Sticky Borders[1]

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Abstract

The stickiness of traded goods prices and the currency in which prices are sticky play a central role in international macroeconomics. Despite the existence of a rich theoretical literature, there is very little empirical evidence that directly measures the extent of price stickiness in traded goods prices. To address these questions, we use unpublished micro data on import and export prices at-the-dock for the United States for the period 1994-2005. We present three main results: First, the trade weighted average price duration in dollars is 12.26 months for imports and 13.77 months for exports. This level of stickiness is similar to earlier evidence on whole-sale prices and about twice as high as recent evidence on retail goods prices for the U.S. The fact that both imports and exports are sticky in dollars suggests that contrary to standard modeling assumptions there is producer currency pricing in U.S. exports and local currency pricing in U.S. imports. Second, there is tremendous heterogeneity in price duration across goods, with differentiated goods adjusting prices far less frequently than homogenous goods. Further, the degree of stickiness does not change significantly around large devaluations. Third, we document that the degree of stickiness in import prices has been increasing throughout the last 10 years, with very little of this increase explained by a compositional shift from homogenous to differentiated goods.

1 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 assign a central role to nominal rigidities. 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 very little 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 We use unpublished micro data on import and export transaction prices collected by the Bureau of Labor Statistics for the United States for the period 1994-2005. We present three main results: First, prices are sticky in US dollars for more than a year, both for imports and exports. Second, there is tremendous heterogeneity across goods. Goods that are more homogeneous adjust prices almost every month, while differentiated goods are sticky for over a year. Third, the degree of stickiness in import prices has been increasing throughout the last 10 years.

More specifically, we estimate the trade weighted average price duration in dollars to be 12.26 months for imports and 13.77 months for exports. Since transactions at the dock reflect business-to-business transactions, our study is most comparable to Carlton (1986) who estimated price durations to be over a year for domestic purchases by large U.S. companies. The stickiness at the dock is much larger than the stickiness at the retail level estimated by Bils and Klenow (2004) for the U.S. who find that the median duration is 4.3 months.[1] When we match the Bils and Klenow (2004) classification of goods with the mostly 4 digit harmonized code classification in our database for imports, we estimate a mean duration of 11.68 months for prices at the dock, while they estimate a mean duration of 3.93 months for retail prices. The significant difference in the stickiness between at the dock and retail prices suggests caution in inferring the behavior of price stickiness of actual traded goods from the behavior of so called 'tradable goods' in the CPI.

[1] Alvarez et. al. (2005) find that in the Euro Area retail price durations are closer to a year.

A related finding is with regard to the currency in which prices are sticky. While it is well known that most U.S. imports and exports are invoiced in dollars[2], we provide evidence of stickiness in these dollar invoiced prices for both exports and imports. This has important implications for theoretical models. It is typically assumed that prices are sticky either in the local currency (Devereux and Engel (2003)) or in the producers currency (Obstfeld and Rogoff (1996)) 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 are about as sticky in foreign currency terms as dollar invoiced prices. In a reduced form sense, this is similar to the assumptions we make in our models, where a firm picks a currency to price in and keeps prices stable in that currency. What is different though, is that for the case of the U.S., both imports and exports are priced in and sticky in dollars. This asymmetry is explored in recent theoretical work by Corsetti and Pesenti (2005).

Our second finding is that there is a large amount of heterogeneity in price stickiness across highly disaggregated goods. The mean duration of prices for imports is 12.48 months and the standard deviation is 14.86 months. Similarly, in the case of exports, the mean duration is 13.62 months with a standard deviation of 14.79 months. This dispersion is partly explained by the mix of homogenous and differentiated goods in trade. Using Rauch's (1999) classification, we find that the mean duration of prices is 4.18 months for the organized exchange category, while it is 9.43 months for the reference good category and 13.57 months for the differentiated goods category. The currency in which the price is set also plays an important role, given the stickiness in the currency. The dollar prices of goods priced in a non-dollar currency change almost every other month. Consequently, even within the pool of differentiated goods, there are goods whose dollar prices change very frequently.

One variable that explains very little of this dispersion is the volatility of the exchange rate during the life of the good. Exchange rate volatility weakly affects the duration only at extreme levels of exchange rate movements. This finding is confirmed when we compare the pre and post average probability of price change during foreign country devaluation episodes and find little

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

difference. A valuable feature of the data is that it includes information on whether a good is traded intra-firm, that is between a parent and an affiliate, or between unrelated firms. At the aggregate level, we find that the difference in duration across these categories is small, with prices for intra-firm transactions stickier by around a month.

Lastly, we document that the degree of stickiness has been changing over time in U.S. imports. In particular, the average probability of price change has declined by 10 percentage points from 1994 to 2004. This has implications for the measurement of pass through at the aggregate level: if stickiness is increasing, then the average pass-through of the exchange rate into U.S. import prices should be declining, all else equal. Indeed, 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. Frankel, Parsley and Wei (2005) also document evidence of declining pass-through using 8 narrowly defined brand commodities. 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, homogenous and differentiated) and within country time trends and very little by a composition story. The sharpest increase in price stickiness is documented in the differentiated goods sector and within this a decline is observable in both consumer goods and capital goods. There is no similar evidence of a substantial trend increase in price stickiness in U.S. exports during this period.

There exists a large literature on exchange rate pass-through into prices of traded goods. See Goldberg and Knetter (1997) for a comprehensive survey. Estimates of pass-through capture the effect of a combination of variables including nominal price rigidities, pricing to market and variable mark-ups. The literature on at-the-dock prices has used mainly aggregate price measures as in Knetter (1989 and 1993) and Campa and Goldberg (2005). To infer the extent of nominal rigidity or the currency in which prices are rigid from only pass-through estimates is difficult in the presence of even a small amount of aggregation in the data. In this regard, our study is unique since it presents the first set of direct evidence on nominal rigidity in international traded goods prices. Since we use the data that underlies the aggregate indices used in numerous papers on passthrough, the evidence we present has direct implications for this literature. Secondly, most studies on pass-through focus on retail prices[3]. Since retail prices include local distribution costs, they include a large non-traded price component. To focus on the trade component we analyze at-the-dock prices.

Our finding that international prices display nominal rigidity suggests the need for more theoretical and empirical work on the microfoundations of price contracting in international transactions. It also suggests the need to understand other aspects of the contract including whether quantities are contracted on. In a question on the survey, which might shed some light on this issue, the BLS questions reporting firms on whether the price quoted is related to the size of the order. In less than 10% of the transactions the response specifies that it is.

The paper is organized as follows: Section 2 describes the data we use. Section 3 documents the degree of price stickiness. Section 4 studies how the degree of stickiness is related to good and transaction characteristics. Section 5 analyses the time trend in price stickiness. Section 6 presents conclusions and directions for future research.

2 Data Description

In this section we describe the price data employed in this study. The prices reflect a transaction price associated with an actual trade. Accordingly, there will be months when there is no price information. We discuss estimation issues in the presence of such gaps in the price series in Section 2.1.

The data is unpublished data collected by the Bureau of Labor Statistics (BLS) in the International Price Program (IPP) and is the data underlying 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 is monthly data that covers the period September 1993 to April 2005. Chapter 15 of the BLS Handbook of Methods (1997) provides a description of the objective, scope and sampling methodology of the IPP. The target universe of the import and export price indices consist of all goods and services sold by US residents to foreign buyers (exports) and purchased from abroad by US residents (imports)[4].

