STICKY BORDERS*

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Abstract

The stickiness and currency of pricing of traded goods play a central role in international macroeconomics, however empirical evidence on these features is seriously limited. To address this we use micro data on U.S. import and export prices at-the-dock for the period 1994-2005, and present four main results: First, the median price duration in the currency of pricing is 10.6 (12.8) months for imports (exports). Second, 90% (97%) of imports (exports) are priced in dollars. Consequently, contrary to standard modeling assumptions, for the U.S, there is producer currency pricing in exports and local currency pricing in imports. Third, import price rigidity has increased by 10 percentage points, with increasing rigidity in differentiated goods prices. Fourth, even conditioning on a price change, exchange rate pass-through into U.S. import prices is low, at 22%.

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I. Introduction

Sticky prices of traded goods play a central role in international macroeconomics. The Mundell-Fleming models of the nineteen sixties, Dornbusch's overshooting exchange rate hypothesis, and the more recent New Open Economy Macroeconomics literature all assign an important role to nominal rigidities. Furthermore, the currency in which prices are sticky and whether there is so called producer currency pricing or local currency pricing, has important implications for exchange rate pass-through and the international spill-over effects of monetary policy. Despite this rich theoretical literature, there is almost no empirical evidence that directly measures the extent of price stickiness and the currency of stickiness in import and export prices.

To address these questions, this paper uses a novel data set to present extensive evidence on price stickiness at the border. We use unpublished micro data on import and export prices collected by the Bureau of Labor Statistics for the United States, for the period 1994-2005. We present four main results: First, prices are sticky in the currency in which they are reported as priced. Second, there is local currency pricing for U.S. imports and producer currency pricing for U.S. exports. Third, there has been a trend decline in the probability of price adjustment for imports. Fourth, exchange rate pass-through into U.S. imports even conditioning on a price change is low.

More specifically, we estimate the trade weighted average price duration for market transactions[1] to be 10.6 months for imports and 12.8 months for exports. Since there is significant product churning in trade, and product replacement is an extreme form of price flexibility, we incorporate these effects into our measures. Transactions at the dock reflect business-to-business transactions and accordingly our estimates of price stickiness can be compared to other studies of wholesale prices. Our estimates are similar to Carlton [1986] who estimated price durations to be over a year for domestic purchases by large U.S. companies and to more recent work by Nakamura and Steinsson [2007], who estimate price durations using U.S. producer price index data to be 9 months.

A second finding is with regard to the currency in which prices are sticky. Close to 90% of U.S. imports and 97% of U.S. exports are priced in dollars. While it has been known that most U.S. imports and exports are invoiced in dollars[2], we provide evidence of stickiness in these dollar invoiced prices. This has important implications for theoretical models. It is typically assumed

[1] A significant fraction of trade takes place intra-firm and the associated prices may simply reflect accounting prices. Since the standard macro model describes market transactions, we exclude intra-firm transactions from our benchmark specifications. Results for intra-firm transactions are reported in Section 3.3.

[2] See Grassman [1973] for early evidence of this.

that prices are rigid either in the local currency (Betts and Devereux [2000], Devereux and Engel [2003]) or in the producers currency (Obstfeld and Rogoff [1995]) and this assumption is symmetric across countries. In the case of the U.S., contrary to this assumption, we find local currency pricing for imports and producer currency pricing for exports. This suggests an asymmetry in terms of which country bears the risk of exchange rate movements. Further, we find that the prices of goods invoiced in a foreign (non-dollar) currency display significant rigidity in the foreign currency. In a reduced form sense, this is similar to the assumptions made in open economy models, where a firm picks a currency to price in and keeps prices stable in that currency. What is different though, is that in the case of the U.S., both imports and exports are priced in and sticky in dollars.[3]

There is also a large amount of heterogeneity in price stickiness across highly disaggregated goods. The weighted median frequency of price change for imports is 9%, the weighted mean is 28.8% and the standard deviation is 27.4%. Similarly, for exports, the weighted median frequency of price change is 7.5%, the weighted mean is 23% and the standard deviation is 26%. Using Rauch's (1999) classification[4], we find that the median duration of prices is 1.2 months for the organized exchange category, while it is 3.3 months for the reference goods category and 14.2 months for the differentiated goods category.

A third finding is that there has been a trend decline in the probability of price adjustment for imports. The average probability of price change has declined by 10 percentage points from 1994 to 2004. Several authors such as Taylor [2000], Marazzi et al [2005] and Campa and Goldberg [2005] have documented the phenomena of declining pass-through at the aggregate level in the 1990s relative to earlier decades. There are several proposed hypothesis for explaining this decline. Some explanations rely on a composition effect- that is the shift from more homogenous goods to differentiated goods, or the shift in country composition towards developing countries such as Mexico and China. When we decompose the increase in price stickiness into composition vs. time varying effects we find that almost all of the decline is explained by within-sector (that is, within differentiated) and within country time trends and very little by a composition story.

The fourth finding is that even conditioning on a price change, trade weighted exchange rate pass-through into U.S. import prices is low, at 22%. We estimate sectoral pass-through for 10 broadly defined sectors and find that for 9 out of the 10 sectors pass-through is less that 33%. In

[3]This asymmetry is explored in recent theoretical work by Corsetti and Pesenti [2005].

[4]Rauch [1999] classified goods on the basis of whether they were traded on an exchange (organized), had prices listed in trade publications (reference) or were brand name products (differentiated).

our analysis, we contribute to the previous literature on measures of pass-through by using price changes at the level of an extremely detailed good, which allows us to use the relevant bilateral exchange rate and to separate market transactions from intra-firm transactions. Further, to deal with the issues of price stickiness, we estimate pass-through conditional on an observed price change, as opposed to the standard lag specification used in aggregate regressions. That is, we measure pass-through as the change in prices in response to the cumulative change in the exchange rate since it last changed its price. We also relate this measure of pass-through to the price stickiness of the good. We divide the goods into 10 quantiles based on their price stickiness and estimate pass-through for the goods within each bin. The correlation between the pass-through estimate and the rank of the bin is -0.83. That is, goods with a lower frequency of price adjustment display higher pass-through. Since differentiated goods sectors empirically display higher price stickiness and these are sectors whose elasticity of demand is arguably less affected by the price the firm sets, we should expect to see higher pass-through in these sectors. The data present mild support for this hypothesis.

On the basis of our findings it is clear that at-the-dock prices of traded goods in the U.S. display significant nominal rigidity and respond only partially to exchange rate movements. To this extent there is support for a basic assumption of open economy macro models that prices display rigidity. However to fully test these models one would, require, among others, information on whether quantities are also contracted on. As Barro [1977] pointed out, when firms engage in long-term contracts, prices may no longer be allocative and contracts can specify not only rigid prices but also rigid quantities. There are two pieces of evidence that suggests that quantities might be flexible in the data. One aspect of the data for U.S. exports is that for close to 40% of market transactions the reporting firm specifies that the country of destination is not a price determining factor. That is the firm claims that they export a good to multiple destinations at the same price. There exist an additional 10% of goods for which the price determining factor is not a specific country, but a region, such as the "European Union". This finding suggests that for a significant number of goods, the price we observe is not specific to a customer. In this case it is difficult to infer that quantities are fixed along side prices, unless it is the case that all customers are buying the exact same quantity.

Second, in another question on the survey, the BLS questions reporting firms on whether the "Price is specific to Quantity Ordered". Indeed for 7% of the import prices and 13% of the export

prices the firm reports that prices are specific to the quantity ordered. For the remainder, 90%, the response is the default, which is that price is not related to the quantity ordered. We examine how rigid the quantity contracts are in the case when the firm specifies that price is related to quantity ordered. We find that for 40% (28%) of exports (imports) a quantity range, such as "1000-5000" units or "minimum of 1000 units" was specified. This again suggests that even when quantities are contracted on, some flexibility is allowed along side the price being completely rigid. While we present novel initial evidence on the non-price aspects of trade contracts there is clearly a need for more empirical work on these issues. One aspect of a long-term relationship that reduces the allocative role of prices are non-price methods of rationing such as delivery lags, as pointed out by Carlton [1986]. Investigating such forms of non-price allocation is important, but beyond the scope of this paper.

The paper is organized as follows: Section II describes the data we use. Section III documents the degree of price stickiness. Section IV analyzes the time trend in price stickiness. Section V studies exchange rate pass-through. Section VI presents a discussion on the non-price aspects of contracts and Section VII concludes.

II. Data Description

In this section we describe the price data employed in this study. The data are unpublished data collected by the Bureau of Labor Statistics (BLS) through the International Price Program (IPP) and underly the construction of import and export price indices for the United States. The primary reason for producing these indices is to deflate the value of U.S. foreign trade. The data made available to us are monthly data that covers the period September 1993 to April 2005.

The target universe of the price indices consist of all goods and services sold by US residents to foreign buyers (exports) and purchased from abroad by US residents (imports).[5] We present details about the sampling procedure in Appendix A.1. Sampling is undertaken at the entry level good (ELI), which in most cases corresponds to a 10 digit harmonized trade code. Within the 10 digit harmonized code, a good is defined as a unique combination of a firm and product. On average,

[5]Chapter 15 of the BLS Handbook of Methods (1997) provides a description of the objective, scope and sampling methodology of the IPP. In our study we exclude services, works of art and antiques (harmonized code 97), articles exported and returned (harmonized code 98) and certain special category goods (harmonized code 99).

there are around 4 goods within each 10 digit classification code in any year. These goods will be our units of observation. An example of a good description is "Lot # 12345, Brand X Black Mary Jane, Quick On/Quick Off Mary Jane, for girls, ankle height upper, TPR synthetic outsole, fabric insole, Tricot Lining, PU uppers, Velcro Strap." The price determining characteristic of the good[6]most often does not specify a specific foreign seller (foreign buyer) in the case of imports (exports). Accordingly, if a U.S. importer (exporter) switches to a different foreign seller this is intended to be captured in the price series for the good. For 6% of the imported goods in the sample, the country from which the good is imported switches during the life of the good. For 33% of the exported goods the country of destination is not a price determining factor for the good.

Price data are collected every month for approximately 20,000 goods (including exports and imports). A reporting company is contacted for the transaction price on a monthly basis. Respondents are asked to provide prices for actual transactions that occur as close as possible to the first day of the month. In several cases a company specifies if a price has been contracted and the period for which it is contracted, including specifying the months in which actual trade will take place. For the periods when the price is contracted, the BLS will use the contracted price without contacting the firm directly and also enter a flag for whether the good is to be traded or not in those months. For the goods in our sample, the BLS contacted 87% of the goods at least once every 3 months, with 45% of the goods contacted on a monthly basis. 100% of the goods very contacted at least once a year[7]. The price information provided by the company is voluntary and confidential.

The BLS prefers to collect prices that, in the case of imports, are 'free on board' (fob) at the foreign port of exportation before insurance, freight or duty are added. In the case of exports, the preferred price basis is 'free alongside ship' (fas), the price of the good at the US port of embarkation. The prices collected are net (exclusive) of duties. Almost all U.S. imports and exports have a reported price in dollars. That is, around 90% of import goods and 97% of export goods have a price reported in dollars[8]. The fraction of imports reported in dollars has increased from 87.9% in 1994 to 93.4% in 2004.

As mentioned earlier, reporting by the firm is voluntary. The standard procedure involves the firm entering information on an information sheet provided by the BLS and sending it back to

[6]The price determining characteristics of a good vary by industry and are determined by the BLS using industry knowledge and input from the reporting firm.

[7]This high frequency of contact reflects the BLS desire to obtain accurate transaction price information and does not necessarily reflect the actual contract length of prices.

[8]This is in line with the evidence reported in ECU (1995) that was presented in Obstfeld and Rogoff [2000].

the BLS. There can therefore be some concern about the quality of reporting. The BLS is clearly interested in obtaining accurate information and accordingly in the first step of data collection, a BLS agent negotiates with the company the number of price quotes that the company would be comfortable reporting on so as not to place undue burden on the firm. The average (median) number of price quotes, per reporting firm was 4.6 (4) in 2004. The average (median) number of price quotes, per reporter (some firms can have multiple reporters) was 3.85 (3) in 2004. The small number of price quotes provided by firms should alleviate concerns regarding misreporting, on the assumption that it lowers the reporting burden on firms.

The BLS also has a policy of contacting a respondent if the reported price has not changed for 12 months or the firm reports that the good has not been traded for 12 months to inquire about why this is the case. This form of quality check helps reduce the chances of mis-reporting.

