Exchange Rate Pass-Through and the Role of Market Shares

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Abstract

This paper examines the effects of changing market shares on exchange rate pass-through to US import prices. Based on a static model of imperfect competition, I predict that a country with a larger share of a host′s import market will have lower pass-through than its competitors. Using highly disaggregated data on US imports, I implement rolling regressions to calculate unique quarterly values of pass-through for specific goods from each exporting country. These values are compared across market shares, indicating a general trend of decreasing pass-through for larger shares. Most specifically, as predicted by the model, the country holding the largest share of the market has significantly lower pass-through than its competitors. The negative relationship between pass-through and market share holds across most categories of goods, most notably the larger categories of imports. Lastly, I show the market share effect is stronger following larger fluctuations in the exchange rate, particularly after large dollar appreciations.

1 Introduction

The primary objective of this work is to determine the relationship between exchange rate pass-through and trade partners' shares of the United States' import market. The reasons for understanding pass-through to import prices relate to the connection between import prices and the overall price level of the US as a whole, as well as the role of the Federal Reserve to adjust monetary policy accordingly. Since import prices play a role in an open economy′s overall price level, the degree to which exchange rate fluctuations are passed on to prices can directly impact the inflation rate of an importing country. On the other hand, since monetary policy is often linked with expected inflation, understanding and anticipating changes in pass-through rates can allow for more effective policy.

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Additionally, pass-through is tied to the balance of payments as relatively small reactions in prices to a depreciation of the dollar (low pass-through) cause a similar reaction in overall import quantities. The better an importer can estimate the degree of pass-through to prices and how it is changing, the better it can predict the impact that currency devaluations will have on volume of trade. With high pass-through rates to import prices, a currency devaluation could improve the trade balance in that higher prices of imports could result in increased demand for domestic goods. If a foreign country controls a larger share of the import market for a good, then in theory firms in that country have greater ability to respond through pricing methods, and in turn have greater effect on the overall import market. Alternatively, an exporter with a smaller share has less freedom in terms of response. By analyzing the relationship between an exporter′s market share of a good and the pass-through for that good, we can gain a better understanding for which industries and which exporters drive these relationships.

The exchange rate disconnect puzzle, as termed by Obstfeld and Rogoff (2001), describes the extreme volatility of exchange rates relative to other key macroeconomic variables. Obstfeld and Rogoff note in defining the puzzle that the exchange rate should be one of the most significant calculations given the sheer number of economic indices that depend on exchange rates[1]. Import prices are perhaps the clearest example of such a measurement that should be closely related to the exchange rate. Low pass-through of exchange rate fluctuations to import prices could at least partially explain this disconnect since import and export prices and quantities are generally the instruments through which exchange rates impact other macroeconomic variables (national income, money supply, interest rates, etc.). If pass-through to import prices were complete, then a stronger tie between exchange rates and these other variables might be observed. So it is essential to understand the theoretical and empirical explanations for low pass-through. In particular, the market shares of exporters in a host country's import market (and the desire to protect these shares) could be partially responsible for low pass-through rates.

I start with a simple, static model of two foreign countries exporting a single good to a host country. Such a model shows how the countries respond to changes in exchange rates and how this behavior differs depending on the size of each country's share of the host country's import market for the good. I find that the general relationship between pass-through and market share is a skewed U-shape, with pass-through being greatest when shares are very large or very small. This model predicts the country holding the larger share will have the lower pass-through rate of the two competitors.

Empirical tests of the model are based on quarterly observations of US imports at the ten-digit

[1]Obstfeld and Rogoff consider the commonly known puzzle of purchasing power parity to be an example of the exchange rate disconnect puzzle in that the exchange rate does not balance out international price differences as would be expected in theory.

Harmonized System level, as well as bilateral exchange rate and price data from 233 countries from 1990 through 2005. Using such highly disaggregated data, I find several results on pass-through rates across market shares. First, countries with market shares at the extreme high and low ends tend to have higher pass-through rates, though this effect is more dramatic with low shares. Second, specifically focusing on the trade partner with the largest share of the market for a commodity, I find that such countries have significantly lower pass-through rates than their competitors. Lastly, the effect of large market shares in particular varies depending on the type of imported good, as well as the size and direction of an exchange rate fluctuation[2].

This paper ties into a vast literature on exchange rate pass-through, both theoretical and emprirical. The most fundamental theoretical explanations for incomplete pass-through to import prices rely on imperfect competition and the markup and marginal cost structures of exporting firms. If the import market for a good were perfectly competitive, then markups would be zero and pass-through would be complete (pass-through = 1). Complete pass-through should also occur under the assumptions of constant markups to marginal costs and production with constant returns to scale. Markets with imperfect competition tend to violate these assumptions, particularly the notion of a constant markup. Even if returns to scale are constant, when foreign firms increase markups following an appreciation of the home country′s currency, the ensuing reduction in import prices is smaller in magnitude than the percent appreciation of the currency (pass-through is incomplete). Interactions between production function types (increasing or decreasing returns to scale) and markups can vary the degree to which exchange rate shocks impact the price of imports. For instance, a foreign exporter with decreasing returns to scale (increasing marginal costs) would further reduce pass-through with increased markups[3].

Many of these theoretical results relate to the seminal model of Dornbusch (1987). While also considering the overall integration of the world trade market for a good and the substitutability of domestic and foreign goods, Dornbusch uses a model of oligopoly to show that pass-through is greater when marginal costs are close to prices (small markups) and the foreign exporter controls a larger share of the import market. At the other extreme, a foreign exporter with only a small share of an import market is predicted to have a lower pass-through (assuming equal markups), thus obtaining increased profits from its small market share. However, the assumption of equal markups is problematic.

In a similar study to this paper, Feenstra et al. (1996) show a general theoretical relationship between market share and pass-through within a specific industry. Their models show an increasing relationship (independent of assumptions on demand) between the variables with pass-through

[2]Another finding is that pass-through tends to be lower for goods that are imported to the US from a relatively small or large number of countries in a specific time period. This relationship generally holds across market shares. However, the data on this is somewhat nebulous and can still be explored further.

[3]Such theory is shown clearly by Olivei (2002) among others.

approaching one as market share approaches 100%. When smaller market shares are considered, assumptions about the nature of the demand function are necessary and the question of whether pass-through increases or decreases with share depends on firm interactions. Here, I expound on these findings and show how pass-through and market shares relate across all imported goods.

The basic theoretical model in this paper derives from Atkeson and Burstein's (2008) use of imperfect competition to explain pricing to market. Their model relies on strategic interactions between firms and shows the importance of the distribution of market shares within an industry in explaining why PPP does not hold. Specifically, Atkeson and Burstein allow for better performing firms to have larger market shares within their industry. Due to the nature of substitution both across and within industries, such firms have larger markups. As is shown above, increased markups are a primary explanation for low pass-through rates[4].

As one of the key questions involving exchange rate pass-through relates to the fall in pass-through to US import prices in the 1990s, many works seek to develop theoretical models to explain low pass-through rates. Such studies focus on the persistence of cost changes and frequency of price adjustments[5], as well as the role of the currency used for pricing goods[6]. The role of non-traded goods is also a factor in creating lower than expected pass-through rates[7] as consumers' ability to substitute towards non-traded goods can impact the export decisions of trade partners. My contribution to this section of the literature is to show how market shares, particularly that of the largest trade partner, can play a role in creating lower pass-through rates.

The empirical literature on pass-through focuses on a wide variety of topics. Some studies aim to simply estimate pass-through in the import and export markets for individual countries, or to make comparisons of imports or exports for multiple countries[8]. Alternatively, other research centers on a particular industry or comparisons of pass-through rates across categories of traded goods. Feenstra et al. (1996) supplement their theoretical predictions on market share and pass-through with data on the auto industry and imports for 48 country combinations. As predicted by the theoretical model, they show a non-linear, increasing relationship between the variables with pass-through approaching one as market share approaches 100%[9]. Another section of the litera-

[4]A similar framework is use by Gust et al. (2010), who use an open economy model to show the effects of competitors' pricing on import prices to a domestic country.

[5]See Taylor (2000), Bergin and Feenstra (2001) and Gopinath and Itskhoki (2010).

[6]See Corsetti and Pesenti (2005) and Gopinath and Rigobon (2008), both of which indicate lower pass-through rates when goods are priced in the importing countrys currency.

[7]See Burstein et al. (2006).

[8]Knetter (1993) compares the pricing-to-market behavior for exports from Japan, Germany, the UK and the US, focusing on the reduction of markups in markets where currency has depreciated in value. He finds that if an exporter faces more competition in the destination market for a good, there is a tendency to hold prices more stable if currency values fluctuate in that market. McCarthy (2007) shows similar results in comparing pass through from exchange rates to CPI and PPI of nine industrialized countries.

[9]More recently, Auer and Schoenle (2012) look at the effects of market structure on exchange rate pass through and use US import data from a large number of exporting countries and more product sectors than are considered in

ture on empirical pass-through serves to test the relationship between pass-through and monetary policy, as well as other pricing behaviors. While theory shows that pass-through rate changes can cause variation in an economy's inflation rate, it is also possible that the opposite can be true where pass-through is influenced by inflationary policies[10]. However, the most common area of recent empirical research focuses on the decline in pass-through in the 1990s and into the 2000s[11]. Exploring the role of market shares can assist in showing and explaining this phenomenon.

In addition to examining overall pass-through to US import prices and the role of market shares, this paper takes into account country of origin and specific commodity to determine the differences across host countries and good types. Specifically, the breadth of this paper will span a larger number of countries and more highly disaggregated goods than other works in the literature. Most papers that measure and analyze exchange rate pass-through and its effects use goods disaggregated at the Harmonized Tariff Schedule (HTS) six- or eight-digit level, or use Standard Industrial Classification (SIC) codes which are less disaggregated than HTS. Additionally, most studies limit the analysis to interactions with major trade partners such as Canada, Mexico, China, Japan and the dominant EU economies. The main contribution of this work is that it will start by considering all countries that imported to the US between 1990 and 2005 and focus on imported goods at the most disaggregated level. By examining various relationships between pass-through and market share at such a highly disaggregated level for a wider selection of exporting countries, I attempt to generate a more detailed analysis of how US import prices respond to exchange rate shocks.

2 A Simple Theoretical Model

Atkeson and Burstein (2008) develop a model comparing two countries trading goods in international markets. Their model compares *goods* that are grouped within *sectors*, defined as "the lowest level of disaggregation of commodities used in economic censuses and price index construction"[12]. For my version of the model, ten-digit goods, as well as the versions of these goods shipped by the competing countries, face constant elasticity of substitution inverse demand functions that depend on elasticities of substitution across goods (η) and within goods (ρ). Elasticity of substitution across goods is greater than one, but less than elasticity of substitution from one version of a good to another. Both elasticities are finite ($1 < \eta < \rho < \infty$). The countries in question

most empirical studies in the pass-through literature.

[10]Taylor (2000) and Campa and Goldberg (2005) examine the roles of the importing country's inflationary environment, finding different results on its significance to pass-through. See also Gagnon and Ihrig (2004) and Brun-Aguerre et al. (2012).

[11]See Marazzi et al. (2005), Marazzi and Sheets (2007), Ceglowski (2010), and Gust et al. (2010).

[12]Atkeson and Burstein's model is based on competition between firms rather than countries. In this paper, I treat each 10-digit commodity in the manner that their research treats *sectors*, while the version exported by each country is equivalent to what they call a *good*. Therefore, competition is at the country-level.

play a game of quantity competition wherein the quantities exported by the other country are taken as given and each country sets its own export quantity accordingly.

Following Atkeson and Burstein's model, the two elasticities of substitution are considered parameters and used to express price elasticity of demand for a good (j) exported by a country (k) as a function of that exporter's market share of the good in question:

$$\epsilon(S_{jk}) = \left[\frac{1}{\rho}(1 - S_{jk}) + \frac{1}{\eta}S_{jk}\right]^{-1} \tag{1}$$

Using the standard expression of markups, $\frac{\epsilon}{\epsilon-1}$, a country with 100% control of the market for a good ($S_{jk} = 1$) will have markups of $\frac{\eta}{\eta-1}$, depending solely on the elasticity of substitution across goods. At the other extreme, countries with infinitesimal shares of a market will have markups close to $\frac{\rho}{\rho-1}$, which depend exclusively on substitutability within goods. As do Atkeson and Burstein, I consider a CES production function such that the total output of good j produced in all K foreign countries ($K = 2$ for simplicity) and sold in country i is given by:

$$y_{ij} = \left[\sum_{k=1}^{K}(q_{ijk})^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{2}$$

The production function (2) corresponds to the theoretical price index for good j in country i:

$$P_{ij} = \left[\sum_{k=1}^{K}(P_{ijk})^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{3}$$

Combining (2) and (3) leads to the inverse demand function within good j:

$$\frac{P_{ijk}}{P_{ij}} = \left(\frac{q_{ijk}}{y_{ij}}\right)^{\frac{-1}{\rho}} \tag{4}$$

In general, Country A's share of the host country's import market is expressed:

$$S_{ijA} = \frac{p_{ijA}q_{ijA}}{\sum_{k=1}^{K} p_{ijk}q_{ijk}} \tag{5}$$

However, combining Equations (3) and (4) allows for an expression of shares based on the

within-good elasticity of substitution:

$$S_{ijA} = \frac{P_{ijA}^{1-\rho}}{\sum_{k=1}^{K} P_{ijk}^{1-\rho}} \tag{6}$$

Atkeson and Bursetin factor in trade costs and aggregate demand across goods to analyze deviations from relative purchasing power parity. Alternatively, in this study, I use the expression for market shares (6) to develop a theoretical model of pass-through based on two foreign countries (A and B) competing in a host country's import market for a single good. As a result (6) simplifies to:

$$S_A = \frac{P_A^{1-\rho}}{P_A^{1-\rho} + P_B^{1-\rho}} \tag{7}$$

Using (1) and the relationship between price elasticity of demand and markups, Country A's export price can be written as a function of marginal costs and their share of the host country's market.

$$P_A = \frac{\epsilon(S_A)}{\epsilon(S_A) - 1} MC_A = \frac{MC_A}{\chi + S_A \zeta} \tag{8}$$

Where

$$\chi = 1 - \frac{1}{\rho} \tag{9}$$

And

$$\zeta = \frac{1}{\rho} - \frac{1}{\eta} \tag{10}$$

Typically, exchange rate pass-through for a good from a certain country is defined as the ratio of percent change in the import price of that country's good to the percent change in the exchange rate between the importing and exporting countries. Pass-through is defined as *complete* if it equals one, meaning a $k\%$ rise in the exchange rate results in a $k\%$ rise in import prices[13]. *Incomplete*

[13]Exchange rate is expressed as the ratio of host country currency to foreign currency. Therefore a rise in the

pass-through refers to pass-through values that are less than one.

