) Cost of Living Survey. The EIU compiles a comprehensive annual survey of prices that international corporations use to estimate the cost of living for an employee living abroad. The dataset contains prices for a wide variety of goods in over 140 cities around the world. For the majority of goods, the EIU provides two prices—one from a supermarket and the other a "moderately-priced" store or outlet. Whenever two prices are listed, I will use only the supermarket price to ensure greater uniformity in pricing (as supermarkets generally offer the most competitive price). In a handful of other cases, the EIU presents a low-priced option and a high (or moderately) priced item. Both options have similar data coverage, so I choose to keep the highest-priced option in all cases.[26] In addition, I eliminate all good associated with US, German, and French education and tuition as the majority of Latin America does not have access to such educational paths.[27] Because of the immense geographical and historical coverage of this dataset, there exists a number of missing price observations for certain goods, cities, and years as well as a large handful of suspiciously high or low observations. While being careful to not unethically eliminate too many observations, I conducted a thorough examination of the remaining data, which resulted in the removal of 15 additional "problematic" goods. These goods must have more than 25% missing observations and must contain at least 25% extraneous

[26] When given the choice between moderate and high-priced, I always choose the high priced option to maintain uniformity.

[27] The dataset contains 15 goods associated with school tuition in the United States, Germany, and France.

observations.[28] After making these drops, the dataset contains 151 goods including food items, household items, recreational items, and alcohol (among others).

The full EIU dataset provides price information for thirteen Latin American countries; however, for this study, I will only use data from one US City (Houston) and the nine Latin American countries for which I also have dollarization data. These countries include Argentina, Chile, Colombia, Ecuador, Mexico, Paraguay, Perú, Uruguay, and Venezuela, and price data is taken from Buenos Aires, Santiago, Bogota, Quito, Mexcio City, Asuncion, Lima, Montevido, and Caracas, respectively.[29] My final dataset contains price information for the eleven aforementioned cities for 151 goods over the period 1990-2006. These goods are listed in Table B1. An asterisk denotes a non-tradeable good.

[28] "Extraneous observation" refers to an observation that differs from the good-specific city average price by a factor of ten or more.

[29] Because of dollarization data limitations, Brazil, Costa Rica, and Panama are not included in this study.

Table B1: Dissagregate Good Prices included in the Final Dataset

(Goods are numbered by Good Codes given in the EIU Dataset)

FOOD

0 – Apples (1kg)
2 – Bacon (1kg)
4 – Bananas (1kg)
6 – Beef, filet mignon (1kg)
8 – Beef, ground (1kg)
10 – Beef, roast (1kg)
12 – Beef, entrecote (1kg)
14 – Beef, shoulder (1kg)
16 – Butter (500g)
18 – Carrots (1kg)
20 – Cheese, imported (500g)
22 – Chicken, fresh (1kg)
26 – Coca-Cola (1L)
28 – Cocoa (250g)
30 – Cornflakes (375g)
32 – Cocoa, beverage (500g)
34 – Eggs (12)
36 – Flour, white (1kg)
38 – Fish, fresh (1kg)
40 – Fish, frozen (1kg)
42 – Coffee, ground (500g)
44 – Ham, whole (1kg)
46 – Coffee, instant (125g)
48 – Lamb, chops (1kg)
50 – Lamb, leg (1kg)
54 – Lemons (1kg)
56 – Lettuce (one)
58 – Margarine (500g)
60 – Milk, pasteurized (1L)
62 – Water, mineral (1L)
64 – Mushrooms (1kg)
66 – Olive Oil (1L)
68 – Onions (1kg)
70 – Orange Juice (1L)
72 – Oranges (1kg)
74 – Peaches, canned (500g)
76 – Peanut or Corn Oil (1L)
78 – Peas, canned (250g)
80 – Pork Chops (1kg)
82 – Pork Loin (1kg)
84 – Potatoes (2kg)
86 – Pineapples, diced (500g)
88 – Spaghetti (1kg)
90 – Sugar, white (1kg)
92 – Tea Bags (25)
94 – Tomatoes (1kg)
96 – Tomatoes, canned (250g)
98 – Water, tonic (1L)
106 – Bread, white (1kg)
108 – Rice, white (1kg)
110 – Yogurt, natural (150g)