[3] For important recent work see Frankel, Parsley and Wei (2005) and Crucini, Telmer and Zachariadis (2005).

[4] Starting in 1989, IPP divided the import and export merchandise into halves. Samples for one import half and one export half are fielded each year, so both universes are fully re-sampled every 2 years. The sampled products are

Price data are collected every month for approximately 20,000 items (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 specifiying the months in which actual trade takes place. For these periods the BLS will use the contracted price without contacting the firm directly. 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[5]. The price information provided by the company is voluntary and confidential.

The reported price by the company can be quoted in many different price bases. 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 item at the US port of embarkation. The price table in the database provides information on the reported price basis (f.o.b., f.a.s, etc.), the currency in which the price is reported, the unit of sale (one, dozen etc.) and the country of imports/export. The country information is more detailed for the case of imports and less so for exports. There is also information on whether the price is 'linked'. A link is used to correct for changes in trade factors such as when there are changes in the discount size/class, the unit of sale, quality etc.

The price program tracks the price of a consistent extremely detailed item over time. An example of an item 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 item description 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. The table that describes the item includes information on the date on which the item was first sampled and in the event the item was discontinued, the month and year in which it was discontinued. We will

priced for approximately 5 years until they are replaced by a new sample of the same half-universe.

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).

[5] 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.

define a good as a unique combination of item code, unit of sale and country code. The reason we distinguish by country of origin/destination is so as to relate the behavior of prices to exchange rate movements. In the case of imports there are 57494 item codes and 62044 goods. In the case of exports there are 46521 item codes and 49095 goods[6].

The 'net price' that the BLS uses in its price index is the reported price adjusted to reflect any changes in item description and trade factors such as foreign currency, discounts etc. The prices collected are net (exclusive) of duties. The net price is always a dollar price. That is, if the reported price is in a foreign currency the relevant exchange rate is used to convert the price into dollars. It is this net price that we use for our analysis. 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[7]. The fraction of imports reported in dollars has increased from 87.9% in 1994 to 93.4% in 2004.

2.1 Estimation Issues

The price data is monthly. However there are several months when the item is not traded or in some circumstances there is a lack of response from the reporting firm. 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 in the import and export database. Since these un-usable prices do not reflect a true transaction price for an item, in our empirical work we will only use prices that the BLS considers 'usable' for constructing the price index in any given month[8]. We also exclude price observations if the size of the (monthly) price change exceeds 100%. There are however very few such observations in the data.

Since we restrict attention to only usable prices, we have several goods that have only a few

[6] Starting June 2002 the BLS instituted a new practice of assigning a new item code to the exact same good if it was selected again in the sample rotation (which takes place every 2 years). Unfortunately, there is no easy way to link the two item codes. The BLS assigned a discontinuation code of 7 to such cases. If we count the number of goods with a discontinuation code of 7 past June 2002, this accounts for only 3.6% of all goods and is therefore a minor fraction of our sample. Moreover, given that goods discontinued for other reasons also received a discontinuation code of 7, this 3.6% is an overestimate of the true number of such incidences.

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

[8] In the sample of 'usable' prices, 6% of the prices are flagged as 'estimated'. We have performed our analysis excluding these prices and obtained very similar results.

observations. In the case of imports, the mean (median) number of observations per good is 18.46 (12). 25% of the good have 4 or less observations. Similarly, in the case of exports, the mean (median) number of observations is 21.56 (15) per item. 25% of the items have 5 or less observations. Secondly, these observations need not be consecutive, because there can be gaps in months when the good is not traded or the reporting company is non-responsive. For instance, if we calculate the usable life of the good as the difference between the last date of a usable price and the first date of a usable price for every good, the mean (median) usable life of the good is 25.05 (20) months for imports. In the case of exports the mean (median) usable life of the good is 28.73 (25) months. Lastly, the goods usable life is shorter than the good's life in the index, calculated as the difference between the date the good was discontinued from the index and the date it was initiated. In the case of imports the mean (median) life of the good is 37.51 (35) months. In the case of exports the mean (median) life of the good is 39.62 (39) months.

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. In the BLS sample, around 30% of goods have their price constant over their entire life, both in the case of imports and exports. A second characteristic of the data is that there is a large amount of heterogeneity across the goods in the behavior of prices. Accordingly, we estimate our price stickiness measure at the good level and then present statistics of the distribution of price stickiness across goods.

Given that several goods have few usable observations, we adopted two approaches in presenting our results. First, we include only those goods that have several consecutive observations. Specifically, we require that there be at least one spell of 12 monthly consecutive usable prices for a good. We then keep all further 12 month usable price spells for the good. The plus to this approach is that we can present simple non-parametric estimates of price stickiness that ignore the issues of censoring and concentrate on the goods heterogeneity aspect of the data alone. A concern with this approach can be that we are excluding goods that get replaced or discontinued more frequently. It may be the case that these goods either have their prices changing very frequently, or have prices that are unchanged for a short duration after which the good is replaced and we might want to treat the replacement of the good as a price change. That is, frequent replacement might be a substitute for price change. Therefore, to capture a larger set of goods, we adopt a second approach where we estimate a constant hazard model and correct for censoring at the good level.

For this, we include all goods that have any 6 or more observations (that is, these observations need not be consecutive).[9] If we exclude goods for which there are only 1 or 2 observations, the first approach accounts for 45% and the second approach for 85% of all goods. In the next sections, we will present details about the two approaches.

2.2 Reporting by firms

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

Another interesting piece of evidence relates to the behavior of prices around the period of the terror strikes in 2001.[10] Following the anthrax attacks and disruption of mail to all governmental offices, the BLS could not receive mail in October 2001. Consequently, for this month, 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 this month firms were more responsive and 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. We accordingly examine if the responses on price change were significantly different for this month. When we calculate the probability of an item having recorded a changed price for this particular month relative to other months in the year, we find no statistical differences.

[9] In this procedure we are excluding mostly goods that have only 1 or 2 observations. It would be safe to assume that the price series for these goods are not very useful.

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

3 Price Stickiness

In this section we report statistics on the duration for which prices are fixed in dollars for imports and exports, which we estimate at the level of the good. We first discuss the case of goods that have at least one spell of 12 consecutive observations, and next, the larger BLS sample. Given that the price series for each good has gaps in the middle and left and right censoring, we present several alternative measures of stickiness. In all our measures we adopt a conservative approach that moves us in the direction of finding shorter durations. The message on price stickiness that we derive is consistent across all these estimates. We find that the trade weighted average price duration (using 2004 weights) in dollars is 12.26 months for imports and 13.77 months for exports.

3.1 Sticky prices: Measures un-corrected for censoring

We first present statistics that are un-corrected for censoring. Given the large amount of heterogeneity in the data, we estimate these statistics at the good level. For this to be a meaningful exercise we need to have a large enough price series for each good. Accordingly, we consider goods that have at least one spell of 12 or more consecutive observations and keep all further 12 months spells. There are 24007 import goods and 18868 export goods that satisfy this criterion.