Additionally, a depreciation of the domestic currency relative to the foreign currency increases marginal costs in the foreign country as measured in domestic currency. Therefore, a rise in the exchange rate can be viewed as an increase in marginal costs of production[14]. As a result, pass-through from Country A can be considered as the ratio of percent change in import prices from A to percent change in A's marginal costs:

$$ERPT_A = \frac{\partial P_A}{\partial MC_A}\frac{MC_A}{P_A} \tag{11}$$

Using the fact that with two competing countries, shares of the import market must sum to one, Equations (7) and (8), as well as their respective versions from Country B can be combined to implicitly solve for the derivative in (11). Pass-through from Country A can then be expressed[15]:

$$ERPT_A = \frac{(\chi + S_A\zeta)(\chi + S_B\zeta) + (1-\rho)(\chi + S_A\zeta)S_A S_B\zeta}{[(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta](\chi + S_B\zeta) + (1-\rho)(\chi + S_A\zeta)S_A S_B\zeta} \tag{12}$$

Three key theoretical predictions arise from this expression of pass-through (Proofs can be found in Section 6).

1. **If $0\% < S_A < 100\%$, then $0 < ERPT_A < 1$.**

   As long as more than one foreign country is competing in the market, pass-through will be greater than zero and less than one. This shows the intuitive result that a relative depreciation in a host country's currency will lead to an increase in import prices as measured in that currency. Hence, pass-through is greater than zero. But pass-through will also be incomplete when competition exists, in part due to the presence of the alternatives available to consumers. This prevents exporting countries from raising prices by the full amount of the exchange rate fluctuation.

2. **Pass-through as a function of market share follows an asymetric U-shape, with minimum pass-through occuring when share is greater than 50%.**

   The model predicts pass-through to be equal to one when share is zero or 100%, and pass-through between zero and one for all other feasible values of share. The exact share that

exchange rate occurs due to a depreciation of the host's currency or an appreciation of the exporter's currency. Under this condition, a rise in the exchange rate means the host's currency is relatively weaker, so prices of its imports (as measured in the host's currency) would be expected to rise.

[14]Feenstra (1989) is among many that show foreign firms respond similarly to changes in exchange rates as they do to changes in input costs.

[15]See details in Section 6.

gives minimum pass-through, as well as the minimum pass-through itself and the degree of skewness in the non-linear function, depend on the two parameters for elasticity of substitution. Figures 1 and 2 show the effect of changing the elasticity within goods (ρ) and across goods (η), respectively. For instance, if η is approximately one (the minimum allowed value) and ρ is significantly greater than η, a country's version of a good is assumed to be easily substituted for the other country's version, but substituting to a different good is essentially impossible. Under such circumstances (setting $\eta = 1.01$ and $\rho = 10$), pass-through decreases with market share almost linearly until share is nearly 100% (See Panel A of Figure 1). Additionally, the minimum pass-through is close to zero in this setting. Compare this to Panel B which keeps $\eta = 1.01$ but reduces ρ to 3, implying that different versions of a good are less substitutable. The general shape remains the same, but pass-through is greater for market shares between zero and 100%. Most notably, the minimum pass-through is greater for higher values of ρ. This minimum pass-through rate also occurs at a slightly smaller value of market share, though this effect appears to be minor.

Changing η while ρ is held fixed produces similar results. Panel A of Figure 2 again shows $\eta = 1.01$ and $\rho = 10$. Panel B keeps the same value of ρ, but increases η to three, implying easier substitution to different goods. As is seen when ρ falls, increases in η result in pass-through rising across all market shares. However, the share producing the minimum pass-through falls noticeably, creating a more symmetric U-shaped distribution. These effects are more dramatic for larger values of ρ, though the minimum pass-through always corresponds to a market share that is greater than 50%.

3. **If $S_A > S_B$, then $ERPT_A < ERPT_B$**

In the-two country model, pass-through for the trade partner with the larger share of the import market is always less than that of the country with the smaller share. If the competing country's marginal cost (or exchange rate) is fixed, then a shock to marginal cost has a greater impact on the price of goods from the country with the smaller share than an equal sized shock would have on goods from the country with the larger share. This occurs because countries with larger shares have larger markups on goods, and larger countries lower markups by a greater percentage when faced with a rise in marginal cost or the exchange rate. Expressed in percent-change notation:

$$\%\Delta Markup = \%\Delta Price - \%\Delta MC \tag{13}$$

Under the assumption that the change in marginal costs (exchange rate) is the same for both

countries, the larger country having a greater percentage drop in markup implies that its export price falls by less than that of the smaller competing country.

These theoretical results suggest that when two countries compete in a host country's import market for a good, the country with the larger share will have the lower pass-through rate. In particular, if it is assumed that within-good elasticity of substitution is relatively large[16] then the downward sloping relationship is more dramatic and suggests that countries with larger shares can have pass-through rates that are far from complete. Under this setting, consumers in the host country can easily substitute goods from one country for goods from another. So exporters with large market shares adjust markups when faced with exchange rate shocks, resulting in lower pass-through rates.

3 Data and Methodology

3.1 General Data Description

The data used in this study are based on the US Imports Harmonized System data disaggregated to ten digits, with monthly observations from April 1990 through December 2005. Specifically each initial observation contains, for each month and each port of entry into the United States, the number of units of each ten-digit good that are imported from each country of origin, and the total dollar value shipped. Dollar values are split into two variables, one for dollars of freight shipped and another for calculated duties to which foreign merchandise imported into the US is subject. Since port of entry is not a variable of interest at this time, quantities and values of each good, from each country, in each month are summed together to give total quantity and value for each good-country-month combination. Due to the importance of analyzing changes from one time period to the next, the monthly totals are then summed up to the quarterly level. This allows for more coverage in the data as there are fewer periods in which a regular exporter of a good does not ship that particular good to the United States[17]. Prices are not directly observed but rather, unit values are calculated from the data on total value and total quantity sold per quarter[18]. Since the United States is the importing country for all data, the total value is based on the cost, insurance and freight calculation (CIF), which includes the freight on board (FOB) value of the goods, insurance

[16] Atkeson and Burstein use $\eta = 1.01$ and $\rho = 10$ as their "benchmark" model parameters. Additionally, Anderson and van Wincoop (2004) find these values to be realistic based on empirical studies of imports.

[17] Henceforth, an observation refers to a good-country-quarter combination.

[18] There is some discussion in the literature about the advantages and disadvantages of actual prices or price indices as opposed to unit values. The primary argument against unit values is they can vary greatly as a result of unseen changes in quality or product combinations. However, at such a disaggregated level (10-digit HTS codes), product mix should not be an issue. Variation in quality within 10-digit codes is also unlikely to cause concern, but as Alessandria and Kaboski (2011) note, it should be taken into consideration as a potential source of bias.

and haulage to the dock in the US. But it does not include additional shipment costs within the US. In terms of the original data, CIF is found by summing the two variables for the dollar value of the shipment. This CIF value is divided by the number of units to calculate the import price for each specific good-country-quarter combination[19].

3.2 Data

Some observations in the import data indicate that shipments were valued at an amount greater than zero, but contained zero units of goods. According to Feenstra (1996) this implies that the actual quantity of the good imported is unknown or was not recorded. All such observations were flagged and dropped from the dataset. Additionally, for some months (and therefore some quarters), the US did not receive imports of a particular good from certain countries.

Following the techniques of Auer and Schoenle (2012), I drop any series in which more than ten percent of quarters between the first and last observations either do not have transactions or are flagged as a result of the issues noted above. The remaining quarters with missing or non-existent data are assumed to have the same quantity and value of imports as the previous quarter. Dropping these series with too many missing values limits the potential breadth of the analysis in terms of the number of trade partners, the number of imported goods and combinations of the two. However, any series whose observations are too sporadic or has too many estimated values is unreliable. This also eliminates trade partners with minimal value of goods imported or one-time transactions, etc.

The data are supplemented using quarterly average nominal exchange rates from the IMF′s International Financial Statistics database, with exchange rate measured as dollars per unit of foreign currency. With this measurement, a depreciation of the dollar implies a rise in the exchange rate. When they are used, US GDP values are found from the IFS database as well. Quarterly CPI values for each country in the analysis are taken from the Laborsta database of the ILO, with CPI being an average of monthly observations when quarterly data is unavailable. The bilateral real exchange rate between the US and each foreign country is then calculated by the equation:

$$RER = NER\frac{CPI_{Foreign}}{CPI_{US}} \tag{14}$$

Since prices are measured in dollars, the real price is found by dividing the calculated price by the US CPI from that quarter. In some cases, only monthly, quarterly, or annual percent changes are available rather than actual nominal exchange rates. However, since the focus of the study is on the change in each variable as opposed to the level, indices can be created based on the percent

[19]The results in this study remain essentially the same when FOB values are used instead of CIF.

changes in exchange rates. Pass-through calculations can then be determined using the created indices. Any import observation that occurs in a quarter for which the exporting country's CPI or exchange rate information is unavailable is dropped (as opposed to having a specific value or an estimate from annual data). Such observations only occur at the beginning or end of the series.

Pass-through calculations are only made for goods classified as manufactured goods due to volatility in quantity and price data for non-manufactures. One clear effect of only considering the manufacturing sector is a reduction in the influence of certain pure commodity-rich (mainly oil-rich) countries such as Saudi Arabia and Venezuela. However, the methodology used does not prohibit non-manufactured goods and could easily be extended. Even with the use of only manufactured goods and the elimination of series with sporadic or too much missing data, the sample still includes over 2.7 million price observations for analysis.

Annual data on US imports from the Center for International Data at the University of California – Davis is used to obtain the SIC code corresponding to each HTS ten digit code. This is particularly useful as SIC codes tend to be more effective in dividing goods based on end uses. While the data analyzed was disaggregated at the HTS ten digit level, SIC codes are used to separate out goods that are classified as manufactures (SIC codes with a first digit of 2 or 3)[20].

Initially, I have data on imports of 22,192 different goods across 63 quarters. There are 233 exporting countries whose presence in the data ranges from two good-quarter combinations (North Yemen) to 498,046 (Canada). There are 857,178 different good-quarter combinations with an average of just under seven competing countries in each, for a total of 8,044,110 observations. When non-manufactured goods are removed, I am left with 20,409 goods from 233 countries and 63 quarters, with totals of 789,411 good-quarter combinations and 7,639,450 observations. This data was used to calculate the each country's market share for each good in any quarter[21].

The CIF values are used as the basis for calculating a foreign country's share of the US import market in a given quarter. The exact calculation is expressed:

$$s_{c,j,t} = \frac{CIF_{c,j,t}}{\sum_{c=1}^{C} CIF_{c,j,t}} \tag{15}$$

Equation (15) gives the simplest possible calculation of market share. Other possible calculations involve using multiple quarter intervals. For example, the source country's share of the market for a good at a given time is the sum of total value of the good imported from that country over the prior four quarters, divided by the total value of the good imported from all countries over those four quarters. Similar calculations can be made with longer intervals. The idea behind

[20]Over ninety percent of the types of goods imported are considered manufactures.

[21]For some aspects of the study, firm-level data would potentially provide better insight than country level data. This issue is addressed in the appendix (Section 7).

this type of calculation is to account for quarter to quarter fluctuations in import quantities and overall values, particularly cases where an exporter sends regular shipments less frequently than once per quarter. Such cases would show up inconsistently if market share were only based on one-quarter calculations. However, preliminary results comparing pass-through and market share do not indicate substantial differences based on the method of calculating share.