Another piece of evidence that we examine relates to the anthrax attacks in October and November 2001. Following the anthrax attacks and disruption of mail to all governmental offices, the BLS could not receive mail, which meant that the standard process through which price data were collected was disrupted.[9] Consequently, in these two months, a BLS agent contacted the firm by phone and communicated with the company reporter directly to obtain the price information. Anecdotal evidence suggests that in these months firms were more eager to provide information to the BLS. For instance, the BLS received many more updates pertaining to company specific information during this month - such as address and contact information. In the Appendix, section A.2, we describe this episode in greater detail and present statistics that show that despite the change in the data collection procedure, there exist almost no differences in the point estimates of the frequency of price change around these months, which again helps reduce concerns about misreporting.

II.A. Data used in Estimation

In this section we describe our treatment of the data. The price data are monthly. However there are several months when the good is not traded or in some cases there is a lack of response from the reporting firm.[10] In this case, the BLS imputes a price for the month and codes the price as being un-usable for the price index. Such prices account for approximately 40% of the observations

[9] We thank Rozi Ulics for bringing this to our attention.
[10] The response rate varies between 70% and 85%.

in the import and export database. In addition, there are months when the good is not-traded and the reporting firm reports an estimated price. These prices are used in the index construction. Since we would like to focus only on prices that are reported as related to an actual transaction, we exclude all prices that are flagged as 'un-usable' or, where the price is estimated, even if it is flagged as 'usable'.[11] With this restriction we keep 90% of all usable prices.

The mean (median) life of a good in the index, as given by the difference between the date the good was discontinued from the index and the date it was initiated is 37.5 (35) months. In several cases a firm reports that a good is being replaced by a close substitute. For price index purposes, the BLS treats the substituted good as a new good, discontinues the price series of the good that was replaced and assigns a new code to the substitute good. The price change associated with this substitution does not affect the price index. In our analysis of price stickiness, we want to allow for price changes associated with such product substitutions. To do this, we link a good across its substitutions, so we have one price series.[12] We exclude price observations if the absolute size of the (monthly) price change exceeds 2 log points. These comprise less than 0.15% of the sample of 2 million price observations for imports and exports. After linking goods across substitutions, there are around 50,000 goods in the import sample and 43,000 goods in the export sample.

Since we restrict attention to only those prices that are reported as transaction prices, we have several goods that have only a few observations. In the case of imports, the mean (median) number of observations per good is 18.5 (12). In the case of exports, the mean (median) number of observations is 21.6 (15) per good. Secondly, these observations need not be consecutive. There can be gaps in months when the good is not traded or the reporting company is non-responsive. Third, around 30% of goods have their price constant over their entire life, both in the case of imports and exports. Finally, there is a large amount of heterogeneity across the goods in the behavior of prices.

Goods that have very few usable observations and frequent gaps in their price series make estimation of price duration and hazards problematic. The censoring problem in estimating hazards is magnified when prices remain constant during the life of the good. There is no simple statistic for computing hazards that can perfectly deal with all these issues.

[11] This is determined by keeping only those prices for which the flag 'price estimated' is set equal to 'N'.

[12] The BLS classifies good discontinuations into the following categories: "Out of business", "Out of scope (not replaced)", "Out of scope (replaced)", "Regular Phaseout", "Accelerated Phaseout", "Refusal", "To be resolved" and "Sample dropped". We use the "Out of scope (replaced)" category along with the item code for the replaced good to link goods.

In our main analysis we follow the frequency approach, which is the standard approach in the micro price literature, as in Klenow and Kryvstov [2005], Nakamura and Steinsson [2007] and Alvarez et. al. (2005). We also present estimates from a maximum likelihood estimation of a hazard function, which is reported in the Appendix, section A.3. Given the large heterogeneity across goods, we measure price stickiness at the good level and then present statistics of the distribution of price stickiness.

In our benchmark specification, we restrict attention to market transactions. It is well known that a sizeable fraction of international trade takes place intra-firm. Intra-firm transactions are related party transactions that take place between a parent and an affiliate. In our sample, 40% of goods are traded intra-firm in the case of imports and 26% in the case of exports. Since intra-firm transaction prices are likely to be accounting prices, we exclude them from our main calculations. In Section 3.3 we present a comparison of the pricing behavior of inter and intra-firm transactions

III. Price Stickiness

In this section, we calculate the frequency of price change for a good in the currency in which the price is reported. The trade weighted median price duration of market transactions (using 2002 trade weights) is 10.6 months for imports and 12.8 months for exports. Prices are indeed sticky in the currency in which they are reported as priced. Since 90% of imports and 97% of exports are priced in dollars, we observe the phenomenon of local currency pricing for imports and producer currency pricing for exports for the U.S.

III.A. Frequency Approach

Table I reports the results for several different specifications, which we describe here. The specification number is reported in column 2. Figure I depicts a hypothetical price series for a good and the value the price change indicator takes in specifications I, III and IV. In these specifications, we include price changes that take place across non-adjacent prices and across product substitutions. This is similar to the approach used in Klenow and Kryvstov [2005]. In Specification I, we calculate the average price change for each good. We then estimate the median frequency across the goods within a 6 digit code and calculate the weighted median across these 6 digit codes using 6 digit trade weights for 2002. The weighted median duration is 13.8 months for imports and 15.6 months

for exports.

Specification II follows the procedure in Aucremann and Dhyne [2004]. When the data have missing prices in the middle of the series and displays left and right censoring Aucremann and Dhyne [2004] propose estimating the frequency of price change as the ratio of the number of price changes in a sufficiently aggregated product category in a month divided by the number of products for which there are two consecutive price observations in the database for that product category. The average frequency of price change for that category is then obtained by averaging across the monthly frequencies across time. We perform this analysis where the product category is the 6 digit harmonized code. There are around 2500 product categories in the database for imports and similarly for exports. The trade weighted median frequency of the distribution across the 6 digit harmonized codes implies a duration of 12 months for imports and 13.8 months for exports.

Specification III is the same as Specification I, except that only contacted prices are used. As mentioned earlier, there are months when the firm reports that its price is contracted and whether actual trade will take place or not. In these months, the BLS pulls the contracted price without contacting the firm directly and these prices are used in our estimation as long as there is a flag that specifies that a trade will take place. If the price is flagged as not associated with a trade, even if it is a contracted price, the price is treated as a missing in our benchmark specification. As one would expect, it is when the goods prices are sticky that we would expect to see such pulled prices. However, we also estimate the frequency of price change, by treating only reported prices that correspond to a firm actually being contacted as a valid price and treat all pulled prices as a missing. The weighted median price duration is 10.6 months for imports and 10.6 months for exports. Not surprisingly, the duration numbers are lower for this specification, however there is still evidence of a significant amount of price stickiness.

In Specification IV, we follow Specification I and in addition adjust the frequencies of goods whose price never changes during its life by the probability of discontinuation. There are several goods in the sample that have a constant price during their life and then get discontinued, but not replaced with a substitute. These could be goods in say the clothing sector that have a fixed price for 6 months and then get discontinued if a new style is introduced. In some cases the reporting firm may simply report this as a discontinuation. The frequency of price adjustment for this good is then 0. However, the more meaningful number for the frequency is $\frac{1}{6}$. To make this correction we estimate the probability of discontinuation within each 6 digit harmonized code that is associated

with the firm reporting either that the good is "out of scope, not replaced" or the firm reports that it is "going out of business". The predominant case is the former where the firm reports that the good is no longer being traded and does not provide a substitute. To be specific, we estimate the life of each good that has been discontinued for either reason and take the inverse of this number for the probability. Next, we obtain the mean probability within each 6 digit harmonized code by averaging across such goods. We then assign the sector specific average probability to each good whose price is unchanged during its life. The assumption is that goods within the same 6 digit harmonized code have a similar probability of being discontinued.[13]According to Specification I, the median frequency of price change for "Women's/Girl's suits, ensembles, pants, dresses" is 0, while according to Specification II the median frequency is 0.13, which implies a duration of 7.7 months.[14]

To summarize, we have presented several estimates of price duration and, depending on the specification, the trade weighted median duration for imports using the frequency approach varies between 11-14 months for imports and 11-16 months for exports. Specification IV is our benchmark specification and will be employed in the rest of the paper. In tables II and III we present estimates for sectors for which the BLS allows public reporting. The trade weights are reported in Column III.[15]

III.B. Price Stickiness and Product Characteristics

There is a large amount of heterogeneity in the level of price stickiness across goods. The weighted median frequency of price change for imports is 9%, the weighted mean is 28.8% and the standard deviation is 27.4%. Similarly, for exports, the weighted median frequency of price change is 7.5%, the mean is 23% and the standard deviation is 26%. To explore some of the factors behind this dispersion, we summarize median and mean frequencies for different categories of goods.

[13]It was not possible to do this at a higher level of disaggregation given the shrinking sample size at higher levels of disaggregation. We also restricted that the life of the good should be at least 3 months given that there is left censoring in the data. Results are however insensitive to this choice.

[14]This procedure cannot be applied more generally to all goods because goods whose prices change very frequently can have their frequency estimates go above one, when the sector wide discontinuation rates are added to it. Ideally, discontinuations should be treated at the good level, but this cannot be done here because discontinuations can arise due to lack of reporting, which cannot be easily handled using the frequency approach. In Appendix A.2. we estimate duration through maximum likelihood estimation where at one extreme we assume that the last price is always a price change, regardless of the reason for discontinuation. This generates durations of 8.5 months for imports and 10 months for exports.

[15]The weights do not sum up to 1 because these are only a subset of categories.

We relate our measures of stickiness to the particular nature of the good traded, by using Rauch's [1999] empirical classification of traded goods into homogenous goods and differentiated goods[16]. With this procedure we can classify around 65% of the goods. The homogenous goods category includes goods that are traded on an exchange and those that are reference priced. Reference priced goods are those whose prices are listed in trade publications and the particular brand name does not affect prices much. Therefore, unlike differentiated goods, it is easier to arbitrage price differences across reference priced goods. All results are presented in Table IV.

For all goods, the median frequency of price change is the highest for goods in the Organized sector (0.83), followed by reference priced goods (0.30) and differentiated goods (0.07). We would expect that the elasticity of demand is higher for homogenous goods as compared to differentiated goods. In menu cost models of price stickiness, as in Barro [1972], the cost to not adjusting prices is greater for goods where the elasticity of demand is high. That is, all else equal, we would expect to see lower price stickiness the higher the elasticity of demand for the good. We do observe here that goods traded on an organized exchange, where the elasticity of demand is the highest indeed have the highest frequency of price adjustment. However, we should be cautious in interpreting the evidence, since the organized sector most likely has the least value-added and are more subject to the influence of commodity prices (or are commodity prices), which explains the high frequency of adjustment.

We also use the end-use classification of goods at the 1 digit level and relate it to our measures of stickiness. There are 6 (1 digit) end-use categories. The median frequency of price change is highest for goods in the 'Food, Feed and Beverages' category (0.40), and 'industrial Supplies and materials' (0.20) category, followed by 'other' (0.09), 'automotive vehicles, parts and engines' (0.08),'capital goods except automotive' (0.07), and 'consumer goods' (0.07).

Around 10% of imports are invoiced in a foreign currency. We find that these foreign invoiced prices are about as sticky in foreign currency terms as dollar invoiced prices. The median frequency for dollar priced goods is 9.1% and it is 7.3% for non-dollar priced goods. The lower median frequency for the non-dollar goods reflects the fact that non-dollar priced goods are concentrated

[16]Rauch [1999] classified enough 5 digit SITCs to cover the majority of trade in each four digit SITC. He then categorized the goods at the 4 digit level according to which of the three categories accounted for the largest share. Each good in our database is mappped to a 10 digit harmonized code. We use the concordance between the 10 digit harmonized code and the SITC2 (Rev 2) codes to classify the goods into the three categories. Since the 10 digit classification is far more detailed than the 4 digit SITC level to which we map the goods, the classification is clearly an approximation.

in the differentiated goods sector.