The measures, or summary statistics, of price stickiness used in the literature are: the probability of change, the inverse of which is the simple average time between changes, and the spell weighted average between changes. Each of these measures is estimated at the good level, i.

Definition 1 *Average probability of price change for good i*

$$\tilde{p}_i = \frac{\sum [\textit{number of price changes for good}_i]}{\textit{total observations of good}_i}$$

Definition 2 *Average time between changes for good i: Each observation is a spell in which prices are fixed*

$$\tilde{t}_i = \frac{\sum [\textit{time between price changes for good}_i]}{\textit{total number of spells for good}_i}$$

This is simply the inverse of the probability of change.

Definition 3 *Spell Weighted average time between changes for good i: Compute the average time between price changes where the observations are weighted by the length of the spell. As before, each observation is a spell in which prices are fixed*

$$\hat{t}_i = \frac{\sum [time\ between\ price\ changes\ for\ good_i]^2}{total\ number\ of\ observations_i}$$

Let us study how these measures perform in an example.

Example 4 *Assume that a good A has prices for $2T$ periods. Suppose that in the first T periods the price changes every month and in the second T periods it changes every 3 months. Further assume that the price series is not censored.*

By construction, good A adjusts prices on average every two months. Assume we compute the probability that prices change next month (Definition 1). If T is big enough, we observe that in T periods there are $T + T/3$ price changes of a total $2T$ observations. In other words, the average probability that a change takes place is 2/3. This statistic implies that on average we observe price changes every month and a half. This measure of duration is biased downwards and accordingly its inverse, the simple average is also biased downwards.

Measure 3 − the spell weighted average of the time between changes[11] − corrects for this problem. In this example, the observations that have one month are weighted by one, and the observations of three months are weighted by 3:

$$\hat{t} = \frac{1 * T * 1 + 3 * T/3 * 3}{T + T/3 * 3} = 2$$

This discussion points to clear advantages of the spell weighted average of the time between changes. Nevertheless, we present results for the probability of change as well.

Probability of Change: We first calculate the average monthly probability of price change at the good level. That is, we calculate the statistic in Definition 1. As mentioned earlier, 30% of

[11] See Bahard and Eden (2003)

items have a price that is unchanging during their life in the sample. For the median item, the probability of price change, λ, is 0.0682 for imports and 0.0556 for exports. The median expected time to price change[12] is then $1/\lambda$, which is 14.66 months for imports and 18 months for exports. There is tremendous amount of dispersion in λ. The mean $\lambda's$ are very different from the median. The mean for imports is 0.21 for imports. There are however only 25% of the items that have a λ that is greater than or equal to 0.21 for imports. Similarly, in the case of exports, the mean is 0.15 and only 23% of exports have a λ that is greater than or equal to the mean.

We also calculate the probability by assuming that the last price is a price change. That is, if a good is observed for 12 months and its price never changes, its probability is estimated to be $\frac{1}{12}$. The simple average of time between changes is 12 months. This clearly is a lower bound on the average price duration. When we make this assumption, the median for imports is 0.11 and the median for exports is 0.095. The median expected time to price change is 9 and 10 months respectively.

Spell Weighted Time Between Price Changes: The next statistic we calculate is Definition 3. We will assume that, for each good, the first price and the last price represents a price change[13]. If there are gaps in the price series, then we assume that the last price before the gap and the first price after the gap represents a new price. By treating the price series as if they are uncensored, if the prices are truly sticky, we are again biasing ourselves downwards in our estimates of the duration for which prices stay unchanged. Despite this, we find that prices stay unchanged for a long time. In the case of imports the mean (median) duration is 13.29 (11) months and in the case of exports the mean (median) duration is 14.78 (12.16) months. The standard deviation is 10.88 months for imports and 11.07 months for exports. Note that this standard deviation is not the precision of the estimates, but a measure of the individual dispersion. Figure 1 presents the cummulative distribution of durations in our sample; these are the two schedules identified as the Duration Imports (12 consecutive) and Duration Exports (12 consecutive).

[Figure 1 here]

[12] This is assuming you can change prices only once a month.

[13] In Section 5 we discuss the evidence on the time variation of probability in the data.

3.2 Estimation of the Duration for the larger BLS sample

In this section, we consider the larger BLS sample of goods with any 6 observations, even if these observations are not consecutive. Given the nature of the price data in this larger sample, we will present estimates from different treatments of the data and show that the average durations are similar across the different measures.

The simple probability of price change for the median item in this sample is 0.06 and the mean is 0.20 for imports. This is very similar to the numbers we obtained for the smaller sample.

In Figure 2 we depict what a typical price series for a good looks like. There are missing observations, several of the spells are censored, and prices are sticky. This good is in the data for 19 months. The dots represent valid prices, the X's represent missing prices or observations, the empty circle indicates the date on which the item is discontinued. The first spell has three months and it is censored. The next spell is a complete spell of three, followed by another complete spell of two and a censored one of two. The last spell is censored and lasts three months, and we know the item is discontinued three months after that.

[Figure 2 here]

Estimating a hazard model in this data requires several changes to the standard procedure that deals with censoring. First, we will assume that every price initiation is a price change, and that every discontinuation is a price change. This implies that we do not allow censoring before the item is included, nor after the item is discontinued, regardless of the reason for discontinuation. We treat all discontinuations as if the good was retired or replaced after this date. This is not always the case. Around 15% of the goods are discontinued because of failure to report by the firm. Another 25% of the goods are phased out by sample design. Hence, we are overstating price changes.

Second, every price after a censored spell will be considered a price change. For example, in Figure 2, we assume that $p(6)$ and $p(14)$ are price changes, even though $p(6)$ is identical to $p(3)$. 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. For example, the first spell has a constant price for three months, and it is censored. However, we know that the spell cannot be censored by more than two months, because observations are re-initiated after that. The usual procedure assumes the censoring is unbounded, (or in other words that it is the expected value of any spell greater than or equal to three). We need to change the specification to bound the censoring, and set it to the expected duration for spells larger than 3 months, but smaller than 6.

Lastly, we have to deal with censoring at the end. The last spell has three months fixed, two missing and then the series is discontinued. So again, we assume that the spell is greater than or equal to three, and smaller than 6. 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. For instance, for the first spell, $S_1 = 3$, and $M_1 = 6$. 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 $e^{-\lambda S_i} - e^{-\lambda M_i} = e^{-\lambda S_i}(1 - e^{-\lambda(M_i - S_i)})$.

Following the discussion from the previous section we have to take care of the bias that aggregation might introduce if stickiness is not constant through time. As was discussed before, the best alternative is to weight the observations by their length. Therefore, the maximum likelihood is the following:

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

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.

There are several goods that have constant prices through out their lives and all the spells are censored. For those goods, the maximization would estimate an expected life of ∞ ($\lambda \to 0$). Clearly, this is not an interesting case. Hence, we set an upper bound of 60, which is the sampling life of a good in the index. There are only 869 imported goods for which this problem exists. All these goods are indeed currently active, and represent the cases in which the estimation of censoring drives the probability to zero. Importantly, these cases represent less than 2 percent of all goods.