3.3 Methodology

The basic regression for exchange rate pass-through follows the model:

$$p^m_{c,j,t} - p^m_{c,j,t-1} = \alpha + \sum_{i=0}^{n} \beta_i \Delta e_{c,t-i} + \sum_{i=0}^{n} \gamma_i x_{t-i} + \varepsilon_{c,j,t} \tag{16}$$

In Equation (16), pass-through is the sum of the β_i terms; $p^m_{c,j,t}$ is the real price of good j, imported from Country c at time t; and $e_{c,t}$ is the real exchange rate between the United States and Country c at time t. Evidence shows that when measured at quarterly frequencies, exchange rate fluctuations tend not to be related to most macroeconomic variables. As a result, it can be assumed that changes in the import price of a specific good do not directly or indirectly impact current period exchange rates.

I initially include just one quarter lag, though estimates in the literature vary in lag use from one quarter up to two years[22]. Clearly this implies a short run analysis of pass-through. As a check on the robustness of the results, I consider longer lag-lengths as well and the basic findings do not change.

The term x_t refers to a vector of additional variables that could be included. In my calculation, I include quarterly changes in real GDP of the US, but other variables could be considered as well. As the sole importer considered in this study, US economic growth should be correlated with demand for imports, which in turn impacts import prices. However, in terms of the values calculated for estimated pass-through, I find that the presence of US GDP does not make a substantial difference. Among other variables to consider would be the change in real GDP of the country of origin, or the change in price of a worldwide commodities index. The latter of these is used by Marazzi and Sheets (2007) to account for the indirect effect of exchange rate variability on import prices, noting that a rise in commodity prices will result in higher costs of production. The x variables could also be used as indicators as was done by Brun-Aguerre et al. (2012) who added variables to separate positive and negative exchange rate shocks, as well as large vs. small shocks. Likewise, I

[22]Ceglowski (2010) comments that bilateral pass-through to import prices is a fast process, generally occurring within six months.

could factor in the size and direction of the price change to determine if exporters might be holding prices more or less stable than the exchange rate. This would indicate what Knetter (1993) calls Local Currency Price Stability. A final consideration would be to include the average price change among other goods with the same two- or four-digit HTS code to account for price of competitors.

3.4 Rolling Regressions for Pass-Through

I use a rolling regression process to capture the pass-through rate of a unique ten digit good imported from a foreign country in a specific quarter. With this method, a linear equation is estimated for the change in import price of a good using a one quarter lag of percent change in the real exchange rate, as in Equation (16). However, in order to establish a time component, only the previous three years of data are used to estimate the pass-through in a particular quarter. For example, the pass-through value for good j, from Country c, at time t is the coefficient on the change in real exchange rate from a regression using only data on imports of j from c between quarters $t-12$ and t. One of the common findings in recent literature on exchange rate pass-through is the idea that pass-through to US import prices as a whole has been falling over the last 30 years. Therefore, it is worth considering that a similar trend could be found on a more micro level. Using the rolling regression process makes it possible to capture any changes over time in the pass-through of specific commodities from certain countries. Additionally, obtaining a unique pass-through calculation for each good and country at each time has the advantage of being paired with a unique, time-specific market share. Other studies that consider market shares[23] use the shares for one time period and assume it holds constant (or changes minimally) over a set number of following periods.

The specificity of the rolling regression methodology does have a slight downside. Since twelve observations are required in order to obtain a pass-through calculation, values for the first three years of data for each series cannot be calculated[24]. Shrinking the pass-through window to four or eight quarters would increase the number of available observations, but it would also increase the variability and noise within each calculation. In most of the pass-through literature where regressions are used, between a two and ten year window is chosen, seen for example in Marazzi and Sheets (2007).

[23] Such as Olivei's (2002) use for calculating trade weights

[24] Using a one-quarter lag and a twelve quarter window in the rolling regression results in pass-through estimates for 1,803,419 observations, from 387,695 good-quarter combinations. The pass-through estimates are from 50 quarters and 9,956 different goods from 134 different countries, ranging from imports in seven good-quarter combinations from Moldova to 178,345 from Canada.

4 Results

4.1 Pass-Through Across Market Shares

In general, I find that the data support the theoretical predictions regarding the relationship between pass-through and market shares. Specifically, pass-through rates tend to follow a skewed U-shape across shares. However, the calculated pass-through values tend to be much smaller than predicted for all sizes of market shares, including a substantial number of combinations with negative pass-through rates.

Due to the size of the dataset and the large number of observations, a plot of pass-through vs. market share for all country-good-month combinations has too much noise to be useful. So I start by rounding market share up to the nearest percent. The average pass-through rates by percent of market share are then plotted in Figure 3.

Despite the substantial noise in the data, Figure 3 shows a skewed U-shaped distribution: a distinct downward trend while market share is below 70%, followed by rise in pass-through as market shares approach 100%[25]. This general trend matches closely with the theoretical results, suggesting that a country with a minimal share of a particular good′s import market in the United States will pass a larger percentage of exchange rate fluctuations into prices. As market shares increase from the low end, countries will pass on a smaller percentages to prices. The rise in pass-through rates at the upper end of the distribution shows that countries with close to full control of the market behave similarly to those with little market power in terms of percentage of exchange rate fluctuations that are passed into prices. Figure 4 shows a similar trend based on the median pass-through rate for each rounded percent of market share. These results follow closely with the basic theoretical model shown in Section 2. Pass-through rates that decrease with market share until reaching a minimum at some share greater than 50% is a predictable result if elasticity of substitution across goods is low relative to elasticity of substitution within goods. Other theoretical results in the literature at least partially predict this behavior as well. According to the early theory put forth by Dornbusch (1987), pass-through should be greatest for when market share is largest. This logic could explain the relatively higher values of pass-through at the upper extreme of the distribution, but it would not predict the overall downward trend that is seen in most of the data. However, Feenstra et al. (1996) show that under the assumption of a CES utility function, a U-shaped relationship as found this study is conceivable.

[25]Figure 3 also indicates a substantial number of negative pass-through rates. This violates the theoretical finding that pass-through should fall between zero and one and implies that exporters raised prices following a dollar appreciation or lowered prices when the dollar devalued. This is in part due to the short-run nature of this calculation, using only one lag. But it also reflects the high level of disaggregation in the data as there is more to variations in individual country's prices of ten-digit goods than simply exchange rate fluctuations. Future work beyond this study will investigate negative pass-through rates and potential causes.

While the trend of pass-through rates across market shares matches the theoretical results, the actual values (particularly those at the extremes) are lower than expected[26]. The model predicts countries with complete control of the market and countries with market shares close to 0% to have complete pass-through. Empirically, however, I find the median pass-through rate of countries with at least 99% shares to be 12.96% while the median pass-through for countries controlling less than 1% of the market is 16.07%[27]. These values are relatively high compared to pass-through rates from market shares in the middle but they do not approach the predicted 100% pass-through from the theoretical model[28].

To further show the empirical relationship between pass-through rates and market shares, I run a quadratic regression of the calculated pass-through values on market share. The regression shows significant coefficients (Table 1) further suggesting that the theoretical relationship holds empirically[29]. The table also shows that this relationship holds when dummy variables representing quarter, two-digit commodity, and country of origin are included in the regressions. Most importantly, the significance of the linear and quadratic coefficients when quarter-dummy variables are included implies that the quadratic relationship exists across the full time-span of the dataset.

This pattern generally reflects the idea that exporters towards the upper and lower extremes of market power are the most likely to pass exchange rates shocks into import prices. This finding supports the model in Section 2 which predicts complete pass-through at the two extremes of market shares. The reduction in pass-through as shares rise from the minimum is also predicted as exporters with larger shares have greater freedom to adjust markups and absorb shocks without directly changing prices while smaller competitors are forced to pass exchange rate depreciations on to prices at a greater rate. Additionally, it could be that countries with larger market shares in competitive markets are driven by a desire to maintain what they have. In the dynamic model of Froot and Klemperer (1989), forward-looking firms are motivated to maintain their current market shares and because of this, exporters will hold prices down when foreign currency appreciates vs.

[26]Low pass-through rates relative to theoretical predictions are common in empirical studies, especially those based on data in the 1990s. Marazzi and Sheets (2007), Ceglowski (2010), and Gust et al. (2010) are among the many works that investigate this puzzle.

[27]These values are particularly low as only one lag is used in the baseline specification of the pass-through calculation (Equation 16). However, pass-through calculations based on longer lags are much lower than the theory predicts as well.

[28]Lower than expected pass-through could also be a result of omitted variables. Clearly, prices do not exclusively depend on the exchange rate as the quality of goods and demand for certain imports are constantly changing. While the rolling regression model accounts for overall price levels in the two countries and GDP of the United States, there are certainly impediments to production and trade at the country and firm levels that are unaccounted for.

[29]Both the theoretical and empirical plots of the data (Figures 1, 2, 3, and 4) show more skew than a standard parabola, as the downward sloping component covers a wider range of market shares than does the upward sloping part. But given the rises at the extremes, it seems appropriate to model based on a quadratic relationship. Linear regressions show significant, negative slope coefficients, implying that the downward trend is the stronger component of the relationship.

the dollar[30]. While these models do not explicitly state whether firms with small, medium or large market shares are more or less inclined to behave this way, it is reasonable to suggest that countries with relative dominance in the US import market for a particular good will resist price adjustment due to exchange rate fluctuations in order to maintain that control.

4.2 Examining the Largest Shares

Having shown the general pattern of pass-through across market shares, I now show that the trade partner holding the largest share has lower pass-through than its competitors. This finding holds fairly consistently across the full timespan of the data and does not vary based on which country has the largest share.

One prediction of the theoretical model discussed in Section 2 is that the country with the larger market share will have the lower pass-through rate (see Section 6.3 for the proof). For this section, I only consider commodity-quarter combinations for which the pass-through rate from the country with the largest share is calculated, plus at least one other observation so as to have a basis of comparison. This clearly implies that only commodity-quarters where at least two countries are competing are included. An initial t-test indicates a significantly lower average pass-through rate for goods with the largest share as compared to other goods ($p < 0.0001$). Similar results are found using the more robust Mann-Whitney test comparing median pass-through for maximum shares (0.0507) with non-maximum shares (0.1139). A chi-square test also suggests a significant relationship ($p < 0.0001$) between an exporter having the largest share of the market and having the lowest pass-through rate in that market.

As is previously noted, one of the common findings in the literature on pass-through is a large drop in pass-through rates in the late 1990s. This trend is found in many calculations of pass-through for both imports and exports worldwide, but it is particularly dramatic in pass-through to US imports. Across all observations with pass-through calculations, I find a median rate of 0.1778 in the first quarter of 1998 which falls to 0.0418 by the second quarter of 2002 before rising again. The established relationship of higher market shares having lower pass-through rates could play a role in this dropoff. Figure 5 shows a plot of the median pass-through from the largest shareholder over time, in comparison to the median pass-through of all goods and competing countries. While the largest exporter's pass-through is fairly consistently lower than that of the smaller exporters across the full time span, this is particularly true for the drop in the late 1990s and early 2000s. In

[30]Kleshchelski and Vincent (2009) show with survey data that firms hold prices stable in order to maintain market share and keep the customers they have. While not directly referring to pass-through, there is also evidence from the industrial organization and marketing literatures suggesting that firms will attempt to maintain market shares to increase long-run profits, even if it means accepting a short term loss. Fornell and Wernerfelt (1987) address this in terms of marketing strategies to maintain market shares. Klemperer (1995) addresses the importance of brand loyalty, noting the long term benefits of low prices to build and keep a share of the market.

fact, during the later quarters, when overall pass-through is at its lowest, the median pass-through rate of the largest exporters is negative, implying that such countries actually lowered prices of imports to the United States following a devaluation of the dollar. This is not necessarily evidence that the largest competitors fully caused pass-through to drop. But it does suggest a possible connection between the two trends. It should also be noted that the median value for the largest market share is between 47% and 49.5% at all times. So it is unlikely that the drop in pass-through was caused by the larger exporters controlling a greater share, but rather it is connected to those countries reducing pass-through rates to even lower than normal values.

4.3 Differences in Pass-Through for Types of Goods

In this section, I show that the overall relationship between pass-through rates and market share holds when taking into account the type good being traded. The general U-shaped pattern is seen in most of the categories of goods when they are viewed individually, particularly those goods that comprise a larger share of total imports.

According to the United States International Trade Commission, imported goods can be broken into twenty categories based on the first two digits of the HTS code. Table 2 indicates the categories, and gives the percentage of the dataset that each comprises[31] as well as the median pass-through rate for goods in each category. Clearly, the twenty categories vary drastically in size. The categories "Machinery and Mechanical Appliances, etc" and "Vehicles, Aircraft, etc" each contain more than 23% of the value, while eight other categories have less than two percent each. Focusing in particular on the largest category (machinery), the median pass-through rate for goods in this category (0.0845) is slightly smaller than the median overall rate (0.1028). However, a plot of pass-through for machinery as compared to pass-through for all goods (Figure 6) shows generally similar patterns for the two groups[32].

Based on regressions of pass-through on market share for each category, ten of the twenty categories show the same positive quadratic relationship ($p < 0.10$) that is seen for the dataset as a whole (Table 3). These ten categories represent 54% of the total observations in the dataset, and 32% of the total value of goods considered. However, only two categories ("Prepared Foodstuffs" and "Footwear, Headgear, etc") completely contradict the general findings, with positive linear and significant negative quadratic coefficients. These two contradicting categories comprise only

[31]"Percentage" of the dataset refers to the percentage of dollar value among imports for which pass-through calculations were made. The only category for which this percentage differs greatly from the percentage of overall import value is "Mineral Products" which is the 6^{th} largest category among all imports, but the 16^{th} largest for which pass-through calculations were made. Most commodities classified as "mineral products" are not manufactures, and are imported more sporadically than most manufactured goods. This explains the large drop in this category's market share.