III.C Inter-firm versus intra-firm transactions

This far our analysis has only included market transactions. Since there is reason to suspect the allocative role of intra-firm prices we exclude them from our benchmark estimates. Nevertheless, since a large fraction of trade takes place intra-firm it is useful to compare the behavior of these prices to market transactions. In this data set the BLS codes a transaction as taking place "intra-firm" if the respondent reports that there is joint ownership without any specification on what the share of ownership is. According to the Bureau of Economic Analysis, which is probably what reporting firms use as their definition, intra-firm includes ownership stakes of 10% or more. In the case when ownership stakes are low the difference between intra-firm and inter-firm transactions should be less apparent. The BLS categorizes intra-firm transactions into four different categories. Based on firm responses, intra-firm transactions are classified as following: "Market Based Pricing", "Cost based pricing", "Other non-market based pricing" and "unknown pricing method". For imports and exports, about 30% of intra-firm goods are coded as following "market based pricing".

The average median frequency of price change is very similar for both intra-firm and market transactions at around 9%. However, there are important differences at a disaggregated level. In general there is less dispersion in intra-firm price durations than there is in market transactions. As Table V reports, across the 6 end-use categories, in the case of imports, price durations vary between 7.2 and 12.5 months. In the case of market transactions, as Table IV highlights, the range is between 2 and 14 months. The most striking difference is in the price durations for the category "Food, Feed and Beverage" and "Industrial Supplies". In both these categories, market transactions have very low price durations of 2.5 and 4.5 months respectively. In the case of intra-firm transactions the price durations are far higher at 6.6 and 7.2 months respectively. If we restrict attention to the sub-category of intra-firm transactions that are coded as following "cost-based pricing", this difference is even larger. It is 12.5 months and 11.1 months for categories where market based transactions generate durations of 2.5 months and 4.5 months, respectively. Neiman [2007] first pointed out this fact that there is less dispersion in intra-firm price durations by comparing durations across Rauch [1999] categories.

In general, it is not obvious whether prices should be more or less sticky for intra-firm compared

to market transactions. On the one hand, since prices are less allocative for intra-firm transactions, one could argue that there is less need to change them often. On the other hand, it could be argued that menu costs are lower for intra-firm transactions which makes it easier to change these prices. Also, demand driven strategic complementarities across firms is more of an issue for inter-firm transactions, which can introduce rigidities in pricing by firms selling to the market as compared to intra-firm transactions. This could generate greater rigidity in market based transactions. In this paper we do not wish to explore the reasons why price durations can differ across market and non-market transactions. So, for the rest of this paper our main focus is on market transactions. [17]

III.D. Comparison to Evidence from Domestic PPI and CPI

Since transactions at the dock reflect business-to-business transactions, it is useful to compare our estimates to other studies on whole sale prices. It is interesting to know if cross-border business to business transactions differ in their price rigidity from domestic transactions.

Carlton [1986] studied the transaction price of intermediate goods purchased by mostly Fortune 500 U.S. companies. He estimated price stickiness to be about a year. This estimate is similar to our estimate for import and export prices.

Nakamura and Steinson [2007] estimate measures of price stickiness using the whole-sale price data that underlies the construction of the U.S. producer price index. They estimate the median price duration to be around 9 months. Our estimates for traded goods prices at-the-dock are higher by a couple of months for imports and by 3 months for exports.

There have also been a number of studies on retail prices, starting with the important work of Bils and Klenow [2004] for the U.S. Since several price changes in the CPI reflect sales prices which are typically not observed in whole-sale prices, we compare our numbers to only the sales adjusted price durations. Klenow and Kryvstov [2005] report the median price duration to be 7 months for U.S. consumer prices. Nakamura and Steinsson [2007] estimate sales adjusted numbers that are higher and lie between 8-11 months, depending on the specification. In similar work on the CPI for the Euro Area, Alvarez et al [2005] find the duration is closer to 12 months. Consequently, while trade prices at-the-dock have a much longer price duration than CPI prices unadjusted for sales (4

[17] For an extensive analysis of comparisons between intra-firm and market transactions using the same data see Neiman [2007].

months), they are closer to the sales adjusted numbers for CPI and estimates for the PPI in the U.S.

In Table VI, we present estimates for categories of goods for which we could find a match between goods in the import price index, consumer price index and producer price index, for which the BLS allows public reporting. Specifically, we used product category descriptions to match[18] ELI's in the CPI to approximately 4 digit harmonized codes in the international price database. Next, we used Nakamura and Steinsson's [2007] matching of goods in the PPI to ELI to form a match across IPP, CPI and PPI (69 categories).[19]

The correlation between price durations for the matched categories in CPI (using Klenow and Krystov [2005] estimates) and IPP is 0.43, while the correlation for matched categories in the PPI and IPP is 0.80. Restricting the sample to only matched categories, the mean duration is 10.3 months for the IPP, 10.6 months for the PPI and 6 months for the CPI.[20] Given that transactions in the PPI are similar to the data analyzed here, it is not surprising that the correlation is much higher and average duration more similar to the PPI than with the CPI.

III.E. Price Stickiness around large Exchange Rate Movements

The fact that prices do not change, in and of itself, need not signify that there are inefficiencies. It could simply be that the underlying cost and demand shocks are such that the optimal flexible price is unchanged. A useful feature of cross-border transactions is that they are subject to exchange rate shocks which are sizable and affect costs in different currencies. In this section we study episodes of large foreign currency devaluations to examine if the probability of price adjustment changes sizeably around them. Since the exchange rate movement is the dominant shock surrounding these episodes the prediction would be that the probability of dollar price decreases should rise significantly after a depreciation.

Specifically, we examine episodes when the exchange rate of a foreign currency depreciated by 15% or more in a month and analyze the behavior of import prices from these countries.[21,22] For

[18] We should note that since the matching was done using a brute-force method of comparing product descriptions the matching is far from perfect.

[19] We would like to thank Emi Nakamura and Jon Steinsson for providing us with their matching. See the on line appendix of Nakamura and Steinsson (2007) for detailed price durations by PPI category.

[20] Using Nakamura and Steinsson [2007] estimates for the CPI the average is 8 months.

[21] We have performed this exercise for alternative large magnitudes and the results are qualitatively the same.

[22] Brazil in our sample had very high and stable inflation of more than 15 percent a month. Therefore movements of

each good we calculate the simple average probability of price change in a 6 month interval before the devaluation and compare it to the probability within a six month period after the devaluation. In general, the change is negligible. In Figure II, time zero corresponds to the month in which the exchange rate depreciates. We computed the proportion of goods changing prices every month, as well as the probability of price increases, and price declines. The three probabilities are depicted in Figure II. The thick line corresponds to the overall probability of price changes, the thin line is the probability of a price decrease, while the dashed line is the probability of observing a price increase. All the probabilities are measured on the left axis. The continuous line marked with diamonds shows the average price change in the data. It is measured on the right axis. As can be seen, there is a small increase in the probability of price change around the crises - one month after - and then the pattern returns to the normal unconditional probability of change of around 20 percent. When we separate the analysis by price increases and decreases, we find that there is a slight increase in the probability of finding a price decrease, while there is a decline in the probability of finding price increases. These changes are as expected, but the pattern is surprisingly weak. In other words, even if we restrict attention to periods of significant exchange rate movements, goods tend to exhibit fairly high price stickiness. Finally, this is the case even when we restrict attention to only differentiated goods.

It is interesting that prices two to three months before the large devaluation are already falling, the largest drop occurs a month after the devaluation, and the speed of price fall starts to decline right after that. Note that the price declines are indeed very small on average — indicating that the pass-through in the short run is relatively small; we return to these issues in Section V.

IV. Price Stickiness and Time Trend

We document that the degree of price stickiness in dollars has been increasing significantly in the last ten years in U.S. imports. For imports, the average probability of price change for market transactions declined by 10 percentage points from 0.32 in 1994 to 0.22 in 2004, that is, there was a 31% decline. In a simple decomposition, we find that the increase in stickiness cannot be explained by a compositional shift in imports towards differentiated goods or a shift in country composition of imports alone.

nominal exchange rates of 15 percent were common. For Brazil, we computed the exchange rate adjusted by inflation, and concentrated on the periods in which the real exchange rate moved by 15 percent.

We compute the monthly average probability of price change by simply dividing the number of price changes by the total number of goods that could have changed prices in that month. We then estimate a 12 month overlapping moving average by regressing the monthly frequency of price change on a constant for each 12 month window. The average for Dec 1994 refers to the average across the monthly probabilities from Jan 1994 to Dec 1994. This is depicted in the top panel of Figure III, where we plot both the point estimates and the ± 2 standard error bands.

Most of the decline takes place during the 90's, and the trend seems to have stabilized significantly in the 2000's. Several authors have documented a phenomena of declining pass-through of exchange rate movements into import prices and into retail prices in the 1990s relative to earlier decades. Taylor [2000] surveys the empirical evidence that documents declining pass-through of exchange rate changes into retail prices. Marazzi et al [2005] in a recent paper estimate the pass-through to U.S. import prices using the aggregate import price index and find evidence of declining pass-through even at the dock, with a substantial decline in the 1990's which coincides with our sample period. If the long-run is not fully captured in the estimation process, increasing price stickiness will reduce pass-through estimates over time.

IV.A. Decomposing Trend Decline in Price Stickiness

One explanation for the increase in average price stickiness could be the changing composition of goods in the U.S. import basket. Presumably, as the composition of imports shifts from homogenous goods to more differentiated goods where there is more of pricing to market, we should observe an increase in stickiness. Indeed, we documented earlier that differentiated goods have sizeably larger price durations than homogenous goods. This composition story however explains very little of the decline. This can be partly seen in the bottom panel of Figure III, where we plot the time trend in the probability of price change separately for the organized, reference and differentiated sector. We have normalized the initial point to 1 for all series. The largest decline of 40% is in the differentiated sector category, followed by 22% in the reference sector. In the organized sector the probability of price change increased by 9%. Consequently, there has been a sizeable decline within the differentiated sector. Furthermore, within the differentiated goods sector, if we break down by end use we observe increases in price stickiness in consumer goods, capital goods and in the auto sector.

The share of homogenous (organized plus reference) goods declined from 25% to 17% of all

goods[23]. For each sector - organized, reference and differentiated, we estimate $\lambda_{s,t}$, which is the average monthly probability of price change in sector s in year t. Suppose $n_{s,t}$ is the fraction of goods in sector s at time t relative to the total number of goods at time t. For any t, average probability at time t, $\Lambda_t \equiv \sum_s [n_{s,t}\lambda_{s,t}]$. We then estimate the following measures,

$$\begin{aligned} \Lambda_{1t} &\equiv \sum_s [n_{s,1994}\lambda_{s,t}] \\ \Lambda_{2t} &\equiv \sum_s [n_{s,t}\lambda_{s,1994}] \end{aligned}$$

The first measure, Λ_{1t}, fixes the sectoral composition at the 1994 level and allows the probability within each category to vary over time. The second measure, Λ_{2t}, fixes the sector probabilities at its 1994 level and allows the composition to vary over time. As can be seen in the top panel of Figure IV almost all of the decline is a within sector decline. If we calculate the following ratio, $\Omega = \frac{Var(\Lambda_t - \Lambda_{1t})}{Var(\Lambda_t)}$, the "residual" variance is 12%.

A second conjecture is that the decline is due to changing country composition in the import basket. That is, the share of China and Mexico in U.S. import trade has grown significantly over the past decade. Since both these countries have fairly stable exchange rates against the dollar one might argue that longer average duration can be explained by a changing country mix. We find some support for this hypothesis, but there is still a sizeable within country decline. In the bottom panel of Figure IV, we plot the time varying country price stickiness, where we fix country composition at the 1994 level. We also plot the decline that would be implied by keeping the within country probability of price adjustment unchanged at the level in 1994 and only allowing for the country composition to change. The "residual" variance that is unexplained by time varying country probability is 8%. Therefore, an explanation for the decline in average probabilities for the period 1994-2004 needs to be one that can explain a general trend decline in probability within each country and particularly among differentiated goods.

V. Price changes and Exchange Rate Pass-through

A question that is of direct relevance to the effects of nominal rigidities on real outcomes is the

[23]That is, all goods that can be categorized as homogenous or differentiated.

magnitude of the price change, when prices adjust. Section V.A reports the average size of price change, conditional on adjusting and the fraction of such price changes that are increases versus decreases. Section V.B studies exchange rate pass-through using the micro data.

V.A. Size of Price Change and the Frequency of Price Increases and Price Decreases

We estimate the average price change within each 6 digit harmonized code for each month for market transactions. We then use trade weights to calculate the weighted statistics for each date. In Table VII we report the average and median across time along with the standard deviation.