The results of estimating the maximum likelihood good by good produces the following results: The average expected life for imports is 12.48 months with a median of 7.64. For exports the average is 13.62 and the median is 9.15. Notice that these estimates are quite in line with the results presented before[14]. The cumulative distribution of duration for both exports and imports are depicted in Figure 1, refered to as Duration Imports (any 6) and Duration Exports (any 6). The estimates from this sample and the 12 consecutive price sample are very similar with a large correlation between the two. A simple OLS regressions (in logs) implies an intercept of 0.09, with slope of 0.91, and R^2 of 0.90. (0.14, 0.90, 0.87 for exports, respectively).

Smoothing over some gaps in the price series As pointed out earlier, we treat the price before a missing price and the price after a missing price as a price change, even if the latter price is exactly equal to the former price. A typical feature of this data is to have the exact same price separated by gaps. We perform another calculation by smoothing over such spells. That is, if a price after a gap is identical to the price before the gap then we extend the spell to include the price after the missing observation. In Figure 2, this would imply that the first spell lasts from month 1 through month 8. If however, the price after a missing is a new price then we truncate the previous price spell at the first missing observation and start a new price spell at the date we have information on the new price. In this procedure we do not correct for any form of censoring, unlike the previous section. The spell length weighted average using this procedure yields a mean (median) 14.29 (10.16) months for imports and mean (median) duration of 16.88 (12.58) months for exports. As expected, the median is affected more than the average when compared to the previous analysis.

Trade Weighted Average: In the previous analysis we gave each good an equal weight in calculating the average across goods. It can be argued that goods with a larger value in trade should be more heavily weighted. While we do not have the goods weight in the index, the BLS

[14] In a further robustness check we consider only on those goods that have at least one uncensored spell. There are only 27915 goods with at least 6 observations that have at least one uncensored spell. This eliminates all goods whose prices are constant. Despite this, we obtain an average (median) of 10.46 (7.00) months.

was able to provide us with weights at the 10 digit harmonized level, referred to as a classification group. This is the lowest level of aggregation at which the BLS performs its sampling. Each item is mapped to a classification group. The mean (median) number of items in a classification group is 3.5 (2) in our sample for imports[15] and 3.68 (2) for exports. For each group, the BLS provided us with data on the dollar value of imports and dollar value of exports for 5 weight years (1995, 2000-04). We report the trade weighted average for 2004 using the weights from 2002 as is the procedure in the BLS index value calculation. We distribute the dollar value for each classification group evenly across the different items within a group to calculate the item weights. This was done separately for imports and exports. Using the item weights we calculate the weighted time between price changes to be 12.26 months for imports and 13.77 months for exports in the larger sample. In the 12 consecutive observation sample it is 12.26 and 12.82 respectively. In summary, the weighted estimates for duration are not very different from the unweighted measures. In the case of imports, crude petrol has the highest weight for 2004 in terms of classification groups in the index and the prices for crude change on a monthly basis. However, the next highest classification group is in the category of cars and the stickiness of these goods is very high.

Summary: We compute average probabilities of price change and average duration good by good for imports and exports. The message we obtain is consistent. The average price stickiness is longer than a year. Finally, it is important to note that the stickiness is in dollars for both imports and exports. This has important implications for theoretical models, since the typical assumption is to assume either stickiness in local currency (Betts and Devereux (2000) and Devereux and Engel (2003)) or in producer currency (Obstfeld and Rogoff (1995)) and this assumption is symmetric across countries. To the contrary, in the case of the U.S. 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 (See Corsetti and Pesenti (2005).)

These findings suggest the need for theoretical and empirical work on the microfoundations of price contracting in international transactions. Indeed, it is useful to understand other aspects of the contract and the nature of bargaining between importers and exporters; including whether or not quantities are contracted on. The BLS questions reporting firms on whether the price quoted is related to the size of the order. In only 10% of the cases is it reported that the price has some

[15] 75% of classification groups have less than or equal to 4 items. The largest classification groups has 70 items.

relation to quantity. This may suggest that quantities are not contracted on for a large fraction of the sample, however it is far from conclusive evidence.

3.3 Related Literature on Price Rigidity

To the best of our knowledge, we present here the first set of direct evidence on the extent of nominal rigidity for at-the-dock prices of traded goods. A distinction from the literature on domestic prices is that we analyse the rigidity in the currency of pricing. In the presence of exchange rate movements this has important implications for pass-through at the dock.

Since transactions at the dock reflect business-to-business transactions, our study is most comparable to Carlton (1986) who also estimated price durations to be over a year for domestic purchases by large U.S. companies. Carlton (1986) studied the transaction price of intermediate goods purchased by mostly Fortune 500 U.S. companies. Since prices at the dock represent whole-sale prices this is the most direct comparison. More recently there has been a number of studies on retail prices using the micro data underlying the consumer price index starting with the important work of Bils and Klenow (2004) (henceforth BK) for the U.S. BK find that the median duration of prices is around 4.5 months at the retail level. In similar work for the Euro Area, Alvarez et al (2005) find the duration is closer to 12 months.

Here we present a comparison of the stickiness measures we obtain for prices at the dock with the BK measures of prices at the retail level, since both studies correspond to the U.S. Since a large part of traded goods are producer goods and BK includes services which is not in our database, to make a more direct comparison, we match the categories in BK with the mostly 4 digit classification in our database for the case of imports. We obtain a match for 106 categories. In the BK subset, the mean (median) is 3.93 (2.85) with a standard deviation of 2.97 months. For the same matched categories we obtain 11.68 (11.40) and a standard deviation of 5.77 months. In Figure 3 we plot log duration from BK and our measures. The two are strongly positively correlated and the duration at the dock measures are in general higher than the retail price measures. This is reflected in the positive and statistically significant constant in the regression. In Table 1, we report the duration numbers for harmonized code categories for which the BLS allows public reporting. As can be seen, in the case of commodities like fuel oil the two measures are very similar, however, for most other categories the stickiness of prices at the dock are much larger. This suggests some important differences between the retail price behavior of tradable goods, and the behavior of actual traded goods.

[Figure 3 here]

[Table 1 here]

There are several reasons why CPI prices can differ from at-the-dock prices. One distinction being that at-the-dock prices involve transactions between firms as opposed to the sale of a good to consumers and the contracting relationship in these two cases can be very different. Further research is required to explore these differences.

4 Price Stickiness and Product Characteristics

There is a large amount of heterogeneity in the level of price stickiness across the goods. The mean duration of a price for imports is 12.48 months and the standard deviation is 14.86 months. Similarly, in the case of exports, the mean duration is 13.62 months with a standard deviation of 14.79 months. To explore some of the factors behind this dispersion, in this section, we correlate our measures of stickiness with characteristics of the goods, the nature of the transaction depending on whether it is traded intra-firm or not, the currency in which the good is priced and the country of origin/destination. We find that stickiness in dollars is much lower for homogenous goods as compared to differentiated goods. The currency of invoicing is also an important variable that explains dollar price stickiness. We find that, consistent with theory, prices are sticky in the currency of invoicing[16].

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. Therefore, we relate our measures of stickiness to the particular nature of the good traded, by using Rauch's (1999)

[16] We present the results for the larger sample only, since the results are very similar for the sample of 12 consecutive observations.

empirical classification of traded goods into homogenous goods and differentiated goods[17]. 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. We would expect that the elasticity of demand is higher for homogenous goods as compared to differentiated goods. When we correlate our measures of stickiness with the Rauch classification we find that goods traded on an organized exchange have the least amount of stickiness. The mean (median) duration of prices is 4.18 (1.66) months for the organized exchange category, it is 9.43 (4.38) months for the reference good category and it is 13.57 (8.61) months for the differentiated goods category.