WAGES

134* – Babysitter, hour
135* – Domestic cleaning, hour
136* – Maid, full-time

ALCOHOL

138 – Beer, local (1L)
140 – Beer, quality (1L)
142 – Cognac, French (700ml)
144 – Gin (700ml)
146 – Liqueur (700ml)
148 – Scotch whisky (700ml)
150 – Vermouth (1L)
152 – Wine, common (750ml)
154 – Wine, fine (750ml)
156 – Wine, superior (750ml)

CLOTHING

157 – Boy's dress trousers
159 – Boy's jacket
161 – Child's jeans
164 – Child's shoes, dress
166 – Child's shoes, sports
167 – Girl's dress
170 – Men's shirt
171 – Men's suit
176 – Men's shoes
178 – Socks, wool
179 – Women's sweater
182 – Women's dress
185 – Women's shoes
187 – Women's panty hose

HOUSEHOLD/PERSONAL

190 – Batteries, D-LR20 (2)
192 – Dishwashing soap (750ml)
194* – Dry cleaning, suit
196* – Dry cleaning, trousers
198* – Dry cleaning, dress
200 – Toaster, electric
202 – Frying pan, Teflon
204 – Insecticide spray (330g)
206* – Laundry service, shirt
208 – Laundry detergent (3L)
210 – Light bulb, 60 watt (2)
212 – Soap (100g)
214 – Toilet Tissue (2 rolls)
216 – Aspirin (100 tablets)
218 – Tissues, facial (100)
220 – Lotion, hand (125ml)
221 – Lipstick, deluxe
223* – Haircut, men's
225 – Razor blades (5)
227 – Shampoo (400ml)
229 – Toothpaste (120g)
230* – Haircut, women's
231* – X-ray
232* – Medical Checkup
233* – Dental Visit

RENTS

234* – Apt, furnished (1bed)
236* – Apt, furnished (2 bed)
238* – House, furnished (3 bed)
242* – Apt, unfurnished (1 bed)
244* – Apt, unfurnished (2 bed)
246* – Apt, unfurnished (3 bed)
248* – House, unfurn. (3 bed)
250* – House, unfurn. (4 bed)

RECREATION

253 – Newspaper, daily local
254* – Fast food meal
255* – Hotel (nightly)
257* – Rental car, mod. (week)
258 – Newspaper, international
259 – News magazine, Time
260* – Hotel, moderate (nightly)
261* – Drink at hotel bar
262* – Cinema Ticket (1 seat)
263* – Meal, simple (1person)
264* – Meal, two-course
265 – Compact Disc Album
266* – Photo develop, color
267* – Cinema tickets (4 seats)
268* – Theater tickets (4 seats)
269 – Film, Kodak color
270 – Novel, paperback
272 – Television, color
273* – Meal, three course
279 – Tennis Balls (6)
294 – Cigarettes, local (20)
296 – Cigarettes, Marlboro (20)
297 – Pipe tobacco (50g)

TRANSPORTATION

298* – Car Insurance premium
300 – Car, compact
302* –Vehicle tune-up
304 – Car, deluxe
306 – Car, family
308 – Car, low-priced
310 – Gas, regular unleaded
311* – Taxi rate (per km)
312* – Taxi fare (from airport)
313* – Taxi initial meter charge
314* – Registration tax

UTITLITES

316*– Electricity bills, monthly
317* – Gas Bills, monthly
320* – Telephone, local call
321* – Water Bills, monthly

(iii) Classification of Countries into High and Low Dollarization Groups

In the exploratory portion of this paper, I separated eleven Latin American nations and the United States into two groups, those with high levels of dollarization and those with low dollarization. The groups are classified as follows:

Low Dollarization	High Dollarization
Argentina (2001 – 2006)	Argentina (1990-2000)
Chile	Costa Rica
Colombia	Ecuador (1999-2006)
Ecuador (1990-1998)	Paraguay (1992-2006)
Guatemala	Peru
Mexico	United States
Paraguay (1990-1991)	Uruguay
Venezuela	

These classifications were made based on a studies of unofficial dollarization by Baliño, Benett, and Borensztein (1999), De Nicoló, et al (2005), and Honohan (2008), etc. The high dollarizers include nations are classified as such by at least two of the aforementioned authors or have a deposit dollarization index of greater than forty percent.[30] The United States is included in the sample of high dollarizers because our premise of stronger integration within the high dollarizers assumes that the prices in the high dollarization nations will converge to the USD price.