[32]Similar graphs for the other 19 categories have substantially more noise due to the reduced number of observations in those categories.

5.41% of the total value of imported goods. Additionally, fifteen of the twenty categories (representing over 90% of the value of imports) indicate the predicted positive U-shaped pattern, though not necessarily with significance. So while the findings within each category are clearly not perfect matches of the overall predicted pattern, there is an indication that the basic relationship holds.

4.3.1 Linear Regression Models

As an alternative, I examine a linear regression of pass-through on market share within each category to show overall downward trend in most types of goods (Table 4). For thirteen of the twenty categories, I find at least moderately significant negative coefficients on the slope term in the linear regression ($p < 0.10$). These thirteen categories comprise 85% of the total observations in the dataset, and 86% of the total value of imported goods. This list also includes the four largest categories and six of the top seven. On the other hand, none of the twenty categories shows a significant positive slope. This suggests that within specific categories of goods, where a relationship exists between pass-through and market share, it is a negative relationship[33]. Countries with larger market shares tend to pass exchange rate movements into prices to a lesser degree than those with small shares, with pass-through rates decreasing linearly starting at the low end of the distribution of market shares.

The fact that a significant negative linear relationship holds across more categories representing a larger proportion of total imports goes against the theoretical U-shaped relationship discussed in Section 2. However, that predicted relationship is not necessarily parabolic. In fact, while the theory predicts complete pass-through when market share is 0% or 100%, as well as a minimum pass-through that occurs when share is greater than 50%, the exact location of the minimum and the skewness of the relationship depend on the elasticities of substitution. These values (elasticity of substitution from one commodity to another and elasticity of substitution from one country's version of a commodity to another country's) are different for each good and each exporting country. Furthermore, the exact nature of how pass-through rises to one at the upper end of the distribution of market shares is unclear. It is entirely possible that within many of the categories, the elasticities are such that the U-shaped distribution is skewed enough that the downslope component dominates, making a linear fit more appropriate than a quadratic. The empirical findings seem to suggest that for a large proportion of traded goods, the elasticity of substitution from one version to another greatly exceeds the elasticity of substitution to a different good. As can be seen in Panel A of Figures 1 and 2, when ρ greatly exceeds η, the model predicts essentially a linear relationship until market share is nearly 100%. Given the relative scarcity of observations with high market

[33]For both the quadratic and linear regressions by category, including country and two-digit good indicators in the calculation does not alter the results. More categories, representing a greater proportion of import quantity and value, show significant negative linear trends than positive quadratic relationships.

shares compared to those at the lower end, it makes sense that the nature of the empirical relationship with pass-through would be less clear as market shares approach 100%. Under these settings, for most categories of imports, the empirical findings reflect the theoretical predictions.

4.4 Effects of Size and Direction of Fluctuations

While Sections 4.1 - 4.3 show the show that pass-through rates behave as predicted across market shares, with the general pattern holding within most specific categories of imports, here I consider asymmetries in pass-through behavior depending on the size and the direction of exchange rate movements. I find that the direction of fluctuations alone does not play a role in determining pass-through. However, the established relationship between pass-through and market share is more dramatic following large exchange rate movements as opposed to small changes. In particular, combining the size and direction effects, I find that the relationship holds with large increases in the dollar's value, but breaks down after a large devaluation.

4.4.1 Symmetry of Exchange Rate Appreciations and Depreciations

Recent theoretical and empirical studies on exchange rate pass-through have made note of possible differences in the way prices respond to exchange rate fluctuations depending on the whether the importing country's currency appreciates or depreciates relative to the exporter's, as well as the size of such fluctuations[34]. I first test whether the direction of the exchange rate fluctuation impacts the rate of pass-through by separating observations for which the real exchange rate rose over the twelve year rolling regression window (dollar depreciation) from those in which the exchange rate fell (dollar appreciation). Noting that over the life of this dataset, the dollar generally became stronger against most foreign currencies, there are more observations for which the exchange rate drops (1,068,254) as opposed to rises (735,211). An initial comparison of pass-through rates suggests that the direction the exchange rate moves does not impact pass-through. While the median pass-through rate following a fall in the real exchange rate (0.1038) is marginally greater than following a rise (0.1014), a Mann-Whitney test does not indicate that the difference is significant (p = 0.36). The mean pass-through is actually slightly greater when the exchange rate increases.

[34]Pollard and Coughlin (2004) examine the possibility of asymmetric effects from exchange rate movements. Using industry-level data on manufactured goods, they find that pass-through behaves differently in most industries following an appreciation of the dollar's value as opposed to a depreciation, though the magnitude and direction of this effect differs across industries. They also find pass-through rates to be different depending on the size of the change in exchange rate, with larger fluctuations resulting in higher pass-through. This difference based on size holds for both rises and falls in the exchange rate and is a stronger effect than the direction effect. Knetter (1994) addresses the possibility of pass-through being different following exchange rate appreciations as opposed to depreciations, and it is also noted by Olivei (2002) as a potential reason for the decline in pass-through in the 1990s.

Additionally, the U-shaped relationship between pass-through and market share remains essentially the same following a rise and a fall, as is seen in the plot of median pass-through rates by rounded market shares (Figure 7). Individual quadratic regressions on observations corresponding to both directions of exchange rate movement show significant positive quadratic coefficients ($p < 0.01$), results that hold when dummy variables for two-digit goods and country of origin are included. Clearly, on its own, the direction in which the real exchange rate moves does not drastically impact pass-through or its relationship with market share.

4.4.2 Larger Exchange Rate Movements Have Greater Effects on Pass-Through

After finding that the direction of a change in exchange rate does not impact pass-through in terms of size or relationship with market share, I next examine the impact of different size changes in the exchange rate. The focus is specifically on the absolute value of the percent change in real exchange rate over the twelve-quarter window for the rolling regressions used to calculate pass-through. Breaking all observations into ten equal sized groups and ordering from smallest to largest by percent change in real exchange rate, the first columns of Table 5 show a general pattern of the median pass-through increasing as the size of the exchange rate fluctuation increases in magnitude. This trend suggests that exporters to the United States adjust markups by a smaller amount when faced with a larger change in the exchange rate, thus allowing prices to reflect the changing dollar value to a greater degree. However, the top group, representing the largest 10% of exchange rate movements, shows a much smaller median pass-through rate following exchange rate fluctuations larger than 30.55% in either direction.

Of greater interest to this study is the relationship of pass-through across market shares based on the size of the exchange rate movement. Quadratic regressions within each group (Table 5) show significant positive quadratic coefficients for each of the top eight groups, indicating that the U-shaped relationship between pass-through and market share predicted in Section 2 and seen with the analysis of the full dataset holds true across the largest 80% of exchange rate movements (though the relationship within largest group is only moderately significant). But this relationship does not hold for small changes in exchange rates. This finding (along with the relatively low median pass-through rates for the lowest two groups) implies that when the real exchange rate remains relatively steady, exporters adjust markups to hold prices more constant, independent of the market shares held by such exporters.

Large Dollar Appreciations Impact Pass-Through More Than Depreciations

The impact of the size of the exchange rate movement on pass-through rates and the seeming lack of importance of the direction of the movement lead to a question of interaction between the size and direction effects. Specifically, I focus only on observations with large changes in the real

exchange rate, defined by an exchange rate movement of at least 13.91%[35] in either direction. The first columns of Table 6 show that the median pass-through is larger following a large appreciation of the dollar (0.1223) than after a dollar depreciation (0.0877). This finding is strengthened by the Mann-Whitney comparison of medians showing that the difference is significant ($p < 0.001$). The mean pass-through rate is also greater following a dollar appreciation. These results point to a general conclusion that US import prices are more responsive to large rises in the value of the dollar than to large falls in value[36].

The difference between large appreciations and large depreciations carries over to the relationship with market shares. While pass-through is lower following a dollar depreciation, it also no longer maintains a significant quadratic relationship across market shares. Table 6 also shows the regression results of pass-through on market share and squared market share based only on observations following large real exchange rate changes. While the linear and quadratic regression coefficients are still positive and negative respectively, the quadratic term is not significant following a dollar depreciation. This finding suggests that market share plays less of a role in exporters' pricing decisions due to a dramatically weakening dollar than under typical circumstances. Alternatively, both coefficients are significant using data following a large dollar appreciation, implying that countries with very large and very small shares of the US market will lower prices the most when faced with a stronger dollar. If the relationship between pass-through and market share is assumed to be linear, regressions show negative trends following large exchange rate changes in either direction ($p < 0.05$). However, when country and two-digit good effects are included, the trend is not significant for large increases in the exchange rate ($p = 0.356$), but remains significant following large decreases ($p = 0.001$).

Examining the differences between pass-through rates following large dollar appreciations and depreciations across categories of imports, linear regressions within each category (Table 7) show that the overall negative trend holds slightly better after dollar appreciations. Seven of the twenty categories have negative slope coefficients following appreciations, but these categories contain 66% of the observations considered and 72% of the value of imported goods. More noticeable is the lack of significant linear relationships in the large categories following dollar depreciations. Six categories of goods show significant negative coefficients, but these categories represent 35% of observations and just 18% of the total import value. These findings further show the collapse of any association between market shares and pass-through following large dollar devaluations.

[35]Note from Table 5 that this value represents the upper 50% of observations when ranked by $|\%\Delta RER|$. 545,819 out of the 900,567 observations considered (60.61%) represent exchange rate decreases. However, this is approximately proportional to the percentage of observations following drops in exchange rate in the full dataset (59.23%). So it seems an appropriate cutoff for comparing the effect of the direction of large exchange rate movements.

[36]Knetter (1994) shows that foreign firms attempting to maintain market shares will adjust markups to a greater degree (and thus have higher pass-through rates) when the home country's currency appreciates rather than depreciates.

The results in this section show some asymmetries in pass-through rates, particularly in terms of behavior across market shares. On its own, the direction of an exchange rate fluctuation does not produce different pass-through results. However, the larger changes in the real exchange rate, specifically those representing a weakening dollar, result in a breakdown of the general relationship between pass-through and market shares. Under such settings, market share is no longer a significant predictor of pass-through rates.

4.5 Robustness Checks

The results presented in this section are based on certain specifications of the rolling regresson model (Equation 16). Specifically, I use a lag length of one quarter and a rolling regression window of twelve quarters. It is necessary to check the effects of changing either of these settings. Therefore, I repeat each section of the analysis using two lags instead of one, and with rolling regression windows of four, eight, and twenty quarters. Additionally, prior to calculating pass-through, I dropped any commodity-country combination for which more than 10% of prices had to be imputed due to incorrect or missing data, or lack of trade in that particular good. While the 10% cutoff is accepted in the literature, I also repeat the calculations using only commodity-country series for which all data is available.

Different Model Specifications Produce Similar Results

In total, there are sixteen different specification combinations (two lag lengths, four windows, and two thresholds for dropping a series). The quadratic regressions of pass-through on market shares are significant under all specifications, though there is more variability in the data when the smaller rolling regression windows are considered. Introducing indicator variables for two-digit commodities does not change the results, but when country-level dummy variables are included the quadratic terms are insignificant in four of the sixteen specifications (two quarter lags, four or twenty quarter windows, both thresholds). The fact that the relationship holds under all specifications with one lag but not with two lags could imply that the observed pattern of pass-through across market shares is more of a short-run effect that fades slightly over time. However, it could also call into question the importance of considering country-specific indicators. Linear regressions find significant negative relationships between pass-through and market share under all specifications, with or without country, quarter, and two-digit good indicators.

The country holding the largest share of the import market for a good has a significantly lower median pass-through rate under all specifications. This effect gets stronger when the model includes two lags instead of one. Plots of median pass-through over time for the country with the largest share vs. all countries (similar to Figure 5) show a larger and more consistent gap be-

tween the two, though this gap is less striking for smaller windows. When considering different categories, the results in the previous sections hold true under all sixteen settings, though fewer categories show any relationship when the window length is set at four quarters. Likewise, large drops in the exchange rate result in larger pass-through rates as well as pass-through that varies with market share under all settings. This relationship breaks down for large rises in the exchange rate in all sixteen versions of the model as well. In general, the threshold for removing a series does not appear to have any effect on the results (at least when that value is set at 90% or greater). Other than in quadratic regressions with country-level dummy variables, varying between one and two quarter lags does not impact the results either. The choice of rolling regression window appears to be the one setting that has some effect as shorter windows do not allow some of the results to show. While the literature provides a basis for using windows of anywhere between four and twenty quarters, this paper's results appear clearest when the model is based on longer windows.

Results Hold Using Market Share Percentiles Instead of Shares

Exporters' market shares are not evenly distributed from 0% to 100%. Substantially more countries have small shares of the market for a good than large shares, as is shown in Table 8. With the exception of a slight increase for countries with 100% of the import market, the number of observations by market share is monotonically decreasing. Because of this trend, I repeat the linear and quadratic regressions using market share percentile rather than actual market shares. This change does not alter the findings of the research as the same general patterns occur.