A second factor in understanding the dispersion is the currency in which goods are invoiced. The stickiness of prices along with the currency of pricing jointly determine the extent of pass-through of exchange rate changes into local currency prices. As mentioned earlier, an overwhelming number of imports and exports are invoiced in dollars. About 10% of imports and 5% of exports 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 average stickiness of dollar priced imports in dollars is 13 months. The average for foreign currency priced imports in the foreign currency is 16 months[18].

It is well known that a large fraction of trade takes place between related parties, that is, are intra-firm transactions as opposed to arms-length. In our larger sample, 40% of items are traded intra-firm in the case of imports and 26% in the case of exports. Since the two types of transactions involve different incentives (with a large literature on transfer pricing), we examine if in the case of price stickiness there is a significant difference between the two. We can perform this exercise

[17] 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 this sense, it should not be surprising that the number for the organized exchange category exceeds 1.

[18] This higher number reflects the fact that the foreign currency priced goods are concentrated in the differentiated goods sector.

because the BLS collects information on whether a transaction is a market transaction or not. At the aggregate level, we find very little difference between the average of price stickiness for goods traded intra-firm Vs. those traded at arms length at the aggregate level. The mean duration is 13.06 months for intra-firm transactions and 12.06 months goods traded at arms-length. This finding is similar to Clausing (2001), who studied intra-firm transfer pricing at the industry level using a shorter period of 1997-99[19].

So far, in our description we have reported on the bivariate relation between price stickiness and the various characteristics of the goods and its transaction for imports. In Table 2 we run a multivariate regression of the log of price duration on all the variables discussed above for both imports and exports. In addition we include country fixed effects. As can be seen, all the main points from the bivariate analysis come through in the multivariate analysis. t-statistics calculated with robust standard errors are reported in parenthesis.

[Table 2 here]

4.1 Price Stickiness and Currency Volatility

In this section we correlate our measures of stickiness with exchange rate and inflation volatility in the country of origin. For each country we estimate the dollar value of the foreign consumer price level as the sum of log nominal exchange rate and log of CPI. We then estimate the standard deviation of this sum during the life of the good, for each good. We regress the good's duration on this measure and find that for very high levels of volatility there is indeed a decline in the duration for which prices stay unchanged. For instance, when the volatility goes up to 20% the duration declines by 1 month. However, for most of the normal range of exchange rate volatility there is very little difference in the duration measures. In fact, when we add this volatility measure to the regression in Table 2, the coefficient on the volatility is significant, but small. When we add the

[19] 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 (mean) duration for 'consumer goods' is 9 (14.27), for 'capital goods except automotive' it is 8.78 (13.59), for 'automotive vehicles, parts and engines' it is 8.49 (13.31), for 'Food, Feed and Beverages' it is 3.63 (8.88) months, for 'industrial Supplies and materials' it is 4.46 (9.05) and lastly for the 'other' category it is 11.28 (18.25) months. Accordingly, it is not only producer goods but also consumer goods that display a large amount of stickiness.

volatility of the dollar value of foreign inflation, instead of the volatility of the nominal exchange rate, then the coefficient becomes insignificant.

Since there are other idiosyncratic cost and demand shocks that effect a good during its life, the lack of an effect from exchange rate movements might arise from a compounding of different factors. Accordingly, we examine episodes of large foreign currency devaluations in our sample since presumably in those cases the exchange rate movement is the dominant shock. 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.[20,21] For 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 4, time zero corresponds to the month in which the exchange rate depreciates. We computed the proportion of items changing prices every month, as well as the probability of price increases, and price declines. The three probabilities are depicted in Figure 4. The thick line corresponds to the overall probability of price changes and it is measured on the left axis. The other two lines are measured on the right axis.

[Figure 4 here]

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 decreasing prices, while there is a decline in the probability of finding price increases. These changes are as expected, but the pattern is surprisingly weak. In summary, even if we restrict attention to periods of significant exchange rate movements, goods tend to exhibit fairly high price stickiness. This is the case even when we restrict attention to only differentiated goods.[22]

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

[21] 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 in 1994. For Brazil, we computed the exchange rate adjusted by inflation, and concentrated on the periods in which it moved by 15 percent.

[22] We concentrated only on imports because the country of destination information is much more limited for exports.

5 Price Stickiness and Time Trend

We document that the degree of price stickiness has been increasing significantly in the last ten years in U.S. imports. For imports, the average probability of price change declined by 10 percentage points from 0.29 in 1994 to 0.18 in 2004, that is, there was a 40% 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. This finding has implications for the literature explaining the decline in pass-through documented for the U.S., where price stickiness can play an important role.

We compute the annual average probability of each good by simply dividing the number of price changes by the total number of usable prices in a given year. We then average across goods to calculate the average probability for the year[23]. Figure 5 presents the probability of prices changing computed every year.

[Figure 5 here]

Most of the decline takes place during the 90's, and the trend seems to have stabilized significantly in the 2000's. Two questions immediately arise from this observation: First, what is behind the increase in stickiness? Second, what are the aggregate implications of the increase in stickiness, especially for pass-through? Indeed, 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.

[23] Note that the average probabilities are higher than the inverse of the duration numbers we calculate for reasons discussed in Section 3.1.

5.1 Decomposing 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 find in our regressions in Table 2 that differentiated goods have sizably larger price durations than homogenous goods. Campa and Goldberg (2004) suggest that this change in composition might be behind the decreasing pass-through. Interestingly though for the sample period that we examine and for the measure of price stickiness, the composition story explains very little of the decline. The share of homogenous (organized plus reference) goods declined from 25% to 17% of all goods[24]. 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,

$$\Lambda_{1t} \equiv \sum_s [n_{s,1994}\lambda_{s,t}]$$

$$\Lambda_{2t} \equiv \sum_s [n_{s,t}\lambda_{s,1994}]$$

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 the results shown in Table 3 suggests the composition effect is minimal and 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 about 11%.

[Figure 6 here]

[Table 3 here]

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

In Figure 6 we plot the average probabilities over time within each type of good. For comparison, we normalize the initial probability to 1 for each category. These were estimated by running a regression of probabilities on time fixed effects for each sector. As can be seen, the largest decline in the probability of price change is observed in the differentiated goods sector (40%), followed by a smaller decline in the reference goods sector (20%) and none at all in the organized goods sector. These declines are also very precisely estimated. 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.

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 very little support for this hypothesis. For instance, for the differentiated goods sector we can estimate the time varying country probability and a time varying country composition similar to the procedure we followed for the sectoral decomposition. The "residual" variance that is unexplained by time varying country probability is 15%. Therefore, an explanation for the decline in average probabilities for the period 1994-2004 needs to be one that is not based on changing country or sector composition but one that can explain a general trend decline in probability within each country and particularly among differentiated goods.