In the case of imports, the weighted average size of price change is small, at negative 1%, while the weighted average absolute size of price change is large at 8.2%. The small average size of price change captures the fact that there are a large number of price decreases alongside price increases. The weighted mean fraction that are price increases are 52%.

In the case of exports, the weighted average size of price change is a negative 1%, the weighted average absolute size of price change is 7.9% and the weighted mean fraction that are price increases are 55%.

V.B Exchange Rate Pass-Through

The extent of pass-through of exchange rates into prices is a widely researched topic. The question is what is the percentage change in local currency import prices resulting from a one percentage change in the exchange rate between the exporting and importing country. As surveyed in Goldberg and Knetter [1997], the standard pass-through regression takes the form

$$\Delta p_t = \alpha + \gamma \Delta e_t + \delta \Delta c_t^* + \psi \Delta d_t + \epsilon_t \tag{1}$$

where if Δp is the percentage change in the dollar import price into the U.S., Δe is the percentage change in the dollar per foreign currency exchange rate, Δc^* is the percentage change in marginal cost in the foreign currency and Δd includes changes in import demand shifters like competitors prices, income etc. Pass-through is defined to be complete if $\gamma = 1$ and incomplete if $\gamma < 1$.

Pass-through can be incomplete because of variable mark-ups and increasing marginal costs. As shown early on in Dornbusch [1987] and Krugman [1987], when firms have market power they

absorb some fraction of the exchange rate movement through varying mark-ups, which restricts the extent of pass-through. Further, if the cost function displays increasing marginal costs, then in response to a foreign nominal appreciation of the exchange rate the firm raises prices, its quantity sold declines, which lowers costs and this in turn reduces the initial incentive to raise prices. This effect also reduces the extent of optimal pass-through. In addition, some fraction of the firms inputs into production may be sourced from countries that are not affected by the exchange rate movement. For instance, if a fraction ϕ of the firms costs are fixed in dollars, then even with constant mark-ups and constant marginal costs, estimated pass-through will be less than 1 and equal to $(1-\phi)$, if these input costs cannot be controlled for separately.

Given the limitations of publicly available data, the estimates of pass-through into import prices have typically been estimated using an aggregate measure of prices for p_t. Studies with data on the price level of a very specific product over time are more the exception than the rule and are restricted to a few goods. Sectoral estimates of pass-through into U.S. import prices use aggregate trade weighted exchange rates for e_t, which may not be the relevant aggregate exchange rate for a sector. Secondly, all indices include prices of intra-firm transactions. Given the allocation issues specific to intra-firm transactions, it is useful to restrict attention only to market transactions. Lastly, as discussed in the previous sections, prices exhibit a large amount of stickiness. Consequently, to capture the effects of pricing to market that do not arise from local currency price stickiness it is useful to condition on price changes.

In this section we contribute to the previous literature by using price changes at the level of an extremely detailed good, by using the relevant bilateral exchange rate, and separating market transactions from intra-firm transactions. Further, to deal with the issues of price stickiness, we estimate pass-through conditional on an observed price change. That is, we measure pass-through as the change in prices in response to the cumulative change in the exchange rate since it last changed its price.[24]

More specifically, we estimate the following regression,

$$\Delta p^{ijc}_{t+k,t} = \alpha^{jc} + \beta_1 \Delta e^{c}_{t+k,t} + \beta_2 \Delta c^{*c}_{t+k,t} + \beta_3 \Delta d^{j}_{t+k,t} + \eta^{ijc}_{t+k,t} \tag{2}$$

[24]In this analysis we do not include price changes across product substitutions, since these substitutions can be associated with quality changes which is why the BLS excludes them from the construction of the price index.

where $\Delta p^{ijc}_{t+k,t}$ is the change in the dollar import price of good i in sector j imported from country c, conditional on adjusting price.[25] For Δc^* we use inflation in the consumer price index in the exporting country.[26] This analysis is therefore subject to the usual caveat in most of this literature that we do not have precise information on the input costs of the foreign firm. As controls for d we use U.S. gross domestic product and U.S. consumer price index inflation in our benchmark specification. In alternate specifications, we control for the price of competitors by using the average price change of other imports entering the U.S. in the same 2 digit harmonized code. We also use the match between harmonized codes and SIC 87[27] to use U.S. producer price indices at 2 digit SIC level as controls for the price of competitors. In all specifications, we estimate a fixed effect for each country and 6 digit harmonized code combination. By doing this we control for any unobserved deterministic trends that are sector and country specific. For instance, if there is a trend decline in the costs of production owing to productivity improvements at the sectoral level that are not captured by the aggregate price level, then the fixed effect will control for this.

We estimate one regression for each of the 20 categories of harmonized codes. The results for the benchmark specification, for market transactions alone, are listed in Table VIII. The trade weighted average exchange rate pass-through across the sectors for market transactions is 21%. This is consistent with the evidence using the aggregate import price index that for the most recent decade, long-run exchange rate pass-through into the U.S. has been very low. With the exception of the category described as "Animal and Vegetable Fats and Oils" which accounts for only 0.12% of total trade and has a pass-through of 86%, the estimated pass-through for each of the other categories is 33% or lower. Similar results are obtained using the alternative specifications reported in Table IX.

In Table X we report the results for intra-firm transactions. Interestingly, the overall trade weighted average for intra-firm transactions is 22%, which is similar to the average for market transactions. However, within each sector, the pass-through's show sizeable differences in their point estimates. If we calculate the absolute size of the difference in the pass-through elasticity by category, the average difference is 11%, which is large given the typical pass-through estimate

[25] Since there are goods which have only a single price change during its life, we treat the first observed price as a new price. We have performed this analysis omitting such price changes and obtained similar results.

[26] We use data from the IMF's International Financial Statistics database for the nominal exchange rate and CPI. For the nominal exchange rate we use the end of the month nominal exchange rate, which we lag by one month before including it in the regression since prices refer to the beginning of the month. This is consistent with the BLS procedure of using a lagged exchange rate when converting prices reported in the foreign currency into dollar prices.

[27] This matching was obtained from Robert Feenstra's web site http://cid.econ.ucdavis.edu/

at the sectoral level. It just so happens that these differences have signs that cancel out in the aggregate and therefore, the averages across types of transactions is similar.

We also relate pass-through to the price stickiness of the good. We divide the goods (market transactions only) into 10 quantiles based on their price stickiness. We exclude goods for which there is no price change during the life of the good, since pass-through estimation is not possible for these goods. For the remainder goods, we estimate the benchmark pass-through regression for the goods within each bin. The median frequency within each bin, the point estimates on the exchange rate coefficient and the standard errors of the estimates are reported in Table XI. The correlation between the pass-through estimate and the rank of the bin is -0.83. That is, goods with a lower frequency of price adjustment display higher pass-through. The largest difference that is significant is between the first decile, with a pass-through of 32% and the 9th decile with a pass-through of 4%. We obtain a similar pattern when we divide the data into 20 quantiles. Since differentiated goods sectors empirically display higher price stickiness and these are sectors whose elasticity of demand is arguably less affected by the price the firm sets, we should expect to see higher pass-through in these sectors. This is the Dornbusch and Krugman effect of pricing to market. The point estimates present some support for this hypothesis, though the differences are not always significant. For a more extensive analysis of the relation between frequency of adjustment, currency of pricing and exchange rate pass-through see Gopinath, Itskhoki and Rigobon [2007].

VI. Discussion on Contracts

On the basis of our findings it is clear that at-the-dock prices of traded goods in the U.S. display significant nominal rigidity and respond only partially to exchange rate movements. In taking this finding to the standard open economy models we need to be clear about what our findings shed light on. In the standard model, a firm sets a price and keeps it fixed for a duration of time. This price is assumed to be common to all customers. Further, while the price is fixed the quantities respond to shocks. The data we analyze involve transactions between firms that most likely involve a contract. As Barro [1977] made clear, when firms engage in long-term contracts, prices may no longer be allocative and contracts can specify not only rigid prices but also rigid quantities. In this case, a rigid price does not generate inefficiencies and monetary shocks will have no effect on output, which is unlike the assumption in standard open economy models.

One question then is, are the prices in this data set capturing a specific price charged by a firm to a specific customer and for a specific quantity. While we do not observe the actual contracts, there are certain inferences we can make based on firm responses. According to the BLS data, for market transactions, for 39% of the goods exported the country of destination is not a price determining factor. That is the firm claims that they export a good to multiple destinations at the same price. There exist an additional 10% of goods for which the price determining factor is not a specific country, but a region, such as the "European Union". The median price duration within this sub-sample (49% of exported goods) is 12.7 months, which is the same for the sample as a whole. This finding suggests that for a significant number of goods, the price we observe is not specific to a customer. This also makes the point that pricing to market, as in price discriminating across country of destination is not very prevalent for a large category of U.S. exports.[28]

Secondly, in a question on the survey, which helps to shed light on the issue of quantities being a part of the contract, the BLS questions reporting firms on whether the "Price is specific to Quantity Ordered". Indeed for 7.2% of the import prices and 13% of the export prices the firm reports that prices are specific to the quantity ordered. For the remainder, 90%, the response is the default, which is price is not related to the quantity ordered. We then examined how rigid the quantity contracts are in the case when the firm specifies that price is related to quantity ordered and provides information on the nature of the relation. For this we went into the details of the reporting firms text comments to extract information about the nature of the quantity contract. The total number of goods for which such information exists is around 9500.

To summarize our results, we categorize goods into 4 broad categories. The first category was where the contract specified a fixed quantity, such as "100000 units". The second category was where a quantity range was specified, such as "1000-5000 units", "10000 or less" etc.[29] The third category was when the responses specified only shipment size such as "container load", "tank load" etc.[30] The last category was when the responses specified the buyer's/seller's class such as "Tier 1 Buyer" or "Bulk Purchaser" etc.[31] We were able to classify over 97% percent of the the imports

[28]Knetter [1989] had found using unit value indices for U.S. exports and German exports, that there was far more pricing to market for German exports than U.S. exports.

[29]Sometimes ranges are specified by using two numbers, but most of the time they are qualified in words. For instance, the firm indicates a quantity and uses words such as less than, under, fewer, up to, greater, over, more than, at least, etc.

[30]Specifically, these include words like, bulk, airplane, railcar, trailer, tank, barge, case price, car load, carload, truck, drum, boat, ship, and container, all of them combined with load, with and without spaces, and allowing for different permutations.

[31]In this case we look for statements such as high volume, low volume, small volume, mid volume, big buy, lower

from a total of 4077 goods for which such information was reported, and 98.2% of the exports from a total of 5536. What is interesting is that even for the firms that reported that prices were related to quantity the contracts provided for some flexibility in quantities. The first category captures goods where the quantity contract is the most rigid, while the remaining three categories allow for some flexibility. The results for only market transactions are reported in Table XII. For 40% of the exports and 29% of the imports a quantity range (second category) was specified. We also report the median frequency of price change within each category and find similar price rigidity across the categories especially for differentiated goods. It is certainly not the case that categories that allowed more quantity flexibility had a higher frequency of price adjustment.[32] This again suggests that even when quantities are contracted on, some flexibility is allowed along side the price being completely rigid.

There are, however, other aspects of a long-term relationship that can reduce the allocative role of prices. As Carlton [1986] pointed out, there are non-price methods of sustaining an efficient allocation. For instance, if demand is high and production is stretched above expected, the buyers would be understanding of some delays in delivery which does not show up in prices. Such aspects of the relation between a buyer and seller can again reduce the allocative role of prices. While we present novel initial evidence on the nature of contracts there is clearly a lot more empirical work than needs to be done, which is beyond the scope of this paper.

VII. Conclusion

The rigidity in price setting is an important ingredient in theoretical models in closed and open economy macroeconomics. The currency in which prices are rigid has important implications for exchange rate pass-through and cross-country spill-over effects of monetary and fiscal policy. We present, to the best of our knowledge, the first set of direct evidence on stickiness in prices of at-the-dock prices of traded goods using detailed unpublished data for U.S. imports and exports. We find that prices display a significant amount of rigidity. The trade weighted median price duration for market transactions is 10.6 months for imports and 12.8 months for exports.

tier, higher tier, mid tier, medium tier, maximum direct, wholesale, and retail.

[32]Non-differentiated goods in the "container" category include a large proportion of commodities, which explains the higher frequency in this bin.