5 Conclusions

The disconnect between exchange rate dynamics and overall price levels remains one of the primary puzzles in international economics, particularly as it pertains to import prices. In this paper I have shown the clear relationship between the size of an exporting country's market share and the degree to which that country passes exchange rate fluctuations into prices. As evidenced by highly disaggregated data on US imports, there is a clear negative relationship showing that pass-through is largest for trade partners with minimal shares of the market for a good. Pass-through rates tend to shrink for countries with larger market shares. Though the trend is less clear, pass-through rates rise for countries with very large market shares. I have also documented the finding that pass-through rates for the country with the largest share have significantly lower rates of pass-through than their competitors. These general findings hold true across many categories of imported manufactured goods, most significantly in the fields with the highest volume and total value of trade. Additionally, I find that the direction in which the exchange rate moves over a given period does not seem to impact pass-through rates. However, when faced with large devaluations of the dollar,

pass-through tends to be lower than following increases in the dollar's value. Any relationship between pass-through and market share also tends to break down in the face of such large devaluations.

A simple theoretical model predicts many of these findings using basic assumptions of demand, production and competition between two exporting countries. In particular, the model predicts a U-shaped relationship similar to that seen in the US import data. It also provides a theoretical basis for the largest trade partner having smaller pass-through rates than its competitors. While the model predicts the highest pass-through rates to occur for countries controlling close to zero or close to one hundred percent of the market, it remains unclear how pass-through rises at the upper end of the distribution. This lack of clarity is seen in the data as the downward trend in pass-through as shares rise from zero is substantially more noticeable than the rise as shares approach 100%.

The findings in this paper contribute to recent studies on low pass-through rates, including many involving the United States' import market. As larger trade partners naturally influence overall import prices to a greater degree, the fact that countries with the smallest shares have the highest pass-through rates can at least partially explain why exchange rate dynamics are not seen in prices to the degree that they are expected. That such trends exist across the categories that dominate US trade in manufactures suggests that the disconnect between prices and exchange rates will persist as long as individual large exporters control trade in specific goods.

6 Appendix-Derivations and Proofs

6.1 Derivation of the Pass-Through Expression (Equation 12)

Country A's share of the import market for a good for which there are two competing importers is given:

$$S_A = \frac{P_A^{1-\rho}}{P_A^{1-\rho} + P_B^{1-\rho}} \tag{17}$$

And B's share is similarly:

$$S_B = \frac{P_B^{1-\rho}}{P_A^{1-\rho} + P_B^{1-\rho}} = 1 - S_A \tag{18}$$

If prices are defined as a markup to marginal costs based on price-elasticity of demand, then prices can be expressed:

$$P_A = \frac{MC_A}{\chi + S_A\zeta} \tag{19}$$

$$P_B = \frac{MC_B}{\chi + \zeta - S_A\zeta} \tag{20}$$

Where

$$\chi = 1 - \frac{1}{\rho} \tag{21}$$

And

$$\zeta = \frac{1}{\rho} - \frac{1}{\eta} \tag{22}$$

Note that since $\eta > \rho > 1$, then $0 < \chi < 1$, $-1 < \zeta < 0$ and $\chi > |\zeta|$. Therefore, if it is assumed that A has a larger share of the import market than B, then $0 < \chi + S_A\chi < \chi + \zeta - S_A\zeta$.

Plug (17) into (19) and solve for P_B as a function of P_A:

$$MC_A = (\chi + \frac{P_A^{1-\rho}\zeta}{P_A^{1-\rho} + P_B^{1-\rho}})P_A$$

$$MC_A = \chi P_A + \frac{P_A^{2-\rho}\zeta}{P_A^{1-\rho} + P_B^{1-\rho}} \tag{23}$$

$$P_A^{1-\rho} + P_B^{1-\rho} = \frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A}$$

$$P_B^{1-\rho} = \frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} \tag{24}$$

Compare (20) with (24):

$$\frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} = (\chi + \zeta - S_A\zeta)^{\rho-1} MC_B^{1-\rho} \tag{25}$$

Plug in (17) for A's share:

$$\frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} = (\chi + \zeta - \frac{P_A^{1-\rho}}{P_A^{1-\rho} + P_B^{1-\rho}}\zeta)^{\rho-1} MC_B^{1-\rho} \tag{26}$$

Replace $P_B^{1-\rho}$ using (24):

$$\frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} = (\chi + \zeta - \frac{P_A^{1-\rho}}{P_A^{1-\rho} + \frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho}}\zeta)^{\rho-1} MC_B^{1-\rho} \tag{27}$$

$$\frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} = (\chi + \zeta - \frac{P_A^{1-\rho}(MC_A - \chi P_A)}{P_A^{2-\rho}\zeta})^{\rho-1} MC_B^{1-\rho} \tag{28}$$

$$\frac{P_A^{2-\rho}\zeta}{MC_A - \chi P_A} - P_A^{1-\rho} = (2\chi + \zeta - \frac{MC_A}{P_A})^{\rho-1} MC_B^{1-\rho} \tag{29}$$

Equation (29) equates two expressions involving only P_A, exogenous variables, and parameters. Due to complications isolating P_A, I use implicit differentiation on both sides of (29) to determine $\frac{\partial P_A}{\partial MC_A}$.

6.1.1 Left Hand Side of (29)

$$\alpha = \frac{\partial P_A}{\partial MC_A} \tag{30}$$

$$\frac{(MC_A - \chi P_A)\zeta(2-\rho)P_A^{1-\rho}\alpha - \zeta P_A^{2-\rho}(1-\alpha\chi)}{(MC_A - \chi P_A)^2} - (1-\rho)P_A^{-\rho}\alpha \tag{31}$$

$$\frac{(MC_A - \chi P_A)\zeta(2-\rho)P_A^{1-\rho}\alpha}{(MC_A - \chi P_A)^2} - \frac{\zeta P_A^{2-\rho}}{(MC_A - \chi P_A)^2} + \frac{\zeta\chi P_A^{2-\rho}\alpha}{(MC_A - \chi P_A)^2} - (1-\rho)P_A^{-\rho}\alpha \tag{32}$$

6.1.2 Right Hand Side of (29)

$$MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}(\frac{MC_A\alpha}{P_A^2}-\frac{1}{P_A}) \tag{33}$$

$$MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{MC_A\alpha}{P_A^2}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{1}{P_A} \tag{34}$$

6.1.3 Solving for α

Equate (32) and (34), then separate terms with α from terms without α.

$$\begin{aligned}&(\frac{(MC_A-\chi P_A)\zeta(2-\rho)P_A^{1-\rho}}{(MC_A-\chi P_A)^2}+\frac{\zeta\chi P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-(1-\rho)P_A^{-\rho}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{MC_A}{P_A^2})\alpha\\&=\frac{\zeta P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{1}{P_A}\end{aligned} \tag{35}$$

$$\alpha=\frac{\frac{\zeta P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{1}{P_A}}{\frac{(MC_A-\chi P_A)\zeta(2-\rho)P_A^{1-\rho}}{(MC_A-\chi P_A)^2}+\frac{\zeta\chi P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-(1-\rho)P_A^{-\rho}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{MC_A}{P_A^2}} \tag{36}$$

Since exchange rate pass-through is the percent change in price due to a percent change in exchange rates (or marginal costs in this example), then A's pass-through is (36) multiplied by $\frac{MC_A}{P_A}$

$$PT=\frac{[\frac{\zeta P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-\frac{MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}}{P_A}]\frac{MC_A}{P_A}}{\frac{(MC_A-\chi P_A)\zeta(2-\rho)P_A^{1-\rho}}{(MC_A-\chi P_A)^2}+\frac{\zeta\chi P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-(1-\rho)P_A^{-\rho}-MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{MC_A}{P_A^2}} \tag{37}$$

6.1.4 Simplifiying the Pass-Through Expression

The numerator of 37 is:

$$[\frac{\zeta P_A^{2-\rho}}{(MC_A-\chi P_A)^2}-\frac{MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}}{P_A}]\frac{MC_A}{P_A} \tag{38}$$

$$\frac{\zeta P_A^{1-\rho} MC_A}{(MC_A - \chi P_A)^2} - \frac{MC_B^{1-\rho} MC_A(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}}{P_A^2} \tag{39}$$

Use $MC_A = (\chi + S_A\zeta)P_A$:

$$\frac{\zeta P_A^{1-\rho}(\chi + S_A\zeta)P_A}{((\chi + S_A\zeta)P_A - \chi P_A)^2} - \frac{MC_B^{1-\rho}(\chi + S_A\zeta)P_A(\rho-1)(2\chi+\zeta-\frac{(\chi+S_A\zeta)P_A}{P_A})^{\rho-2}}{P_A^2} \tag{40}$$

$$\frac{\zeta P_A^{2-\rho}(\chi + S_A\zeta)}{(S_A\zeta P_A)^2} - \frac{MC_B^{1-\rho}(\chi + S_A\zeta)(\rho-1)(\chi+\zeta-S_A\zeta)^{\rho-2}}{P_A} \tag{41}$$

Use $MC_B = (\chi + \zeta - S_A\zeta)P_B$:

$$\frac{P_A^{2-\rho}\chi\zeta + P_A^{2-\rho}S_A\zeta^2}{(S_A\zeta P_A)^2} - \frac{(\chi + S_A\zeta)(\rho-1)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)} \tag{42}$$

$$\frac{(\chi + S_A\zeta)P_A^{-\rho}}{S_A^2\zeta} - \frac{(\chi + S_A\zeta)(\rho-1)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)} \tag{43}$$

The denominator of 37 is:

$$\frac{(MC_A - \chi P_A)\zeta(2-\rho)P_A^{1-\rho}}{(MC_A - \chi P_A)^2} + \frac{\zeta\chi P_A^{2-\rho}}{(MC_A - \chi P_A)^2} - (1-\rho)P_A^{-\rho} - MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{MC_A}{P_A})^{\rho-2}\frac{MC_A}{P_A^2} \tag{44}$$

Use $MC_A = (\chi + S_A\zeta)P_A$:

$$\frac{((\chi + S_A\zeta) - \chi P_A)\zeta(2-\rho)P_A^{1-\rho}}{((\chi + S_A\zeta) - \chi P_A)^2} + \frac{\zeta\chi P_A^{2-\rho}}{((\chi + S_A\zeta) - \chi P_A)^2} - (1-\rho)P_A^{-\rho}$$
$$- MC_B^{1-\rho}(\rho-1)(2\chi+\zeta-\frac{(\chi + S_A\zeta)}{P_A})^{\rho-2}\frac{(\chi + S_A\zeta)P_A}{P_A^2}$$

$$\frac{S_A\zeta^2(2-\rho)P_A^{2-\rho}}{(P_AS_A\zeta)^2} + \frac{\zeta\chi P_A^{2-\rho}}{(P_AS_A\zeta)^2} - (1-\rho)P_A^{-\rho} - MC_B^{1-\rho}(\rho-1)(\chi+\zeta-S_A\zeta)^{\rho-2}\frac{(\chi + S_A\zeta)}{P_A} \tag{45}$$

$$\frac{(2-\rho)P_A^{-\rho}}{S_A} + \frac{\chi P_A^{-\rho}}{S_A^2\zeta} - (1-\rho)P_A^{-\rho} - MC_B^{1-\rho}(\rho-1)(\chi+\zeta-S_A\zeta)^{\rho-2}(\chi+S_A\zeta)P_A^{-1} \tag{46}$$

Use $MC_B = (\chi+\zeta-S_A\zeta)P_B$:

$$\frac{(2-\rho)P_A^{-\rho}}{S_A} + \frac{\chi P_A^{-\rho}}{S_A^2\zeta} - (1-\rho)P_A^{-\rho} - \frac{(\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)} \tag{47}$$

$$\frac{((2-\rho)S_A\zeta+\chi-(1-\rho)S_A^2\zeta)P_A^{-\rho}}{S_A^2\zeta} - \frac{(\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)} \tag{48}$$

Pass-through is now a combination of 43 and 48

$$ERPT = \frac{\frac{(\chi+S_A\zeta)P_A^{-\rho}}{S_A^2\zeta} - \frac{(\chi+S_A\zeta)(\rho-1)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)}}{\frac{[(2-\rho)S_A\zeta+\chi-(1-\rho)S_A^2\zeta]P_A^{-\rho}}{S_A^2\zeta} - \frac{(\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}}{P_A(\chi+\zeta-S_A\zeta)}} \tag{49}$$

$$ERPT = \frac{\frac{(\chi+S_A\zeta)P_A^{-\rho}(\chi+\zeta-S_A\zeta)P_A-(\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}S_A^2\zeta}{S_A^2\zeta P_A(\chi+\zeta-S_A\zeta)}}{\frac{[(2-\rho)S_A\zeta+\chi-(1-\rho)S_A^2\zeta]P_A^{-\rho}P_A(\chi+\zeta-S_A\zeta)-(\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}S_A^2\zeta}{S_A^2\zeta P_A(\chi+\zeta-S_A\zeta)}} \tag{50}$$

$$ERPT = \frac{(\chi+S_A\zeta)(\chi+\zeta-S_A\zeta)P_A^{1-\rho} - (\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}S_A^2\zeta}{[(2-\rho)S_A\zeta+\chi-(1-\rho)S_A^2\zeta]P_A^{1-\rho}(\chi+\zeta-S_A\zeta) - (\rho-1)(\chi+S_A\zeta)P_B^{1-\rho}S_A^2\zeta} \tag{51}$$