A possible reason for the increase in stickiness could be due to the change in the currency of invoicing over time since we find that non-dollar priced imports have their dollar prices changing on a monthly basis. As mentioned earlier, the fraction of imports reported in dollars has increased from 87.9% in 1994 to 93.44% in 2004. Figure 7 plots a decomposition of the decline in the probability of price change based on the currency of invoicing. The line "Time varying currency composition" plots the yearly probability of price change assuming that probabilities within dollar invoiced and non-dollar invoiced categories stay unchanged at their level in 1994 and allowing only the fraction of goods invoiced in each category to change. The line "Time varying currency stickiness" plots the yearly probability of price change assuming that the fraction of goods invoiced in each currency stays unchanged at the level in 1994 and allowing only the average probability within each category to change. As the plots depict, the time varying currency composition can explain a significant decline in average probability especially in the later years. The Time varying currency stickiness also plays a significant role particulary in the earlier years.

[Figure 7 here]

In the case of U.S. exports the decline in the probability of price change is of a smaller magnitude. It declines from a little over 0.18 to a minimum of 0.14 before returning to 0.16 at the end of the sample.

As mentioned before, the increase in stickiness observed in the data has implications on the decline in exchange rate pass-though measures documented in the literature. Further research is required, where a careful modelling of the pricing decisions by firms connects both the stickiness and the pass-through.

6 Conclusions

Price stickiness plays a central role in our understanding of monetary policy, and it is an important ingredient in theoretical models in closed and open economy macroeconomics. To understand the price behavior of actual traded goods, we have used unpublished data from the BLS to measure the degree of price stickiness for imports and exports. We have three main findings: prices are sticky, and in dollars for both U.S. imports and exports; there is a large degree of heterogeneity at the good level with differentiated goods displaying most rigidity; and the degree of stickiness in imports has been trending upwards in recent years.

Our first finding is that prices are indeed very sticky at the dock for the U.S. The trade weighted average price duration in dollars is 12.26 months for imports and 13.77 months for exports. These results are robust to different measures of stickiness that deal with heterogeneity and censoring present in the data. Second, we find that there is a large amount of heterogeneity across goods that can be partly explained by the type of good − that is if it is homogenous or differentiated and the currency in which the good is invoiced. Since prices are sticky in the currency in which they are invoiced in, foreign currency invoiced goods display dollar price changes on a monthly basis. Lastly, we studied the time trend in the degree of stickiness and documented a decrease in the probability of observing price changes in the sample in imports. This pattern is particularly pronounced in differentiated goods imports. Such a trend is less apparent for exports.

These results have important implications for models in international economics. The fact that U.S. imports and exports are sticky in dollars suggests that unlike the standard modeling assumption that all countries have either local currency or producer currency pricing the U.S. has both. This has implications for which country bears the risk of exchange rate movements and the impact of exchange rate movements on the trade balance. Secondly, the finding that price stickiness has increased over time has implications for aggregate measures of pass-through in the data. We find that the time trend is not due to a compositional shift towards differentiated goods or a simple change in country composition. The decline is observable in both consumer goods and capital goods. This evidence can shed light on alternative theories for the decline in pass-through in recent decades documented in the literature. Finally, prices are far more sticky in traded goods prices at-the-dock than prices of goods in the CPI for the U.S. The reasons for the differences need to be further explored both empirically and theoretically. The differences in contracting relationship for prices at the dock which involves transactions between firms vs. retail prices where the sale is to a final consumer is one avenue that needs to be further explored theoretically.

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PSL	HTS Code Description	BK LI Description	BK	GR
2710	Processed petrol	Fuel oil	1.3	1.0
2711	Natural and petrol gases	Bottled or tank gas	2.6	2.1
0306	Crustaceans	Shellfish (excl canned)	2.2	2.3
07	Edible vegatables	Other fresh vegetables	1.3	4.5
91	Watches and clocks	Watches	4.8	7.4
20	Vegatable and fruit products	Other processed vegetables	3.5	8.4
8471	Automatic data processing machines	Personal computers and peripheral equip.	2.1	10.1
8523	Prepared unrecorded media audiovisual	Records and tapes, prerecorded and blank	8.2	11.4
8528	Reception apparatus broadcast video media	Televisions	2.7	11.4
9405	Lamps and light fixtures	Lamps and lighting fixtures	4.6	11.6
6403	Footwear w/composite material	Girls /Men's /Boys /Women's Footwear	3.4	11.7
4011	New pneumatic tires	Tires	2.7	11.9
8521	Video recording equipment	Video cassette rec., disc players, cameras	2.7	12.2
70	Glass and glassware	Glassware	4.9	12.3
8708	Parts and accessories for vehicles	Vehicle parts and equipment other than tires	5.8	12.3
4202	Leather cases, bags, luggage	Luggage	2.6	13.2
38	Miscellaneous chemical products	Coolant, brake fluid, hydraulic fluid, additives	7	13.4
8516	Electric portable heaters house items	Portable cool/heat equip small appliances	4.8	13.5
8704	Motor vehicles for transport of goods	New trucks	2.1	13.9
6110	Knit/Crochet sweatshirts, pullovers, sweaters	Men's sweaters	1.7	13.9
9401	Seats and parts	Sofas	3.6	14.2
30	Pharmaceuticals	Prescription drugs and medical supplies	5.4	14.3
7113	Articles of jewelry containing precious metal	Jewelry	3.7	14.3
6203	Men's/boys' suits, ensembles, pants	Men's suits	3.3	14.9
6204	Women's/Girl's suits, pants, dresses	Women's suits	1.6	15.6
3926	Other plastics	Plastic dinnerware	9.3	16.1
6402	Partially waterproof footwear	Girls /Men's /Boys /Women's Footwear	3.4	16.1
63	Other textile articles	Kitchen and dining room linens	8.4	16.8
6205	Men's/boys' shirts	Men's shirts	2.5	17.7
8703	Passenger vehicles, capacity$<$10	New cars	2	18.7
37	Photographic and cinemegraphic goods	Photographic and darkroom supplies	18.4	18.7
9403	Other furniture and parts	Occasional furniture	4.3	19.3
2208	Undenatured ethyl alcohol w$<$80% concent	Distilled spirits at home (excl whiskey)	6.5	19.9
9018	Medical devices	Medical equipment for general use	9.7	22.5

Table 1: Comparison between the Bils-Klenow measures of stickiness of retail prices (BK) and this papers estimates for stickiness at-the-dock (GR), reported for only those harmonized code categories for which the BLS allows public reporting. Sectors are matched based on their descriptions.

	Imports	Exports	Imports	Exports
Constant	0.98 (29.81)	1.00 (36.21)	1.07 (30.72)	1.08 (28.22)
Reference	0.73 (21.13)	0.53 (12.95)	0.67 (18.67)	0.32 (7.38)
Differentiated	0.99 (26.18)	0.89 (26.37)	0.96 (24.40)	0.77 (17.47)
Intra-Firm	0.13 (9.51)	0.12 (8.19)	0.11 (7.74)	0.11 (6.58)
Nondollar	-1.79 (-95.87)	-1.79 (-49.29)	-1.82 (-93.27)	-1.82 (0.04)
Industrial Supplies	-0.08 (-3.07)	0.14 (4.92)	-0.08 (-2.96)	0.23 (0.03)
Capital goods excl auto	0.28 (9.23)	0.49 (16.36)	0.26 (8.20)	0.54 (0.04)
Auto parts engines	0.27 (8.27)	0.34 (10.34)	0.26 (7.43)	0.39 (9.39)
Consumer goods	0.25 (8.65)	0.49 (16.44)	0.22 (7.48)	0.51 (13.13)
Other enduse	0.55 (9.38)	0.51 (11.12)	0.54 (9.20)	0.49 (8.22)
Standard Deviation of Exchange Rate			-0.005 (6.47)	0.001 (1.08)
Country Fixed Effects	Y	Y	Y	Y
No, of observations	27636	23862	24916	13038
Adjusted R2	0.29	0.22	0.29	0.25

Table 2: Duration and product characteristics. The dependent variable is log duration. t-stats calculated using robust standard errors are reported in parenthesis. The standard deviation of exchange rate refers to the standard deviation of the nominal exchange rate in percentage terms.