We also find that prices are rigid in the reported currency of pricing. Since 90% of U.S. imports and 97% of U.S. exports are prices in dollars, this is evidence of producer currency pricing in U.S. exports and local currency pricing in U.S. imports. The fact that U.S. imports and exports are sticky in dollars suggests that unlike the standard modeling assumption that all countries are symmetric and there is only local currency or producer currency pricing, at least vis-a-vis the U.S. there is asymmetry. This has implications for which country bears the risk of exchange rate movements and the impact of exchange rate movements on the trade balance. There is also considerable heterogeneity in price durations across goods and across time. The average frequency of price change in imports has declined by 10 percentage points over the period 1994-2005. Most of this decline has taken place within differentiated goods and is a feature of the frequency of price change for most countries. Our estimates of exchange rate pass-through show that, even conditioning on a price change, exchange rate pass-through into import prices is low at 22%. Given the significant levels of nominal rigidity and low exchange rate pass-through, it is useful to explore both theoretically and empirically the nature of the non-price aspects of contracts across trading firms. We present important initial evidence on the nature of quantity contracts, however there is clearly more work that needs to be done.

Appendix

A.1 Sampling Procedure

The International Price Program of the BLS selects companies and good categories using a stratified sampling design and probability sampling procedure. The data used for sampling are obtained from the U.S. Customs Service for imports. The data for exports are obtained from the Canadian Customs Service for exports to Canada and from the Bureau of the Census for exports to the rest of the world.

Sampling is undertaken in 3 stages. In the first stage company and strata pairs are selected, henceforth referred to as company/strata. Strata here refers to mostly a 4 digit harmonized trade code. At this stage, the aggregate dollar value of trade by a company in a particular strata in the reference year for the sample is calculated. A consistency rank, which indicates the frequency of a company's trade in the stratum is also estimated for each company within each strata. The rank can vary from 1 (very infrequent trade) to 7 (very frequent trade). To decrease the risk of non-response, nearly all of the sample is selected from the consistent company/strata (i.e. consistency ranks of 5, 6, or 7). The BLS also estimates a stratum probability for each company/strata by estimating the ratio of the dollar value of trade by a company in a particular strata to the total dollar value of trade in that strata in the reference sample year. The BLS selects company/strata using these probability measures. By using this method of sampling, consistent company/strata with large dollar volumes of trade in the sampled good areas have a greater probability of selection than inconsistent company/strata and those dealing in smaller volumes. The number of company/strata to be selected from each stratum is allocated based on that stratum's dollar value. This allocation is adjusted to ensure that the expected number of companies selected across all the strata will yield the desired number of companies to be initiated, consistent with budget and program resources.

In the second stage, company and ELI pairs are selected within the strata. ELI stands for "Entry Level Item" and mostly refers to a 10 digit harmonized trade code. The number of goods to request for each company and ELI pair is based on a probability proportionate to size sampling methodology, similar to the first stage. The final stage is the selection of goods within chosen company and ELI combinations. For each assigned ELI, the reporting firm is asked to name all good categories traded during the reference period. The respondent assigns a measure of size to each category based on one of the following (in order of collection preference): 1. Actual dollar

values of trade or percentages 2. Estimated dollar values of trade or percentages 3. Ranking of good categories in order of dollar value of trade 4. Equal probability. The BLS assigns a percentage to each good category and categories are selected for further disaggregation to finally arrive at a unique good to be priced.

A.2 Anthrax episode

In this section we analyze the behavior of prices during the months of October and November 2001 when owing to the anthrax attacks the firms were contacted by phone to obtain price information, which was a departure from their standard practice of collecting price information via mail.

The time-line of events were as follows. After 9/11, the International Price Program (IPP) was concerned about how the attacks would affect response from the reporters. At the end of September, the October repricing forms were mailed to the respondents (excluding telephone and non-mail respondents) as usual. However, on October 15, U.S. postal delivery service to government agencies was suspended because of the anthrax attacks. By this time some forms had already been returned by respondents via the mail (some received, some not) although the exact number is not documented. The rest of the respondents were contacted directly by IPP staff for October prices via phone. Anecdotal accounts indicated that the data collection effort was surprisingly successful and relatively easy, possibly because of residual sympathy for the government by respondents after both attacks.

The disruption to mail service continued throughout November, so instead of mailing forms out to respondents, all respondents for the November repricing period were contacted via phone by IPP staff and requested to either give their data over the phone, or fax back forms generated and faxed to them by the industry analyst. It is not known how many were faxed the forms. Finally, mail service resumed on Nov 26, 2001.

In Table A1 we report some statistics to compare across months. The response rate for the month of October for imports was 74%, which was lower than the rate for September of 79%. The response rate rebounded to 85% in November. In the second column we report the fraction of goods that reported a price change in each of the last 5 months of 2001. This fraction is almost identical across these months. This is also the case if we compare it to the other months of 2001 or months in 2000. Similarly, if we look only at contacted prices, this fraction across the months in 2001 are

almost identical at 0.22. A similar pattern is observed for the case of exports.

A.3 Maximum likelihood estimation of hazards

In this section we present the duration numbers obtained from estimating a hazard model. We make several conservative assumptions, so accordingly the numbers reported are closer to a lower bound estimate for price stickiness. For details about this procedure we refer readers to Gopinath and Rigobon [2006]. In this estimation we assume that every price initiation is a price change, and that every discontinuation is a price change. Secondly, every price after a censored spell will be considered a price change regardless of whether the price is the same before and after the missing price spell. These two assumptions imply that our estimates of the hazard are conservative in terms of the measured stickiness.

Third, we have to deal explicitly with censoring that takes place in the middle of the data. These spells have a minimum duration, but also a maximum one. The only goods that are censored in the standard sense, and will be treated as such, are those that are still active in the data set, for whom we have no discontinuation date yet.

Formally, assume that D_i is an indicator that takes the value of one when spell i is complete (uncensored), and zero otherwise. Assume the spell durations are indicated by S_i. Finally, assume that M_i is the (strict) maximum of the spell. We assume that the spells are exponentially distributed with parameter λ. This means that the probability of observing a complete spell of length S_i is $\lambda e^{-\lambda S_i}$. If the spell is censored, then the probability is the accumulation of all the spells greater than or equal to S_i, given by $e^{-\lambda S_i}$. In our case, the upper bound spells are those in which there is always a maximum which implies that the probability of observing the censored spell is $e^{-\lambda S_i} - e^{-\lambda M_i} = e^{-\lambda S_i}(1 - e^{-\lambda(M_i - S_i)})$. Also to allow for the fact that stickiness may change over time, we weight the observations by their length. Therefore, the maximum likelihood is the following:

$$\pounds(\lambda) = \sum_{i:\{D_i=1\}} S_i \cdot \ln(\lambda) - \sum_i S_i^2 \cdot \lambda + \sum_{i:\{D_i=0\}} S_i \cdot \ln(1 - e^{-\lambda(M_i - S_i)}) \tag{3}$$

where the first two terms are the standard terms in constant hazard models with weighting, and the last term is the correction for truncated censoring.

We estimate the maximum likelihood good by good, for each good that has at least 6 or more

observations. The trade weighted median is 8.5 months for imports and 10 months for exports.

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Notes

[1]A significant fraction of trade takes place intra-firm and the associated prices may simply reflect accounting prices. Since the standard macro model describes market transactions, we exclude intra-firm transactions from our benchmark specifications. Results for intra-firm transactions are reported in Section 3.3.

[2]See Grassman [1973] for early evidence of this.

[3]This asymmetry is explored in recent theoretical work by Corsetti and Pesenti [2005].

[4]Rauch [1999] classified goods on the basis of whether they were traded on an exchange (organized), had prices listed in trade publications (reference) or were brand name products (differentiated).

[5]Chapter 15 of the BLS Handbook of Methods (1997) provides a description of the objective, scope and sampling methodology of the IPP. In our study we exclude services, works of art and antiques (harmonized code 97), articles exported and returned (harmonized code 98) and certain special category goods (harmonized code 99).

[6]The price determining characteristics of a good vary by industry and are determined by the BLS using industry knowledge and input from the reporting firm.

[7]This high frequency of contact reflects the BLS desire to obtain accurate transaction price information and does not necessarily reflect the actual contract length of prices.

[8]This is in line with the evidence reported in ECU (1995) that was presented in Obstfeld and Rogoff [2000].

[9]We thank Rozi Ulics for bringing this to our attention.

[10]The response rate varies between 70% and 85%.

[11]This is determined by keeping only those prices for which the flag 'price estimated' is set equal to 'N'.

[12]The BLS classifies good discontinuations into the following categories: "Out of business", "Out of scope (not replaced)", "Out of scope (replaced)", "Regular Phaseout", "Accelerated Phaseout", "Refusal", "To be resolved" and "Sample dropped". We use the "Out of scope (replaced)" category along with the item code for the replaced good to link goods.

[13]It was not possible to do this at a higher level of disaggregation given the shrinking sample size at higher levels of disaggregation. We also restricted that the life of the good should be at least 3 months given that there is left censoring in the data. Results are however insensitive to this choice.

[14]This procedure cannot be applied more generally to all goods because goods whose prices change very frequently can have their frequency estimates go above one, when the sector wide discontinuation rates are added to it. Ideally, discontinuations should be treated at the good level, but this cannot be done here because discontinuations can arise due to lack of reporting, which cannot be easily handled using the frequency approach. In Appendix A.2. we estimate duration through maximum likelihood estimation where at one extreme we assume that the last price is always a price change, regardless of the reason for discontinuation. This generates durations of 8.5 months for imports and 10

months for exports.

[15]The weights do not sum up to 1 because these are only a subset of categories.

[16]Rauch [1999] classified enough 5 digit SITCs to cover the majority of trade in each four digit SITC. He then categorized the goods at the 4 digit level according to which of the three categories accounted for the largest share. Each good in our database is mappped to a 10 digit harmonized code. We use the concordance between the 10 digit harmonized code and the SITC2 (Rev 2) codes to classify the goods into the three categories. Since the 10 digit classification is far more detailed than the 4 digit SITC level to which we map the goods, the classification is clearly an approximation.

[17]For an extensive analysis of comparisons between intra-firm and market transactions using the same data see Neiman [2007].

[18]We should note that since the matching was done using a brute-force method of comparing product descriptions the matching is far from perfect.

[19] We would like to thank Emi Nakamura and Jon Steinsson for providing us with their matching. See the on line appendix of Nakamura and Steinsson (2007) for detailed price durations by PPI category.

[20]Using Nakamura and Steinsson [2007] estimates for the CPI the average is 8 months.

[21]We have performed this exercise for alternative large magnitudes and the results are qualitatively the same.

[22]Brazil in our sample had very high and stable inflation of more than 15 percent a month. Therefore movements of nominal exchange rates of 15 percent were common. For Brazil, we computed the exchange rate adjusted by inflation, and concentrated on the periods in which the real exchange rate moved by 15 percent.

[23]That is, all goods that can be categorized as homogenous or differentiated.

[24]In this analysis we do not include price changes across product substitutions, since these substitutions can be associated with quality changes which is why the BLS excludes them from the construction of the price index.

[25]Since there are goods which have only a single price change during its life, we treat the first observed price as a new price. We have performed this analysis omitting such price changes and obtained similar results.

[26]We use data from the IMF's International Financial Statistics database for the nominal exchange rate and CPI. For the nominal exchange rate we use the end of the month nominal exchange rate, which we lag by one month before including it in the regression since prices refer to the beginning of the month. This is consistent with the BLS procedure of using a lagged exchange rate when converting prices reported in the foreign currency into dollar prices.

[27]This matching was obtained from Robert Feenstra's web site http://cid.econ.ucdavis.edu/

[28]Knetter [1989] had found using unit value indices for U.S. exports and German exports, that there was far more pricing to market for German exports than U.S. exports.

[29]Sometimes ranges are specified by using two numbers, but most of the time they are qualified in words. For instance, the firm indicates a quantity and uses words such as less than, under, fewer, up to, greater, over, more than,

at least, etc.

[30]Specifically, these include words like, bulk, airplane, railcar, trailer, tank, barge, case price, car load, carload, truck, drum, boat, ship, and container, all of them combined with load, with and without spaces, and allowing for different permutations.

[31]In this case we look for statements such as high volume, low volume, small volume, mid volume, big buy, lower tier, higher tier, mid tier, medium tier, maximum direct, wholesale, and retail.

[32]Non-differentiated goods in the "container" category include a large proportion of commodities, which explains the higher frequency in this bin.