Use $P_A^{1-\rho} = (P_A^{1-\rho}+P_B^{1-\rho})S_A$, $P_B^{1-\rho} = (P_A^{1-\rho}+P_B^{1-\rho})S_B$, and $\chi+\zeta-S_A\zeta = \chi+S_B\zeta$:

$$ERPT = \frac{(\chi+S_A\zeta)(\chi+S_B\zeta) + (1-\rho)(\chi+S_A\zeta)S_AS_B\zeta}{[(2-\rho)S_A\zeta+\chi-(1-\rho)S_A^2\zeta](\chi+S_B\zeta) + (1-\rho)(\chi+S_A\zeta)S_AS_B\zeta} \tag{52}$$

6.2 Proof that 0 < ERPT < 1

Rewrite (52) as:

$$ERPT = \frac{A + C}{B + C} \tag{53}$$

where

$$\begin{aligned} A &= (\chi + S_A\zeta)(\chi + S_B\zeta) \\ B &= [(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta](\chi + S_B\zeta) \\ C &= (1-\rho)(\chi + S_A\zeta)S_AS_B\zeta \end{aligned} \tag{54}$$

By the definitions of χ and ζ, as well as the restrictions on ρ and η, it is clear that A and C are positive. Comparing A and B:

$$\begin{aligned} &S_A^2 < S_A \\ &(1-\rho)S_A^2 > (1-\rho)S_A \\ &\rho S_A + (1-\rho)S_A^2 > S_A \\ &-\rho S_A\zeta - (1-\rho)S_A^2\zeta > -S_A\zeta \\ &2S_A\zeta - \rho S_A\zeta - (1-\rho)S_A^2\zeta > S_A\zeta \\ &2S_A\zeta - \rho S_A\zeta + \chi - (1-\rho)S_A^2\zeta > \chi + S_A\zeta \\ &(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta > \chi + S_A\zeta \\ &[(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta](\chi + S_B\zeta) > (\chi + S_A\zeta)(\chi + S_B\zeta) > 0 \end{aligned} \tag{55}$$

So the denominator of (52) is greater than the numerator, implying that pass-through is positive and less than one (as long as the country does not have 100% market share).

6.3 Proof that Country A has Lower Pass-Through

If the pass-through for Country A is given by (52),

$$ERPT_A = \frac{(\chi + S_A\zeta)(\chi + S_B\zeta) + (1-\rho)(\chi + S_A\zeta)S_AS_B\zeta}{[(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta](\chi + S_B\zeta) + (1-\rho)(\chi + S_A\zeta)S_AS_B\zeta} \tag{56}$$

then the pass-through for Country B can be expressed:

$$ERPT_B = \frac{(\chi + S_B\zeta)(\chi + S_A\zeta) + (1-\rho)(\chi + S_B\zeta)S_BS_A\zeta}{[(2-\rho)S_B\zeta + \chi - (1-\rho)S_B^2\zeta](\chi + S_A\zeta) + (1-\rho)(\chi + S_B\zeta)S_BS_A\zeta} \tag{57}$$

It can be shown that the denominators of (52) and (57) are equal (see below). So the lower numerator corresponds to the country with the lower pass-through rate. The numerators are identical except pass-through for A contains a multiple of $\chi + S_A\zeta$ in the second term of the numerator while that term in pass-through for B is multiplied by $\chi + S_B\zeta$. Since $\chi + S_B\zeta > \chi + S_A\zeta$, this implies that Country B (with the smaller market share) has larger pass-through.

6.3.1 Proof that the Denominators of (52) and (57) are Equal

$$
\begin{aligned}
&S_A S_B = S_A S_B \\
&S_A(1 - S_A) = (1 - S_B)S_B \\
&S_A - S_A^2 = S_B - S_B^2 \\
&(1-\rho)S_A - (1-\rho)S_A^2 = (1-\rho)S_B - (1-\rho)S_B^2 \\
&(1-\rho)S_A\chi\zeta - (1-\rho)S_A^2\chi\zeta = (1-\rho)S_B\chi\zeta - (1-\rho)S_B^2\chi\zeta \\
&(2-\rho)S_A\chi\zeta - (1-\rho)S_A^2\chi\zeta + S_B\chi\zeta = (2-\rho)S_B\chi\zeta - (1-\rho)S_B^2\chi\zeta + S_A\chi\zeta
\end{aligned}
\tag{58}
$$

$$
\begin{aligned}
&(2-\rho)S_A\chi\zeta + \chi^2 - (1-\rho)S_A^2\chi\zeta + (2-\rho)S_A S_B\zeta^2 \\
&\qquad + S_B\chi\zeta - (1-\rho)S_A^2 S_B\zeta^2 + (1-\rho)S_A S_B\zeta + (1-\rho)S_A^2 S_B\zeta^2 \\
&= (2-\rho)S_B\chi\zeta + \chi^2 - (1-\rho)S_B^2\chi\zeta + (2-\rho)S_B S_A\zeta^2 \\
&\qquad + S_A\chi\zeta - (1-\rho)S_B^2 S_A\zeta^2 + (1-\rho)S_B S_A\zeta + (1-\rho)S_B^2 S_A\zeta^2
\end{aligned}
$$

$$
\begin{aligned}
&[(2-\rho)S_A\zeta + \chi - (1-\rho)S_A^2\zeta](\chi + S_B\zeta) + (1-\rho)(\chi + S_A\zeta)S_A S_B\zeta \\
&\qquad = [(2-\rho)S_B\zeta + \chi - (1-\rho)S_B^2\zeta](\chi + S_A\zeta) + (1-\rho)(\chi + S_B\zeta)S_B S_A\zeta
\end{aligned}
$$

7 Appendix - Potential Problem with Country-Level Data

It should be noted that while the import data is highly disaggregated, the lack of firm level data creates a potential problem. Market shares and pass-through rates would ideally be calculated at the firm level to get a true sense of the nature of competition within the import market for each good. With data only available at the country level, competition can only exist between countries. A country that controls the market for a specific good might actually have many competing exporting firms that could price goods differently than a single firm would.

But while firm-specific data on US imports is unavailable at this time, I do have information on the number of shipments of each good to the United States from all exporting countries in a given quarter. Figure 8 shows the average number of shipments of a good per quarter in relation

to the number of foreign countries competing in the market for the good in that quarter. There is a clear positive linear relationship, showing that more shipments tend to be received in quarters when more countries are competing in the market for a good. For reference, the comparison of shipments and number of exporting countries should be used in conjunction with Figure 9 which shows the number of commodity-quarter combinations versus the number of exporters for the combination. There are over 80,000 commodity-quarter combinations where one country controls 100% the market, but as Figure 8 indicates, this number declines to under 3,000 when 31 countries are competing and under 1,000 when 41 countries are involved. As a result, the relationship between total shipments and competing countries should be focused on the low end of the spectrum displayed in Figure 8. This still shows a clear upward trend with a small dip at the very beginning.

Specifically, I examine the 81,085 cases where there is only one exporter of a good to the United States in a quarter. These cases average 38.83 shipments per quarter as opposed to 40.50 shipments per country per quarter when more than one country is involved. A larger number of shipments does not necessarily imply a larger number of exporting firms as one firm could be responsible for multiple shipments of a commodity in a quarter. But it seems reasonable to assume an association between total shipments and number of exporting firms. Without firm-specific data, analyzing at the country level seems to be the best choice, but this issue underscores the potential benefit of obtaining data with information on specific firms exporting to the United States.

8 Tables and Figures

Table 1: Quadratic regressions of pass-through on market share.

Country Fixed Effect Included	2-Digit Good Fixed Effect Included	Quarter Fixed Effect Included	Share		Share^2	
			Coefficient	t-Statistic	Coefficient	t-Statistic
No	No	No	−1.5770	−12.00**	1.1717	7.33**
No	No	Yes	−1.6110	−12.25**	1.2020	7.52**
No	Yes	No	−1.7297	−12.86**	1.2417	7.61**
No	Yes	Yes	−1.7667	−13.12**	1.2753	7.81**
Yes	No	No	−0.9446	−6.93**	0.8152	5.01**
Yes	No	Yes	−0.9774	−7.16**	0.8448	5.19**
Yes	Yes	No	−1.0465	−7.50**	0.8402	5.06**
Yes	Yes	Yes	−1.0836	−7.76**	0.8745	5.27**

** denotes $p < 0.01$

Table 2: Market shares and median pass-through rates by category of imported good.

Category	Percent of Market Share	Median Pass-Through
Live Animals; Animal Products	0.61%	0.2261
Vegetable Products	0.35%	0.1103
Animal or Vegetable Fats and Oils	0.23%	0.2077
Prepared Foodstuffs	2.92%	0.1728
Mineral Products	1.22%	0.0898
Products of the Chemical Industries etc	6.08%	0.1296
Plastics and Rubber Articles	3.00%	0.1180
Raw Hides and Skins, Leather, etc	1.28%	0.0609
Wood and Articles of Wood	1.83%	−0.0261
Pulp of Wood etc	3.17%	0.1638
Textile and Textile Articles	9.85%	0.1055
Footwear, Headgear, etc	2.49%	0.0448
Misc Manufactured Articles	1.33%	0.1222
Precious or Semi Precious Stones, etc	2.93%	−0.0153
Base Metals and Articles of Base Metals	6.32%	0.0551
Machinery and Mechanical Appliances, etc	27.38%	0.0845
Vehicles, Aircraft, etc	23.62%	0.1118
Optical, Photographic, etc	2.69%	0.1122
Arms and Ammunition	0.07%	0.2270
Articles of Stone, Plaster, etc	2.61%	0.1111

Table 3: Quadratic regression results of pass-through on market shares by category of goods.

Category	Percent of Market Share	Share Coefficient	Share t-statistic	Share^2 Coefficient	Share^2 t-statistic
Machinery, Mechanical Appliances, etc	27.38%	−1.3116	−3.23**	0.6750	1.24
Vehicles, Aircraft, etc	23.62%	−1.0378	−1.64	0.5431	0.75
Textile and Textile Articles	9.85%	−1.4927	−6.87**	1.5723	5.54**
Base Metals, Articles of Base Metals	6.32%	−1.9934	−6.21**	1.0903	2.59**
Products of the Chemical Industries etc	6.08%	−0.1190	−0.38	0.2920	0.80
Pulp of Wood etc	3.17%	−2.7997	−3.90**	2.6085	3.00**
Plastics and Rubber Articles	3.00%	−2.7128	−3.72**	1.8779	1.90†
Precious or Semi Precious Stones, etc	2.93%	−13.9153	−3.44**	15.9888	3.15**
Prepared Foodstuffs	2.92%	1.3379	5.13**	−1.5211	−5.17**
Optical, Photographic, etc	2.69%	−1.9974	−2.63**	1.8801	2.16*
Articles of Stone, Plaster, etc	2.61%	−0.2804	−0.32	−3.0605	−2.64**
Footwear, Headgear, etc	2.49%	1.0452	1.42	−2.3497	−2.77**
Wood and Articles of Wood	1.83%	−1.8214	−2.21*	1.4459	1.74†
Misc Manufactured Articles	1.33%	−4.9904	−4.88**	4.5518	3.26**
Raw Hides and Skins, Leather, etc	1.28%	−2.3534	−2.00*	−1.8712	−1.23
Mineral Products	1.22%	−1.5361	−1.29	1.5301	1.21
Live Animals; Animal Products	0.61%	−3.9259	−5.34**	4.2178	5.88**
Vegetable Products	0.35%	−3.1298	−3.98**	2.9123	3.43**
Animal or Vegetable Fats and Oils	0.23%	−0.7017	−0.65	0.7087	0.66
Arms and Ammunition	0.07%	1.7842	0.89	−1.1618	−0.47

** denotes $p < 0.01$ * denotes $p < 0.05$ † denotes $p < 0.10$

Table 4: Linear regression results of pass-through on market shares by category of goods.

Category	Percent of Market Share	Share Coefficient	t-statistic
Machinery and Mechanical Appliances, etc	27.38%	−0.8397	−5.73**
Vehicles, Aircraft, etc	23.62%	−0.5841	−3.05**
Textile and Textile Articles	9.85%	−0.3666	−4.80**
Base Metals and Articles of Base Metals	6.32%	−1.2137	−10.92**
Products of the Chemical Industries etc	6.08%	0.1204	1.23
Pulp of Wood etc	3.17%	−0.7483	−3.41**
Plastics and Rubber Articles	3.00%	−1.4206	−5.35**
Precious or Semi Precious Stones, etc	2.93%	−1.9222	−1.40
Prepared Foodstuffs	2.92%	0.0492	0.64
Optical, Photographic, etc	2.69%	−0.4182	−1.94†
Articles of Stone, Plaster, etc	2.61%	−2.4947	−8.64**
Footwear, Headgear, etc	2.49%	−0.9211	−4.62**
Wood and Articles of Wood	1.83%	−0.4160	−2.28*
Misc Manufactured Articles	1.33%	−1.8838	−5.12**
Raw Hides and Skins, Leather, etc	1.28%	−3.7371	−10.43**
Mineral Products	1.22%	−0.1503	−0.45
Live Animals; Animal Products	0.61%	0.2800	1.64
Vegetable Products	0.35%	−0.5416	−2.46*
Animal or Vegetable Fats and Oils	0.23%	0.0046	−0.02
Arms and Ammunition	0.07%	0.8670	1.31

** denotes $p < 0.01$ * denotes $p < 0.05$ † denotes $p < 0.10$

Table 5: Median pass-through rates and quadratic regression results of pass-through on market shares by size of change in real exchange rate.