Year	Monthly Probability	Time Varying Sectoral Probability	Time Varying Sectoral Composition
1994	0.29	0.29	0.29
1995	0.28	0.28	0.29
1996	0.26	0.26	0.29
1997	0.25	0.25	0.28
1998	0.24	0.25	0.28
1999	0.21	0.22	0.28
2000	0.19	0.20	0.28
2001	0.18	0.20	0.28
2002	0.18	0.19	0.28
2003	0.18	0.19	0.28
2004	0.18	0.20	0.28

Table 3: Decomposing the Time Trend in Price Stickiness. The annual average probability of price change is calculated for each good by dividing the number of price changes by the total number of usable prices in a given year. The average probability for the year, reported in column 2 is calculated by averaging across goods.

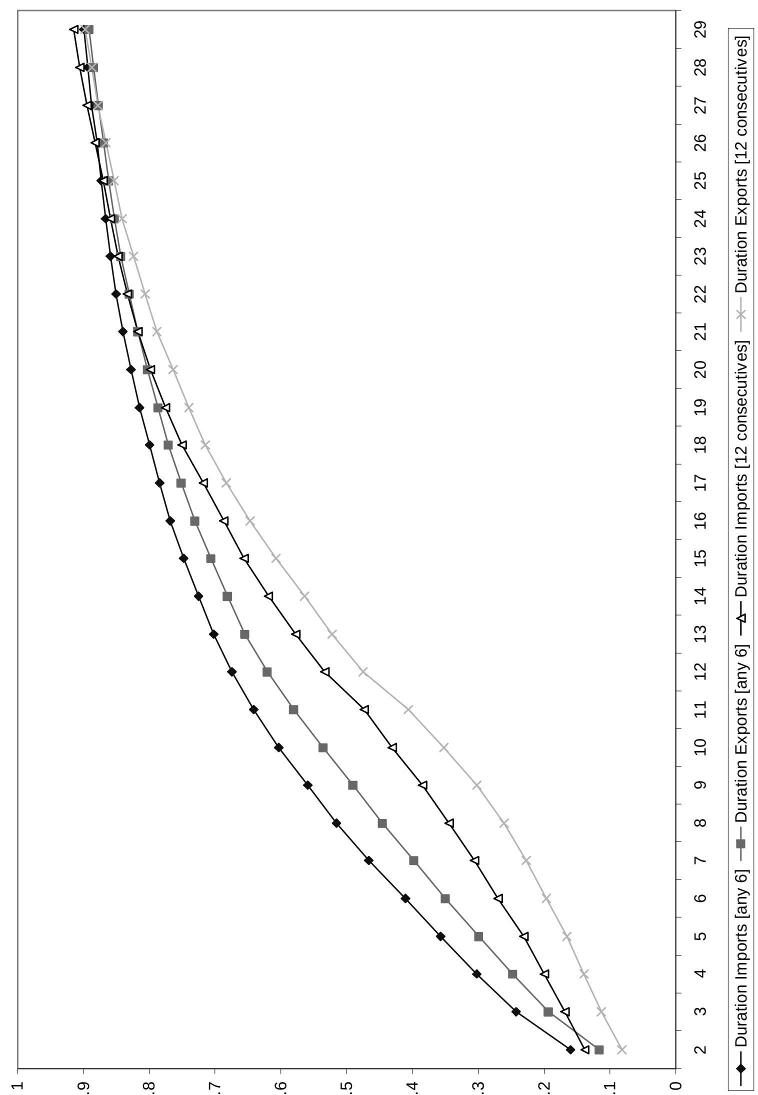

Figure 1: Cumulative distribution of price duration for imports and exports. The number of months are plotted on the x-axis and the fraction of goods with average duration less than or equal to a certain number of months is plotted on the y-axis. Duration Imports (12 consecutive) refers to the measures when we restrict the sample to goods that have at least one spell of 12 consecutive observations. Duration Imports (any 6) refers to the measures using the larger sample of all goods that have any 6 observations that need not be consecutive.

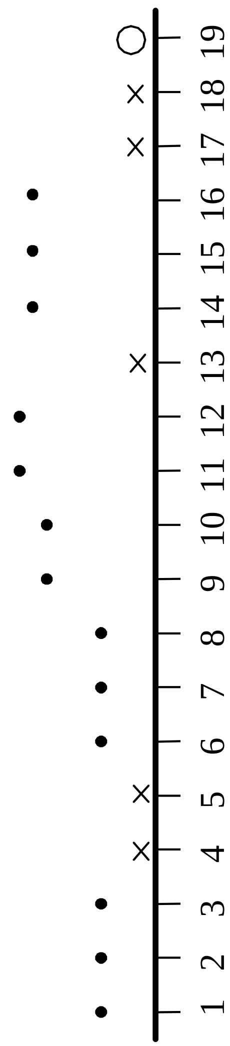

Figure 2: Depiction of a typical price series for a good. Dots represent usable prices, the X's represent missing prices and the empty circle indicates the date on which the good was discontinued.