Table I
Median Price Duration

			Median Frequency	Median Duration	No. of goods
Imports	I.	Non-Adjacent Prices including substitutions	0.07	13.8	28139
	II.	Aucremann and Dhyne	0.08	12.0	27183
	III.	Non-Pulled Prices	0.09	10.6	28139
	IV	Including Discontinuations	0.09	10.6	28139
Exports	I.	Non-Adjacent Prices including substitutions	0.06	15.6	29651
	II.	Aucremann and Dhyne	0.07	13.8	29651
	III.	Non-Pulled Prices	0.09	10.6	28685
	IV.	Including Discontinuations	0.07	12.8	29651

Notes: For each specification we report weighted medians of the frequency of price change and implied median duration for market transactions. Specifically, for specifications I and III, we calculate the average frequency of price change for each good and then calculate the un-weighted median within each 6 digit harmonized trade code. We then calculate the weighted median across these medians by using the trade weights for the 6 digit harmonized code. For specification II, we estimate the average frequency within each 6 digit harmonized code and report the trade weighted median across the 6 digit codes. Only market transactions are included.

Table II
Frequency of Price Adjustment for Imports by Sector

Primary Strata	Description	Frequency	Duration	Trade Weight
P2711	Natural and petrol gases	100.0	1.0	1.1
P7601	Unwrought aluminum	100.0	1.0	0.4
P7108	Un-worked gold	100.0	1.0	0.2
P2710	Processed petrol	100.0	1.0	1.8
P2709	Crude petrol	100.0	1.0	7.0
P7110	Un-worked platinum	99.6	1.0	0.2
P09	Coffee, tea, mates	88.2	1.1	0.2
P4407	Wood sawn or chipped lengthwise	87.7	1.1	0.6
P0306	Crustaceans	72.7	1.4	0.4
P07	Edible Vegetables	69.8	1.4	0.3
P47	Pulp of wood and other wood wastes	60.9	1.6	0.2
P8802	Other aircraft and spacecraft	50.0	2.0	1.0
P4801	Newsprint	41.7	2.4	0.3
P16	Prepared foodstuffs	40.5	2.5	0.2
P8471	Automatic data processing machines, computer hardware	30.4	3.3	4.4
P4802	Uncoated paper/paperboard	27.3	3.7	0.3
P20	Vegetable and fruit products	20.0	5.0	0.2
P8528	Reception apparatus for broadcast video media	15.7	6.4	0.9
P8523	Prepared unrecorded media for audiovisual machines	15.6	6.4	0.2
P49	Printed materials	15.0	6.7	0.3
P8473	Parts and accessories of typewriters and word processors etc.	13.1	7.6	2.1
P6204	Women's/Girls's suits, ensembles, pants dresses	13.0	7.7	0.9
P8407	Spark igniting combustion engines	12.4	8.1	0.7
P8521	Video recording equipment	11.3	8.9	0.4
P63	Other textile articles	11.1	9.0	0.5
P8413	Liquid pumps and their parts	11.1	9.0	0.2
P8542	Integrated circuits and micro-assemblies	10.8	9.3	2.0
P3923	Plastic packaging materials	10.0	10.0	0.2
P7113	Articles of jewelry containing precious metal	10.0	10.0	0.5
P8483	Shafts/gears/transmission systems	9.4	10.7	0.3
P8481	Taps, valves, cocks for pipes and tanks	9.3	10.7	0.5
P38	Miscellaneous chemical products	9.1	11.0	0.4
P37	Photographic and cinematographic goods	9.1	11.0	0.2

P8411	Turbojets, turboprops, and gas turbines	9.1	11.0	0.9
P69	Ceramics	9.1	11.0	0.3
P8414	Air pumps, compressors, ventilators, and parts	9.1	11.0	0.4
P8536	Switches, fuses, circuit breakers, voltage<1000V	9.1	11.0	0.4
P9401	Seats and parts	8.9	11.2	0.8
P8525	Transmission devices for playing audiovisual media	8.9	11.2	2.0
P8527	Reception apparatus for broadcast sound media	8.7	11.5	0.6
P3004	Uncombined medicaments	8.7	11.5	1.6
P6203	Men's/boys' suits, ensembles, pants	8.3	12.0	0.6
P8708	Parts and accessories for above vehicles	8.3	12.0	2.6
P33	Perfume, cosmetic, toilet oils	8.2	12.2	0.3
P8409	Parts of above engines	8.0	12.5	0.4
P32	Tanning and coloring materials	7.9	12.7	0.2
P8504	Transformers, converters and inductors, and parts	7.8	12.8	0.6
P9405	Lamps and light fixtures	7.8	12.8	0.4
P6110	Knit/crochet sweatshirts, pullovers, vests, sweaters	7.7	13.0	1.0
P91	Watches and clocks	7.6	13.2	0.3
P8431	Parts ground shaping machines for mining, snow plows etc	7.5	13.2	0.3
P8704	Motor vehicles for transport of goods	7.5	13.4	1.5
P4202	Leather cases, bags, luggage	7.4	13.4	0.4
P9032	Automatic regulating/control devices	7.4	13.5	0.3
P68	Articles of stone	7.4	13.6	0.3
P8479	Machines of industrial function not mentioned	7.3	13.7	0.3
P8544	Insulated wire	7.2	13.9	0.7
P8517	Electric phone equipment	7.1	14.0	1.0
P8501	Electric motors	7.1	14.0	0.4
P8516	Electric portable heaters, blow-dryers, house items	7.1	14.0	0.4
P83	Miscellaneous articles of base metals	7.1	14.0	0.4
P8703	Passenger vehicles, capacity<10	6.9	14.5	10.0
P30	Pharmaceuticals	6.7	15.0	1.9
P6109	Knit/crochet, tank tops and similar garments	6.6	15.1	0.3
P9506	Articles for physical exercise	6.6	15.1	0.3
P2208	Ethyl Alchohol, undenat, und 80% alc, spirit bev etc.	6.6	15.2	0.3
P8701	Tractors	6.4	15.7	0.3
P9403	Other furniture and parts	6.3	15.9	1.0

P4011	New pneumatic tires	6.3	16.0	0.4
P8534	Printed circuits	6.2	16.1	0.2
P8529	Parts used for reception of media	6.2	16.1	0.4
P9503	Other toys, puzzles, models	6.1	16.3	0.7
P82	Tools and implements of base metals	6.1	16.5	0.4
P6402	Partially waterproof footwear	5.9	16.8	0.3
P8518	Microphones	5.9	17.1	0.2
P6403	Footwear with composite material soles and uppers.	5.7	17.6	0.9
P9504	Articles for arcade, parlor and table games	5.6	18.0	0.5
P9021	Orthopedic devices (crutches, trusses)	5.6	18.0	0.2
P9018	Medical devices	5.3	18.8	0.7
P6205	Men's/boys' shirts	4.9	20.4	0.2
P8541	Semiconductors	4.8	21.0	0.3
P96	Miscellaneous manufactured articles	4.7	21.5	0.2
P3926	Other plastics	4.6	21.7	0.3
P70	Glass and glassware	4.4	22.5	0.4
P7102	Unset diamonds	3.6	27.8	1.1

Notes: The table reports the median frequency (in percentages), implied median duration and trade weight for import sectors for which the BLS allows public reporting. Only market transactions included.

Table III
Frequency of Price Adjustment for Exports by Sector

Primary Strata	Description	Frequency	Duration	Trade Weight
D1001	Wheat	100.0	1.0	0.5
D1201	Soybeans	100.0	1.0	0.9
D7108	Un-worked gold	100.0	1.0	0.4
D4703	Non dissolving grade chemical wood-pulp, soda/sulfate	58.3	1.7	0.3
D3901	Ethylene polymers	51.5	1.9	0.4
D31	Fertilizers	50.0	2.0	0.3
D4407	Wood sawn or chipped lengthwise	43.6	2.3	0.3
D23	Food residues, wastes	37.8	2.6	0.6
D54	Man made filaments	15.6	6.4	0.3
D3920	Other flat plastics, uncombined	14.3	7.0	0.4
D20	Vegetable and fruit products	12.5	8.0	0.3
D8532	Capacitors	12.5	8.0	0.3
D8471	Automatic data processing machines, computer hardware	11.3	8.9	3.3
D7102	Unset diamonds	10.8	9.2	0.7
D2710	Processed petrol	9.9	10.1	0.9
D8525	Transmission devices for playing audiovisual media	9.7	10.3	0.8
D8411	Turbojets, turboprops, and gas turbines	9.5	10.5	2.2
D83	Miscellaneous articles of base metals	9.1	11.0	0.5
D82	Tools and implements of base metals	9.0	11.1	0.4
D8704	Motor vehicles for transport of goods	9.0	11.1	0.9
D8540	Gaseous tubes, cathode ray tubes, television tubes	8.9	11.2	0.3
D8703	Passenger vehicles, capacity<10	8.8	11.3	3.1
D28	Inorganic chemicals	8.7	11.5	0.9
D8421	Centrifuges and purifiers of liquids/gases and parts	8.6	11.7	0.6
D3923	Plastic packaging materials	8.3	12.0	0.4
D1005	Corn	8.0	12.5	0.8
D8701	Tractors	7.8	12.8	0.3
D8414	Air pumps, compressors, ventilators, and parts	7.7	13.0	0.5
D8524	Recorded media	7.6	13.2	0.5
D3907	Polyacetate	7.5	13.2	0.4
D61	Knitted and crocheted apparel	7.4	13.5	0.5
D8409	Parts of above engines	7.4	13.5	0.7
D70	Glass and glassware	7.3	13.7	0.5

D2402	Cigars, cigarettes, cheroots, cigarillos	7.2	13.9	0.2
D8481	Taps, valves, cocks for pipes and tanks	7.2	14.0	0.5
D37	Photographic and Cinematographic goods	7.1	14.0	0.4
D38	Miscellaneous chemical products	7.1	14.0	1.6
D8536	Switches, fuses, circuit breakers, voltage<1000V	7.1	14.0	0.8
D8542	Integrated circuits and microassemblies	7.1	14.0	5.8
D8544	Insulated wire	7.1	14.0	0.7
D3822	Laboratory reagents	7.0	14.4	0.4
D8413	Liquid pumps and their parts	6.9	14.5	0.5
D8803	Parts of above craft	6.9	14.5	1.6
D9001	Fiber optic cable	6.8	14.8	0.3
D8415	Air conditioners and parts	6.7	15.0	0.3
D8479	Machines of industrial function not mentioned	6.6	15.1	1.0
D9027	Instruments for chemical analysis	6.5	15.4	0.5
D8418	Refrigerators, freezers and parts	6.4	15.5	0.3
D8408	Compression ignition combustion engines	6.4	15.6	0.4
D9401	Seats and parts	6.2	16.1	0.4
D7326	Other items of iron/steel	6.0	16.7	0.3
D8708	Parts and accessories for above vehicles	5.9	17.0	4.4
D9021	Orthopedic devices (crutches, trusses)	5.9	17.0	0.5
D8473	Parts and accessories of typewriters and word processors etc.	5.9	17.0	2.6
D33	Perfume, cosmetic, toilet oils	5.9	17.0	0.7
D8534	Printed circuits	5.6	17.8	0.3
D9032	Automatic regulating/control devices	5.5	18.2	0.4
D3004	Uncombined medicaments	5.3	19.0	1.3
D8431	Parts ground shaping machines for mining, snow plows etc	5.3	19.0	1.2
D9018	Medical devices	5.2	19.2	1.5
D8407	Spark igniting combustion engines	5.1	19.5	0.9
D8517	Electric phone equipment	5.1	19.8	1.3
D32	Tanning and coloring materials	5.0	20.0	0.6
D34	Soaps, washes, polishes, pastes, waxes	4.9	20.5	0.4
D9030	Optical testing instruments (spectrometer)	4.9	20.5	0.7
D8529	Parts used for reception of media	4.6	21.9	0.7
D8541	Semiconductors	4.5	22.0	0.6
D9031	Other measuring instruments	4.4	22.8	0.4

D3926	Other plastics	4.3	23.0	0.5
D21	Misc. Edible preparations	4.3	23.5	0.4
D3002	Blood and derivatives	4.2	24.0	0.4
D8504	Transformers, converters and inductors, and parts	4.1	24.3	0.4

Notes: The table reports the median frequency (in percentages), implied median duration and trade weight for export sectors for which the BLS allows public reporting. Only market transactions included.