(iv) Rogers (2007) Dispersion Measure applied to High/Low Dollarization Groups

In a study of price convergence throughout the European Union, John Rogers (2007) employs a measure of price dispersion that facilitates the examination of price behavior over

[30] There is a natural break in the data around forty percent. The low dollarizing nations have dollarization indexes between zero and fifteen percent, while the high dollarizing nations have indexes between forty and eighty percent.

time throughout Europe as a whole. Because Rogers's measure investigates integration within a group of countries, rather than city pairs, it proves useful for the comparison of integration between the high dollarization nation group and low dollarization nation group.

Rogers's dispersion measure is calculated as the standard deviation of the city-average demeaned prices in each group of cities.[31] His basic unit of calculation is the demeaned price,

$$P^*_{i,k,t} = P_{i,k,t} / Q_{i,t} \qquad (1)$$

where $P_{i,k,t}$ is the price of the item (i) in city (k) in year (t) and $Q_{i,t}$ is the cross-city mean price of an item (i) in year (t). Rogers then takes the standard deviation of these demeaned prices to calculate a measure of dispersion for each group of cities in the sample (in his case all EU cities) (Eq 2).

$$\textbf{Dispersion} = \sigma[P^*_{i,k,t}] \qquad (2)$$

In my study, I separated the cities into those from high-dollarization nations and those from low-dollarization countries. Finally, I calculated the standard deviation of the city-average demeaned prices for each nation group to obtain an annual measure of price dispersion for each dollarization group.

[31] Rogers divides goods into item groups (i.e. tradables and non-tradeables), but for simplicity, we will calculate his measure across all goods.

References

Anderson, James E., and Eric van Wincoop. 2004. "Trade costs." *Journal of Economic Literature* 42, (3) (September 2004): 691-751.

Asplund, Marcus, and Richard Friberg. 2001. "The law of one price in Scandinavian duty-free stores." *American Economic Review* 91, (4) (September 2001): 1072-83.

Baliño, T., Bennet, A., Borensztein, E. 1999. "Monetary policy in dollarized economies (Occasional Paper 171)." Washington, DC: International Monetary Fund.

Bergin, Paul R., and Reuven Glick. 2007. "Global price dispersion: Are prices converging or diverging?" *Journal of International Money and Finance* 26, (5) (9): 703-29.

Broda, Christian, and Eduardo Levy-Yeyati. 2006. "Endogenous deposit dollarization." *Journal of Money, Credit, and Banking* 38, (4) (June 2006): 963-88.

Connell, Paul G. J., and Shang-Jin Wei. 2002. "The bigger they are, the harder they fall": Retail price differences across U.S. cities. *Journal of International Economics* 56, (1) (January 2002): 21-53.

Craig, Ben, and Christopher J. Waller. 2004. "Dollarization and Currency Exchange." *Journal of Monetary Economics* 51 (2004): 671-89.

Crucini, Mario J., Chris I. Telmer, and Marios Zachariadis. 2005. "Understanding european real exchange rates." *American Economic Review* 95, (3) (June 2005): 724-38.

De Nicoló, G., P. Honohan, and A. Ize. 2005. "Dollarization of the Banking System: Good or Bad?" *Journal of Banking and Finance*, 29(7), 1697-727.

Engel, Charles, and John H. Rogers. 1996. "How wide is the border?" *The American Economic Review* 86, (5) (Dec.): 1112-25.

Engel, Charles, and John H. Rogers. 2004. "European product market integration after the euro."

Faber, Riemer P., and Ad C. J. Stokman. 2009. "A short history of price level convergence in Europe." *Journal of Money, Credit, and Banking* 41, (2-3) (March-April 2009): 461-77.

Feige, Edgar L. 1994. "The underground economy and the currency enigma."

Feige, Edgar L., Michael Faulend, Velimir Sonje, and Vedran Sosic. 2003. "Unofficial dollarization in Latin America: Currency substitution, network externalities, and irreversibility." In *The dollarization debate.*, eds. Dominick Salvatore, James W. Dean and Thomas D. Willett eds, 46-71. Oxford and New York: Oxford University Press.

Frankel, J. A., and A. K. Rose. 2000. "Estimating the effect of currency unions on trade and output." *Estimating the Effect of Currency Unions on Trade and Output.*

Fraser Institute. 2008. *Website of the Economic Freedom Network*: "Economic Freedom of the World Data." Jan. 2010. Online. Available http://www.freetheworld.com/datasets_efw.html.