Absolute Percent Change in Real Exchange Rate	Median Pass-Through	Share		Share^2	
		Coefficient	t-statistic	Coefficient	t-statistic
$0 < \lvert\%\Delta RER\rvert \leq 2.90$	0.0674	−0.1638	−0.38	−0.7155	−1.38
$2.90 < \lvert\%\Delta RER\rvert \leq 5.34$	0.1134	−0.5881	−1.52	0.3800	0.81
$5.34 < \lvert\%\Delta RER\rvert \leq 7.67$	0.0735	−4.2745	−7.50**	2.8199	4.20**
$7.67 < \lvert\%\Delta RER\rvert \leq 10.07$	0.1067	−4.5457	−7.92**	4.1614	6.18**
$10.07 < \lvert\%\Delta RER\rvert \leq 13.91$	0.0953	−1.5518	−3.75**	1.3972	2.81**
$13.91 < \lvert\%\Delta RER\rvert \leq 17.32$	0.1328	−1.2998	−3.11**	1.2451	2.43*
$17.32 < \lvert\%\Delta RER\rvert \leq 20.62$	0.1399	−0.9898	−2.22*	1.1446	2.03*
$20.62 < \lvert\%\Delta RER\rvert \leq 24.10$	0.1505	−0.6027	−2.26*	0.6754	2.08*
$24.10 < \lvert\%\Delta RER\rvert \leq 30.55$	0.1371	−0.6383	−2.81**	0.5246	1.97*
$30.55 < \lvert\%\Delta RER\rvert$	0.0496	−0.4081	−2.18*	0.4490	1.86†

** denotes $p < 0.01$ * denotes $p < 0.05$ † denotes $p < 0.10$

Table 6: Median pass-through rates and quadratic regression results of pass-through on market shares following large real exchange rate rises and falls.

Percent Change in Real Exchange Rate	Median Pass-Through	Share Coefficient	Share t-statistic	Share^2 Coefficient	Share^2 t-statistic
Dollar Appreciates	0.1223	−1.1286	−6.29**	1.1974	5.43**
Dollar Depreciates	0.0877	−0.0691	−0.25†	−0.0244	−0.07

** denotes $p < 0.01$ * denotes $p < 0.05$ †denotes $p < 0.10$

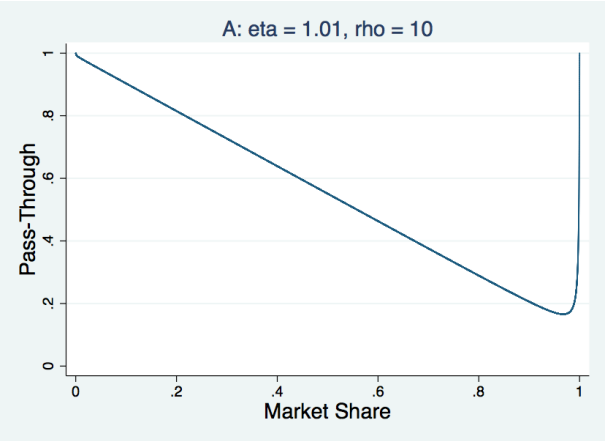
Table 7: Linear regression results of pass-through on market shares by category of goods following large rises and falls in the real exchange rate.

	Exchange Rate Increase		Exchange Rate Decrease	
Category	Share Coefficient	t-statistic	Share Coefficient	t-statistic
Machinery and Mechanical Appliances, etc	−0.0631	−0.22	−0.3540	−1.76†
Vehicles, Aircraft, etc	−0.3695	−1.18	−0.6221	−2.26*
Textile and Textile Articles	−0.3223	−2.06*	−0.2325	−2.30*
Base Metals and Articles of Base Metals	−0.2135	−0.96	−0.4840	−3.12**
Products of the Chemical Industries etc	0.0106	0.07	0.4695	4.04**
Pulp of Wood etc	−0.9266	−1.51	−0.2034	−0.64
Plastics and Rubber Articles	−1.4964	−1.74†	−0.3440	−1.13
Precious or Semi Precious Stones, etc	1.7769	1.24	2.7350	3.12**
Prepared Foodstuffs	−0.4411	−3.64**	−0.2328	−2.34*
Optical, Photographic, etc	−0.4712	−1.30	−0.3760	−1.23
Articles of Stone, Plaster, etc	0.2340	0.35	−0.1274	−0.22
Footwear, Headgear, etc	0.4089	1.29	−0.4852	−1.15
Wood and Articles of Wood	−1.0814	−3.41**	1.1098	4.77**
Misc Manufactured Articles	−0.3602	−0.77	−0.7221	−1.66†
Raw Hides and Skins, Leather, etc	2.7513	3.59**	−0.1475	−0.25
Mineral Products	0.0467	0.14	0.7918	1.40
Live Animals; Animal Products	−0.5214	−3.45**	0.2535	1.21
Vegetable Products	−1.8283	−3.88**	−0.4841	−2.24*
Animal or Vegetable Fats and Oils	−0.5545	−0.99	0.2701	0.70
Arms and Ammunition	1.2847	1.30	0.0468	0.07

** denotes $p < 0.01$ * denotes $p < 0.05$ †denotes $p < 0.10$

Table 8: Distribution of observations by market share.

Percent of Market Share	Frequency	Percent
<1%	445.150	25.37%
1-2%	181.164	10.32%
2-3%	119.220	6.79%
3-4%	89.262	5.09%
4-5%	71.430	4.07%
5-6%	58.714	3.35%
6-7%	49.774	2.84%
7-8%	43.348	2.47%
8-9%	38.038	2.17%
9-10%	34.023	1.94%
10-15%	128.097	7.30%
15-20%	86.978	4.96%
20-30%	113.875	6.49%
30-40%	73.604	4.19%
40-50%	53.083	3.02%
50-60%	40.700	2.32%
60-70%	33.365	1.90%
70-80%	28.347	1.62%
80-90%	25.695	1.46%
90-99.99%	31.212	1.78%
100%	9.891	0.56%



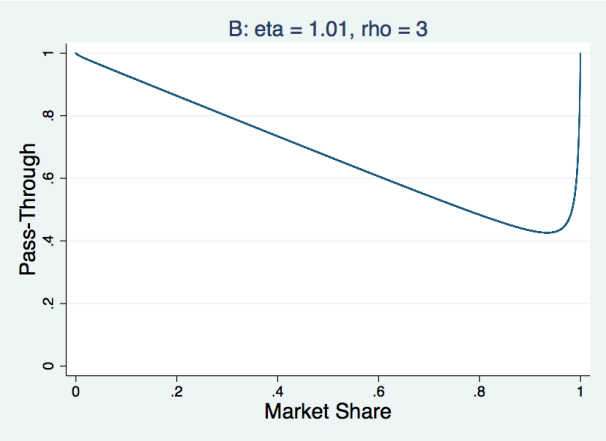
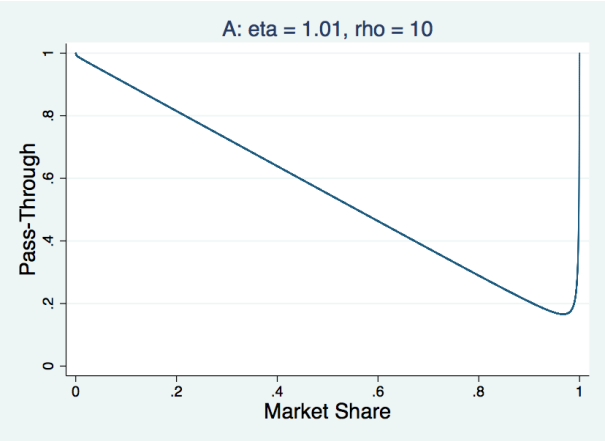


Figure 1: Theoretical Relationship between Pass-Through and Market Share: The effect of ρ.



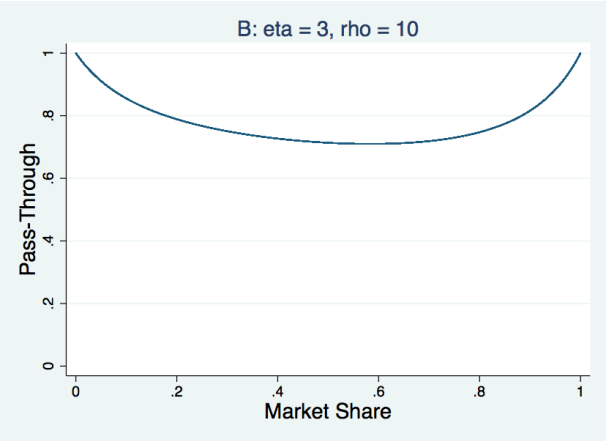


Figure 2: Theoretical Relationship between Pass-Through and Market Share: The effect of η.

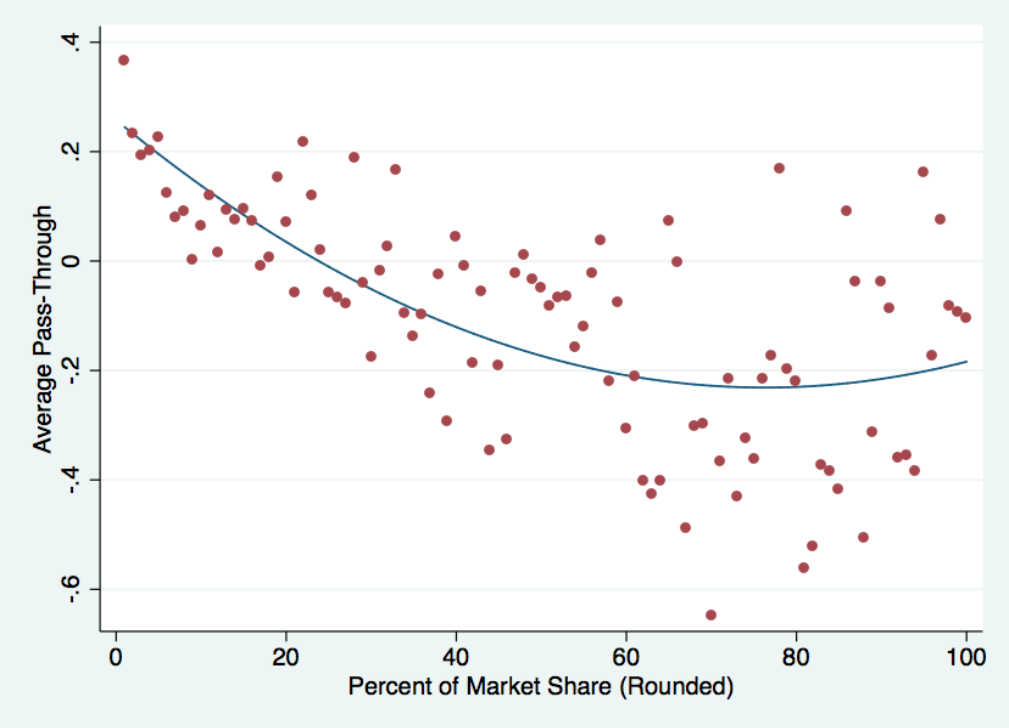


Figure 3: Average pass-through by market share (rounded up to the nearest integer percent) with the best quadratic fit.

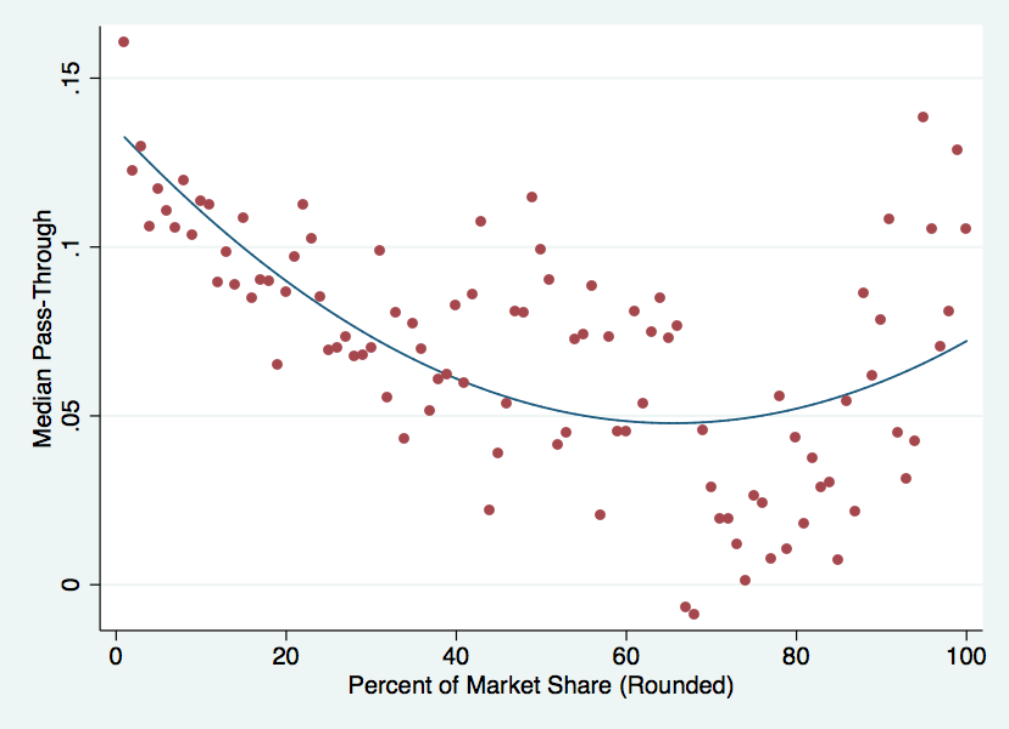


Figure 4: Median pass-through by market share (rounded up to the nearest integer percent) with the best quadratic fit.