Table IV
Frequency of Price Adjustment and Goods Characteristics

		Median	Mean	No. of goods
Imports	Organized	0.83	0.69	923
	Reference	0.30	0.39	3130
	Differentiated	0.07	0.15	15783
	Food, Feed, Beverage	0.40	0.44	2381
	Industrial Supplies	0.20	0.34	4064
	Capital Goods	0.07	0.13	3617
	Auto-vehicles	0.08	0.14	840
	Consumer Goods	0.07	0.14	8908
	Others	0.09	0.11	147
Exports	Organized	0.73	0.61	1204
	Reference	0.27	0.39	3967
	Differentiated	0.07	0.14	14801
	Food, Feed, Beverage	0.52	0.49	2016
	Industrial Supplies	0.17	0.33	5477
	Capital Goods	0.07	0.11	4638
	Auto-vehicles	0.08	0.13	2560
	Consumer Goods	0.07	0.12	4910
	Others	0.09	0.10	368

Notes: The organized, reference and differentiated categories refer to the Rauch (1999) conservative classification of goods. The next group of categories refers to the end-use 1 digit classification codes. Only market transactions are included.

Table V
Frequency of Price Change: Intra-Firm Transactions

		All		Cost based		Other Non-market	
		Freq.	Nobs.	Freq.	Nobs.	Freq	Nobs.
Imports	Food, Feed, Beverage	0.14	603	0.08	144	0.06	28
	Industrial Supplies	0.13	1958	0.09	305	0.06	40
	Capital Goods	0.08	4358	0.09	1085	0.08	85
	Autovehicles	0.09	1197	0.09	365	0.06	14
	Consumer Goods	0.08	2949	0.08	827	0.08	70
	Others	0.09	56	0.05	11	na.	na.
Exports	Food, Feed, Beverage	0.32	428	0.08	123	0	13
	Industrial Supplies	0.11	1447	0.07	392	0.15	30
	Capital Goods	0.07	1821	0.07	650	0.08	50
	Autovehicles	0.08	878	0.08	144	0.04	14
	Consumer Goods	0.07	1963	0.07	513	0.05	46
	Others	0.10	153	0.10	33	na.	na.

Notes: This table reports the median frequency of price change for intra-firm transactions. `All' refers to all intra-firm transactions. Columns labeled as 'Cost-based' and `Other Non-Market' refer to those intra-firm transactions that are reported as following "cost based pricing" and "other non-market based pricing" respectively.

Table VI
Comparing Price Durations in Import Prices, Consumer Prices and Producer Prices

PSL Code	Code Description	Import Prices	Producer Prices	Consumer Prices
P2711	Natural and petrol gases	1.0	1.0	4.7
P2710	Processed petrol	1.0	1.0	1.5
P07	Edible vegetables	1.4	1.1	1.4
P8471	Automatic data processing machines	3.3	6.7	2.0
P20	Vegetable and fruit products	5.0	1.1	5.5
P8528	Reception apparatus for broadcast video media	6.4	10.5	4.6
P8523	Prepared unrecorded media for audiovisual machines	6.4	11.8	13.4
P6204	Women's/Girls's suits, ensembles, pants dresses	7.7	19.6	5.4
P8521	Video recording equipment	8.9	15.4	5.2
P7113	Articles of jewelry containing precious metal	10.0	23.8	8.1
P9401	Seats and parts	11.2	14.5	7.6
P6203	Men's/boys' suits, ensembles, pants	12.0	19.6	10.0
P8708	Parts and accessories for vehicles	12.0	12.0	11.2
P9405	Lamps and light fixtures	12.8	18.9	9.9
P6110	Knit/crochet sweatshirts, pullovers, vests, sweaters	13.0	19.6	8.6
P4202	Leather cases, bags, luggage	13.4	14.5	9.0
P8516	Electric portable heaters, blowdryers, house items	14.0	13.9	10.3
P8703	Passenger vehicles, capacity<10	14.5	3.4	1.3
P2208	Undenatured ethyl alcohol w/ <80 percent concentration	15.2	11.9	7.8
P6402	Partially waterproof footwear	16.8	16.7	9.9
P6403	Footwear with composite material soles and uppers.	17.6	16.7	9.9
P6205	Men's/boys' shirts	20.4	19.6	12.2

Notes: The table reports median durations within each product category. The estimates for producer prices are from Nakamura and Steinsson (2007). The estimates for sales adjusted consumer pries are from Klenow and Kryvstov (2005). For import prices we use only market transactions.

Table VII
Size of Price Changes and Fraction Price Increases

		Size of Price Change	Absolute Size of Price Change	Fraction Price Increases
Imports	Median	-0.001	0.078	0.558
	Mean	-0.006	0.082	0.516
	Std. Dev.	0.029	0.022	0.135
Exports	Median	-0.007	0.078	0.535
	Mean	-0.008	0.079	0.547
	Std. Dev.	0.023	0.021	0.089

Notes: The numbers reported are conditional on price adjustment for market transactions. The mean price change, conditional on adjusting prices, was calculated for each 6 digit harmonized code by year and month. The average size of price change for each date was calculated as a weighted average using 6 digit harmonized code weights. The median and mean of this distribution across dates is reported in the table. A similar procedure was followed for the 'Absolute Size of Price Change' and the 'Fraction of Price Increases'.

Table VIII
Pass-through of Exchange Rates into Import Prices: Market Transactions

Category Name	Harmonized codes	Trade Weight	β_{ER}	σ_{ER}	N	R^2
Live Animals; Animal Products	01-05	0.01	-0.11**	0.05	6078	0.08
Vegetable Products	06-14	0.01	0.12***	0.03	8068	0.02
Animal or Vegetable Fats and Oils	15	0.00	0.86***	0.27	449	0.13
Prepared Foodstuffs	16-24	0.02	0.08***	0.02	5767	0.09
Mineral Products	25-27	0.11	0.32***	0.07	4127	0.03
Products of the Chemical/allied industries	28-38	0.07	0.12**	0.05	3196	0.24
Plastics and Rubber Articles	39-40	0.03	0.08***	0.03	2733	0.15
Raw Hides and Skins, Leather etc.	41-43	0.01	0.16***	0.05	670	0.22
Wood and Articles of Wood	44-46	0.01	0.03	0.03	5331	0.03
Pulp of Wood/other fibrous cellulosic material	47-49	0.02	0.12	0.07	2081	0.13
Textile and Textile Articles	50-63	0.07	0.18***	0.03	2833	0.41
Footwear, Headgear etc.	64-67	0.02	0.11***	0.04	711	0.20
Miscellaneous manufactured articles	68-70	0.05	0.11*	0.06	1227	0.30
Precious or Semi Precious Stones etc.	71	0.02	-0.01	0.06	2995	0.13
Base Metals and articles of base metals	72-83	0.05	0.19***	0.02	6354	0.21
Machinery and Mechanical Appliances etc.	84-85	0.28	0.26***	0.02	9570	0.18
Vehicles, aircraft etc.	86-89	0.17	0.26***	0.04	3121	0.13
Optical, Photographic etc.	90-92	0.04	0.24***	0.05	1469	0.33
Arms and Ammunition	93	0.00	0.03	0.04	149	0.29
Articles of Stone, Plaster etc.	94-96	0.01	0.32***	0.09	535	0.36

Notes: β_{ER} is the coefficient on the log change in the exchange rate and σ_{ER} is the robust standard error of the coefficient. All regressions include fixed effects for every harmonized 6 digit code and country pair. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

Table IX
Pass-through of Exchange Rates into Import Prices: Market Transactions
Alternate Specification

Category Name	β_{ER}^{I}	β_{ER}^{II}
Live Animals; Animal Products	-0.11**	0.45
Vegetable Products	0.13***	0.03
Animal or Vegetable Fats and Oils	0.85***	0.87***
Prepared Foodstuffs	0.08***	0.08***
Mineral Products	0.20***	0.02
Products of the Chemical/allied industries	0.12**	0.10
Plastics and Rubber Articles	0.08***	0.04
Raw Hides and Skins, Leather etc.	0.16***	0.20***
Wood and Articles of Wood	0.05*	0.03
Pulp of Wood/other fibrous cellulosic material	0.11	0.02
Textile and Textile Articles	0.17***	0.07***
Footwear, Headgear etc.	0.10***	0.09**
Miscellaneous manufactured articles	0.11*	0.08
Precious or Semi Precious Stones etc.	-0.01	-0.00
Base Metals and articles of base metals	0.19***	0.09***
Machinery and Mechanical Appliances etc.	0.16***	0.23***
Vehicles, aircraft etc.	0.16***	0.28***
Optical, Photographic etc.	0.14***	0.23***
Arms and Ammunition	0.03	0.07
Articles of Stone, Plaster etc.	0.33***	0.24

Notes: β_{ER}^{I} is the coefficient on the change in the log of the exchange rate in a specification which includes controls for the dollar price change of other firms in the same 2 digit harmonized code. β_{ER}^{II} includes, in addition, the change in the U.S. producer price index at the 2 digit SIC 87 code level. All regressions include fixed effects for every harmonized 6 digit code and country pair. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively. Only market transactions are included.

Table X
Pass-through of Exchange Rates into Import Prices: Intra-Firm Transactions

Category Name	Harmonized codes	Trade Weight	β_{ER}	σ_{ER}	N	R^2
Live Animals; Animal Products	01-05	0.01	0.07	0.06	1039	0.05
Vegetable Products	06-14	0.01	0.01	0.18	1210	0.02
Animal or Vegetable Fats and Oils	15	0.00	0.70***	0.10	504	0.30
Prepared Foodstuffs	16-24	0.02	0.20**	0.09	1304	0.18
Mineral Products	25-27	0.11	0.44***	0.13	411	0.07
Products of the Chemical/allied industries	28-38	0.07	0.21***	0.05	3019	0.27
Plastics and Rubber Articles	39-40	0.03	0.25***	0.03	2120	0.23
Raw Hides and Skins, Leather etc.	41-43	0.01	0.29***	0.08	313	0.25
Wood and Articles of Wood	44-46	0.01	0.09	0.16	1117	0.02
Pulp of Wood/other fibrous cellulosic material	47-49	0.02	0.21***	0.06	1565	0.09
Textile and Textile Articles	50-63	0.07	0.09	0.08	744	0.32
Footwear, Headgear etc.	64-67	0.02	0.33*	0.18	218	0.10
Miscellaneous manufactured articles	68-70	0.05	-0.07	0.10	864	0.17
Precious or Semi Precious Stones etc.	71	0.02	-0.01	0.13	911	0.34
Base Metals and articles of base metals	72-83	0.05	0.28***	0.03	4001	0.20
Machinery and Mechanical Appliances etc.	84-85	0.28	0.25***	0.02	16196	0.16
Vehicles, aircraft etc.	86-89	0.17	0.13***	0.03	4212	0.08
Optical, Photographic etc.	90-92	0.04	0.26***	0.03	3016	0.24
Arms and Ammunition	93	0.00	0.15	0.09	122	0.27
Articles of Stone, Plaster etc.	94-96	0.01	0.27***	0.08	501	0.24

Notes: β_{ER} is the coefficient on the log change in the exchange rate and σ_{ER} is the robust standard error of the coefficient. All regressions include fixed effects for every harmonized 6 digit code and country pair. ***, ** and * refer to significance at the 1%, 5% and 10% levels respectively.

Table XI
Relation between Price Stickiness and Pass-through Conditional on Price Adjustment

Decile	Median Frequency	β_{ER}	σ_{ER}
1	0.03	0.32	0.07
2	0.05	0.17	0.04
3	0.08	0.25	0.04
4	0.11	0.17	0.03
5	0.15	0.23	0.03
6	0.22	0.17	0.03
7	0.33	0.16	0.03
8	0.50	0.09	0.02
9	0.78	0.04	0.02
10	1.00	0.11	0.04

Notes: We divide goods (market transactions only) into 10 bins based on their measure of price stickiness. The median frequency within each bin is reported in column 2. Column 3 reports the exchange rate pass-through coefficient calculated within each bin and Column 4 reports the robust standard error.