Glick, Reuven, and Andrew K. Rose. 2002. "Does a currency union affect trade? The time-series evidence." *European Economic Review* 46, (6) (June 2002): 1125-51.

Goldberg, Pinelopi K., and Frank Verboven. 2005. Market integration and convergence to the law of one price: Evidence from the european car market. *Journal of International Economics* 65, (1) (January 2005): 49-73.

Goldberg, Pinelopi Koujianou, and Frank Verboven. 2001. The evolution of price dispersion in the european car market. *The Review of Economic Studies* 68, (4) (Oct.): 811-48.

Goldberg, Pinelopi Koujianou, and Michael M. Knetter. 1997. Goods prices and exchange rates: What have we learned? *Journal of Economic Literature* 35, (3) (Sep.): 1243-72.

Gulde, Anne-Marie, David Hoelscher, Alain Ize, David Marston, and Gianni De Nicoló. 2004. Financial stability in dollarized economies.International Monetary Fund, IMF Occasional Papers.

Heritage Foundation and Wall Street Journal. 2010. *2010 Index of Economic Freedom.* Jan. 2010. Online. Available http://www.heritage.org/index/Download.aspx.

Honig, Adam. 2009. Dollarization, exchange rate regimes and government quality. *Journal of International Money and Finance* 28, (2) (March 2009): 198-214.

Honohan, Patrick. 2008. The retreat of deposit dollarization. *International Finance* 11, (3) (Winter 2008): 247-68.

Hufbauer, Gary Clyde, Erika Wada, and Tony Warren. 2002. The benefits of price convergence: Speculative calculations. *Policy Analyses in International Economics*(65).

Ize, Alain, and Eduardo Levy Yeyati. 2005. Financial de-dollarization: Is it for real? International Monetary Fund, IMF Working Papers.

Klein, Michael W. 2005. Dollarization and trade. *Journal of International Money and Finance* 24, (6) (October 2005): 935-43.

OANDA. 2010. "Currency Tools." Jan. 2010. Online. Available http://www.oanda.com/currency/.

Obstfeld, Maurice, and Alan M. Taylor. 1997. Nonlinear aspects of goods-market arbitrage and adjustment: Heckscher's commodity points revisited. *Journal of the Japanese and International Economies* 11, (4) (December 1997): 441-79.

Ozsoz, Emre. 2009. Evaluating the effects of deposit dollarization in financial intermediation in transition economies. *Eastern European Economics* 47, (4) (July-August 2009): 5-24.

Parsley, David C. and Shang-Jin Wei. 2002. "Currency Arrangements and Goods Market Integration: A Price-based Approach." Working Paper. Vanderbilt University.

Parsley, David C., and Shang-Jin Wei. 2001. Explaining the border effect: The role of exchange rate variability, shipping costs, and geography. *Journal of International Economics* 55, (1) (10): 87-105.

Parsley, David, and Shang-Jin Wei. 2001. Limiting currency volatility to stimulate goods market integration: A price-based approach.C.E.P.R. Discussion Papers, CEPR Discussion Papers.

Penaloza, Roberto V. 2005. Dollarization and price dynamics.

Reinhart, Carmen M., Kenneth S. Rogoff, and Miguel A. Savastano. 2003. Addicted to dollars.National Bureau of Economic Research, Inc, NBER Working Papers.

Rogers, John H. 2007. Monetary union, price level convergence, and inflation: How close is europe to the USA? *Journal of Monetary Economics* 54, (3) (April 2007): 785-96.

Rose, A. K. 2000. One money, one market: The effect of common currencies on trade. *Economic Policy*(30): 7-45.

Rose, Andrew K., and Charles Engel. 2002. Currency unions and international integration. *Journal of Money, Credit, and Banking* 34, (4) (November 2002): 1067-89.

Taylor, Alan M. 2001. Potential pitfalls for the purchasing-power-parity puzzle? sampling and specification biases in mean-reversion tests of the law of one price. *Econometrica* 69, (2) (March 2001): 473-98.

United States Treasury Department. 2006. "The use and counterfeiting of United States Currency Abroad", Part 3, January (2006).

World Bank. 2008. Data retrieved November 2009 from World Development. Indicators CD-ROM.

Yeyati, E. L. 2006. Financial dollarization: Evaluating the consequences. *Economic Policy* 21, (45): 61-118.