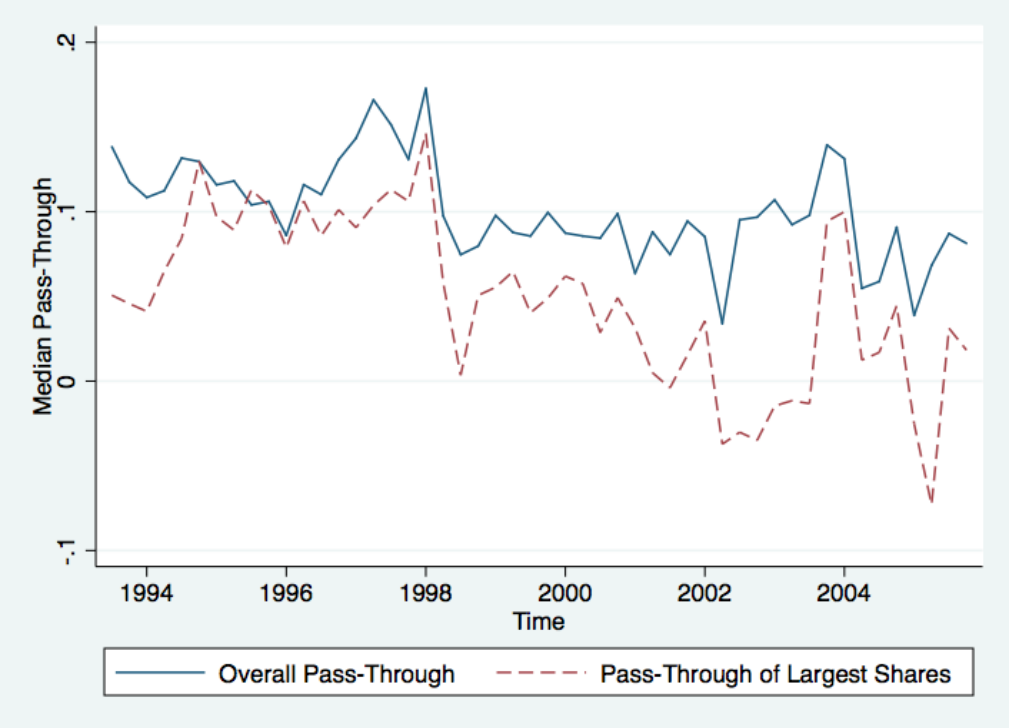


Figure 5: Median pass-through over time for all data and specifically for countries holding the largest share of a good's market in a quarter.

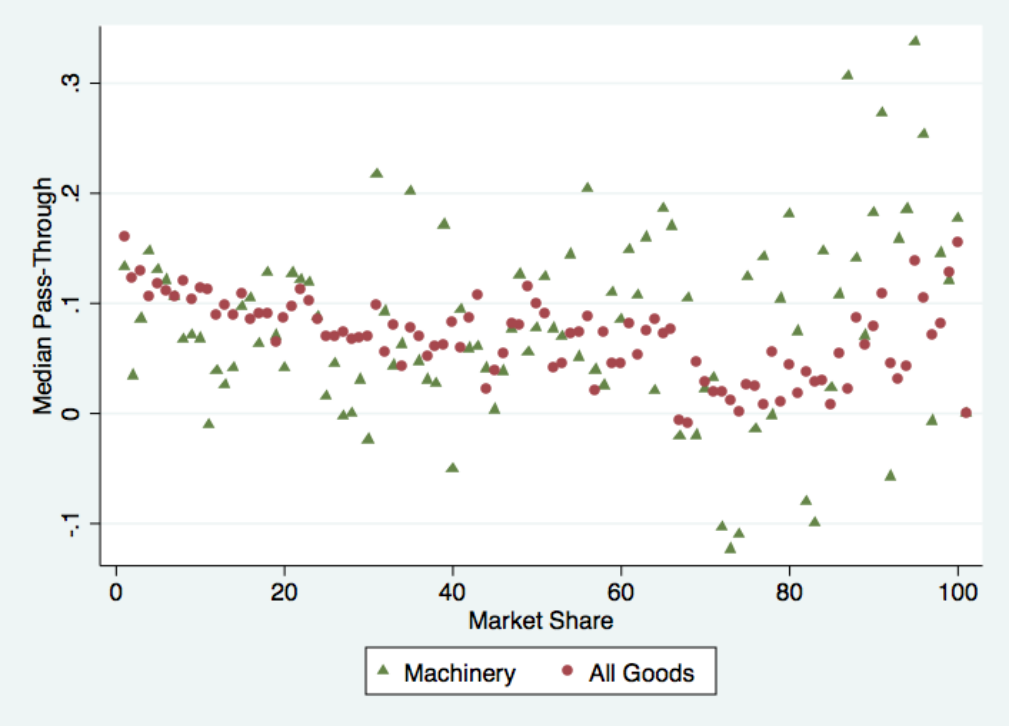


Figure 6: Median pass-through by market share for machinery compared with non-machinery with the best linear fit for both groups.

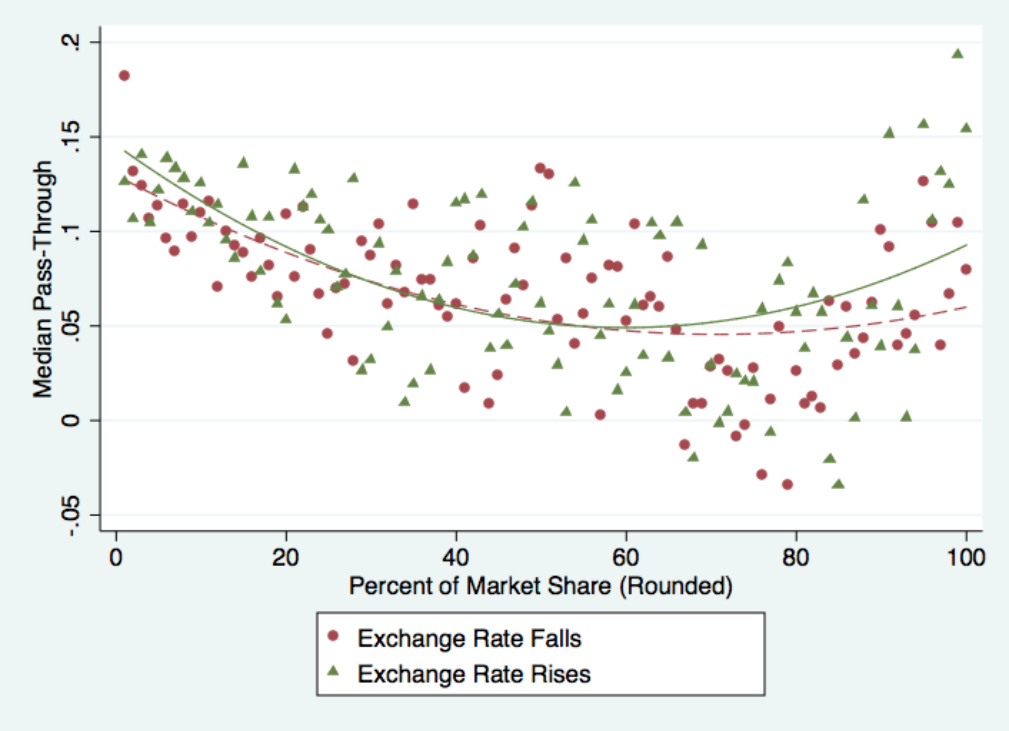


Figure 7: Median pass-through by market share following a rise and fall in the real exchange rate.

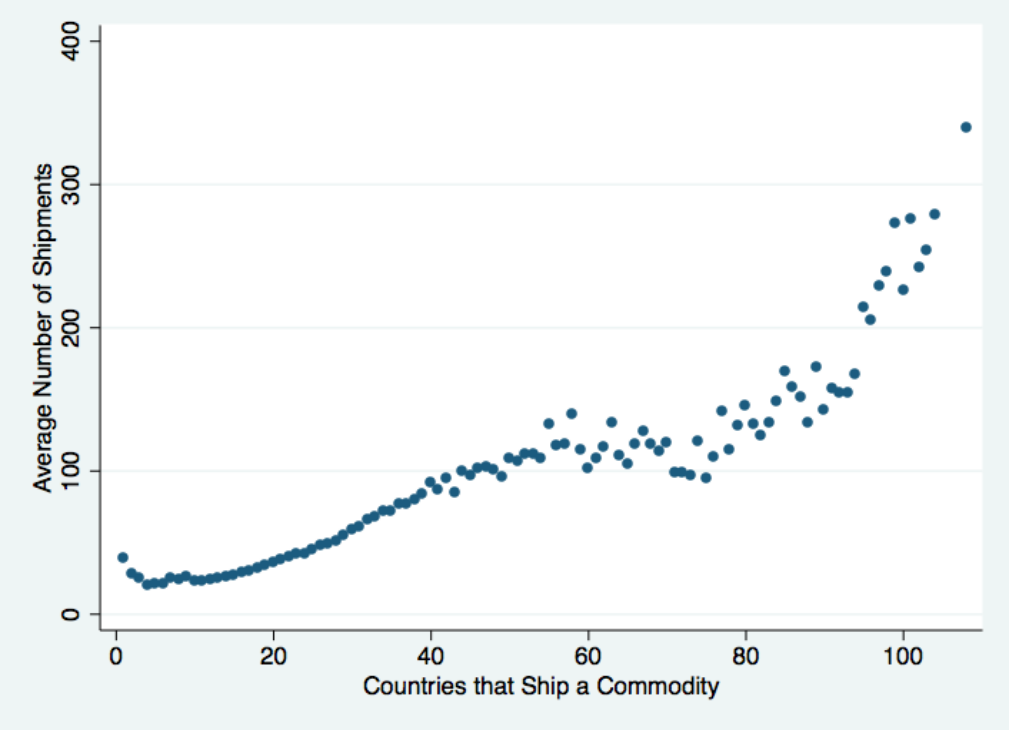


Figure 8: Average quarterly number of shipments, per country per quarter, of a commodity by number of countries shipping in a quarter.

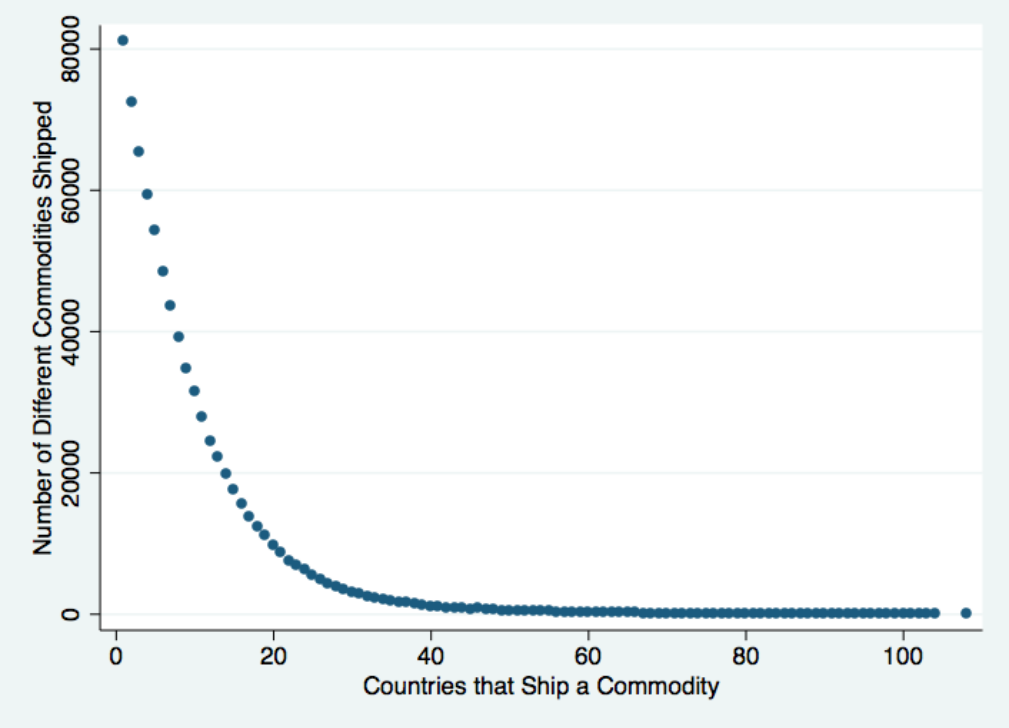


Figure 9: Number of commodity/quarter combinations by number of countries shipping in a quarter.

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