Table XII
Some Evidence on the Type of Quantity Contract

Imports	All		Differentiated	
	No. of Goods	Freq.	No. of Goods	Freq.
Fixed Quantity	1261	8.5	657	7.1
Quantity Range	728	9.1	396	7.4
Container	536	20.0	248	9.6
Buyer\Seller Class	68	9.0	29	5.4

Exports	All		Differentiated	
	No. of Goods	Freq	No. of Goods	Freq.
Fixed Quantity	1818	7.9	805	6.7
Quantity Range	1807	7.7	796	6.7
Container	816	11.6	284	9.8
Buyer\Seller Class	139	8.5	73	7.6

Notes: `Fixed Quantity' refers to a fixed number such as ``100000 units". 'Quantity Range' refers to a range such as "1000-5000 units", ``10000 or less" etc. 'Container' refers to bulk shipments such as "container load", "tank load" etc. The last category 'Buyer\Seller Class' refers to "Tier 1 Buyer", "Bulk Purchaser" etc. Frequencies are reported in percentages. "Differentiated" refers to the Rauch classification. Only market transactions included.

Table XII:
Anthrax Experiment

	Month	Response Rate	Fraction price change	
			All Prices	Contacted Prices
Imports	August	83	0.14	0.21
	September	79	0.15	0.22
	October	74	0.15	0.22
	November	81	0.15	0.22
	December	76	0.14	0.22
Exports	August	84	0.14	0.21
	September	83	0.14	0.20
	October	76	0.14	0.22
	November	85	0.15	0.22
	December	81	0.15	0.22

Notes: This table reports reporting firm response rates, the average fraction of price changes (all prices and only those prices that were obtained by contacting the firm) around the months of the Anthrax attack in October 2001.

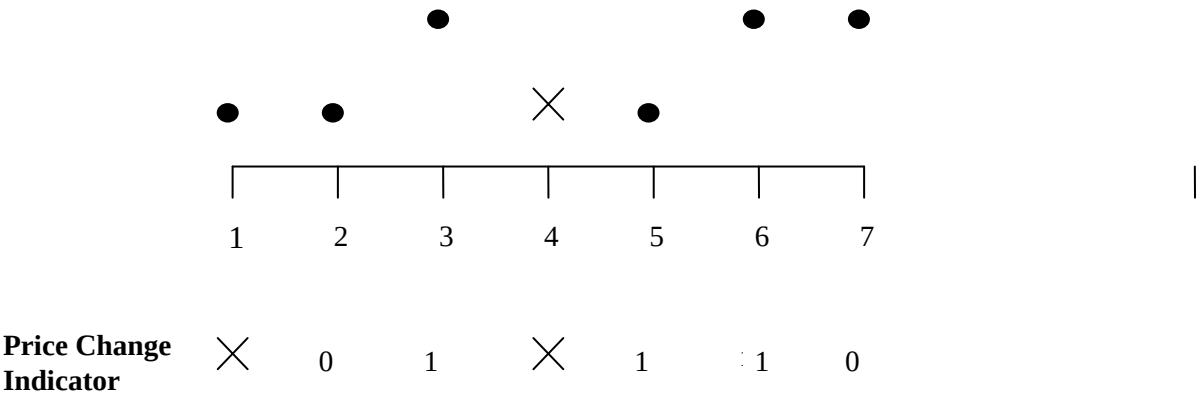


Figure I
A Hypothetical Price Series for a good

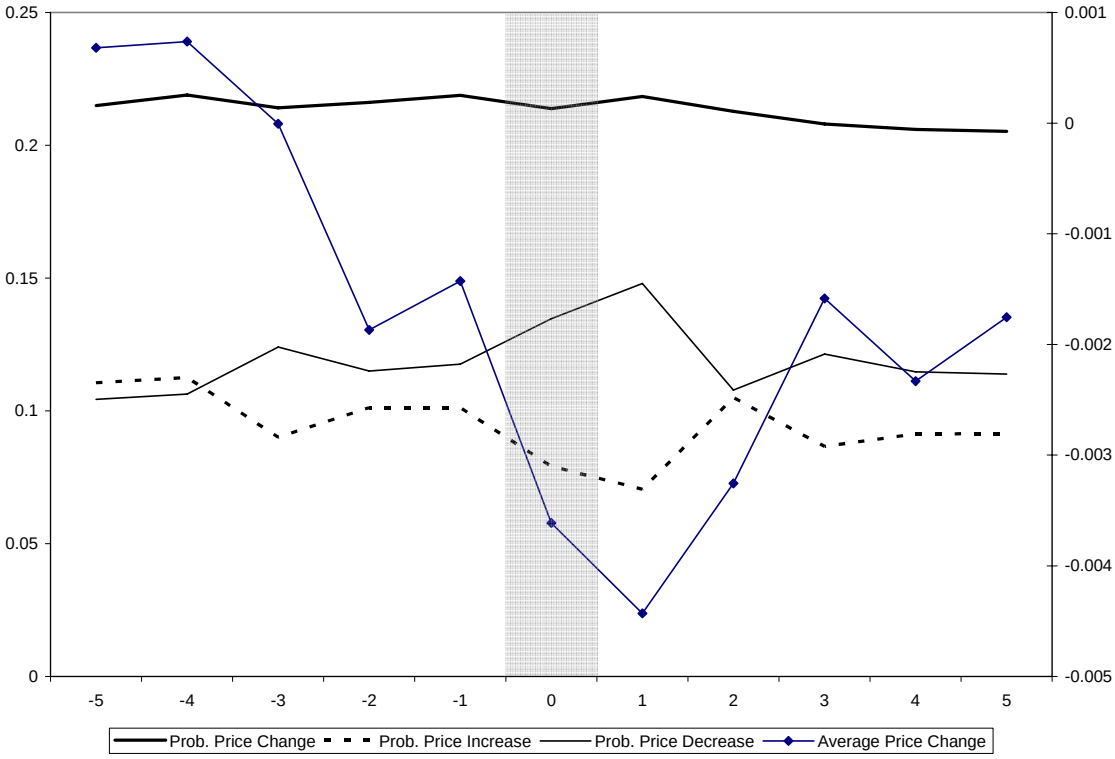
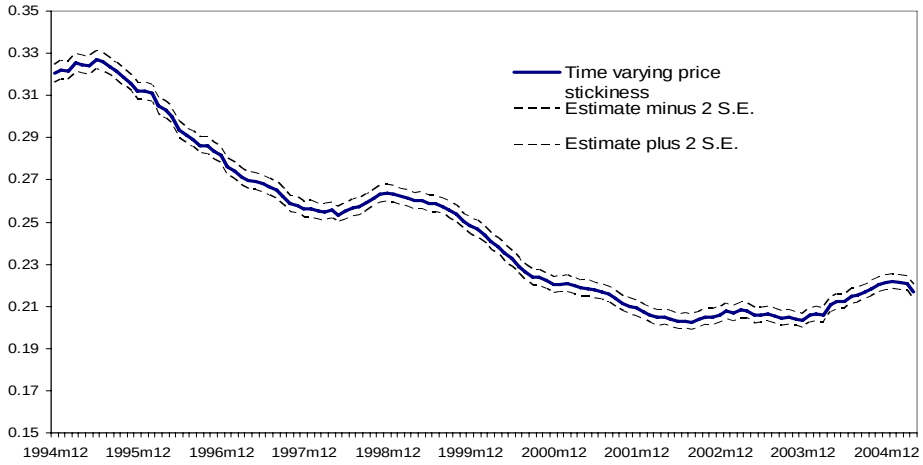


Figure II: Price adjustments around large devaluations

Time Trend in Frequency of Price Adjustment



Time Trend in Frequency of Price Adjustment in Differentiated, Reference and Organized Sectors

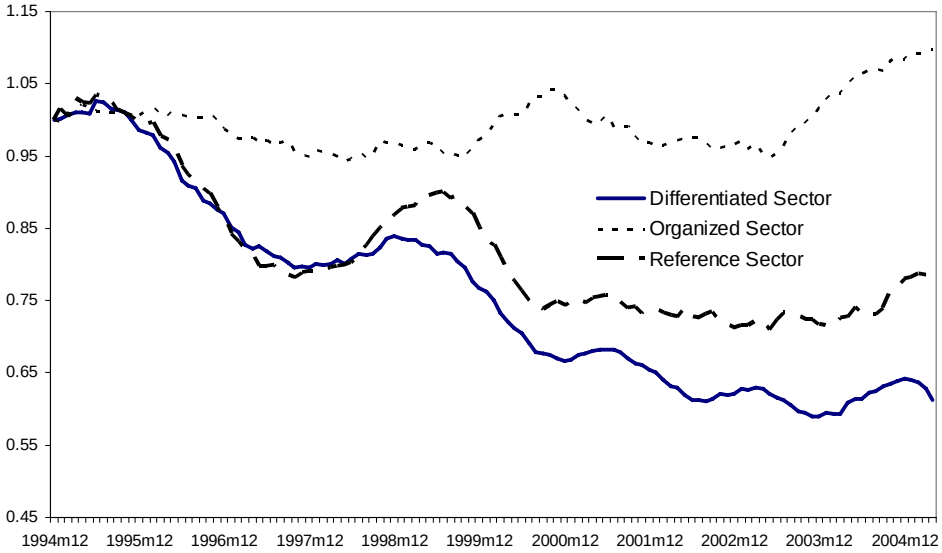
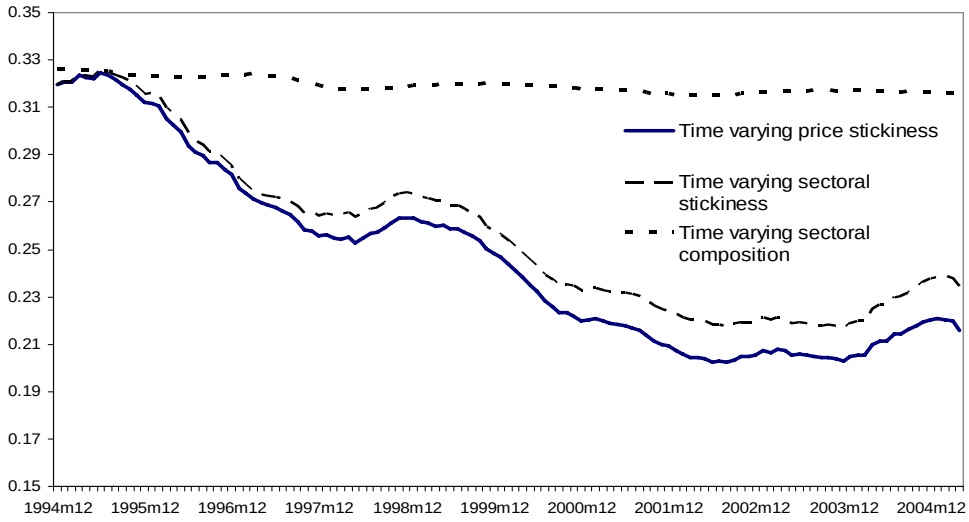


Figure III

Decomposition of trend decline using Rauch classification



Decomposition of trend decline using country composition

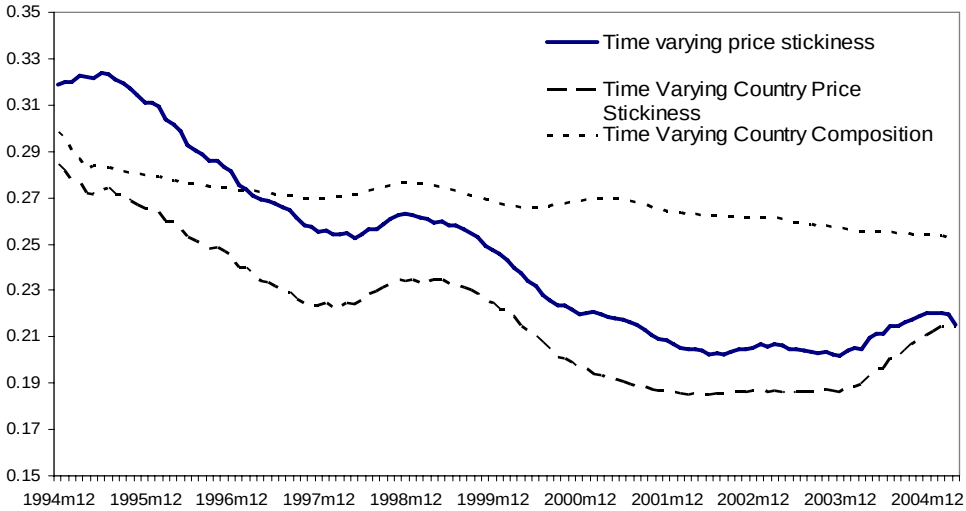


Figure IV