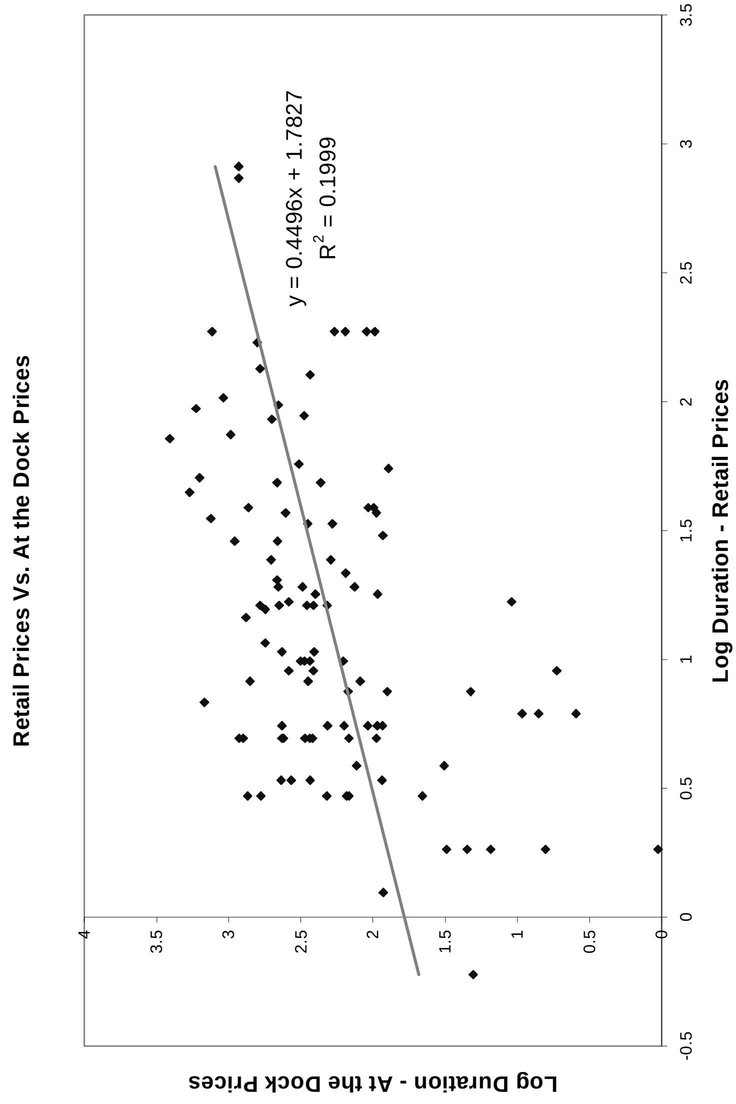

Figure 3: Relation between the log of the duration measures estimated in this paper for goods at-the-dock and the Bils-Klenow (2004) measures of duration for retail prices. The matching with the BK categories was done based on description of the category. Each observation for at-the-dock prices is the average duration within, in most cases, a 4 digit harmonized code in our sample.

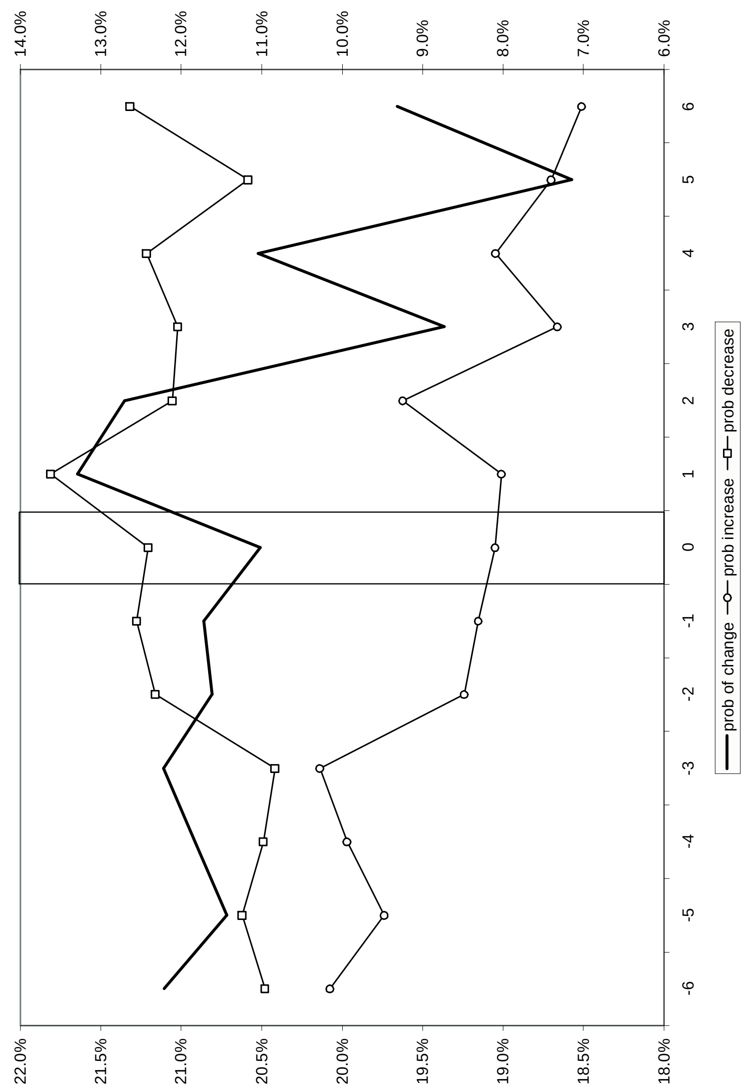

Figure 4: Probability of Price change around large devaluations. Large devaluations are defined as exchange rate depreciations of 15 percent or more in a single month. The plot covers the period 6 months before and 6 months after the depreciation. 'Prob increase (decrease)' refers to the probability of price change conditional on the price change being a price increase (decrease).

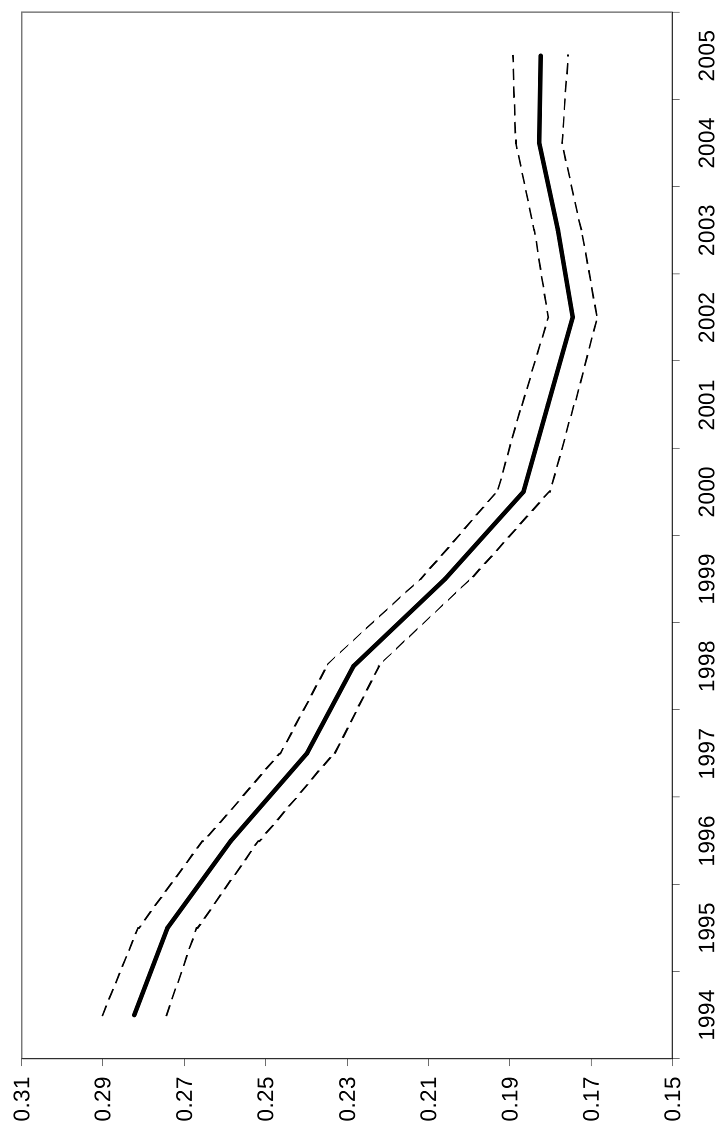

Figure 5: Time Trend in the Probability of Price change. The annual average probability of price change is calculated for each good by dividing the number of price changes by the total number of usable prices in a given year. The average probability for the year, reported in column 2 is calculated by averaging across goods. The bands represent 95% confidence intervals.

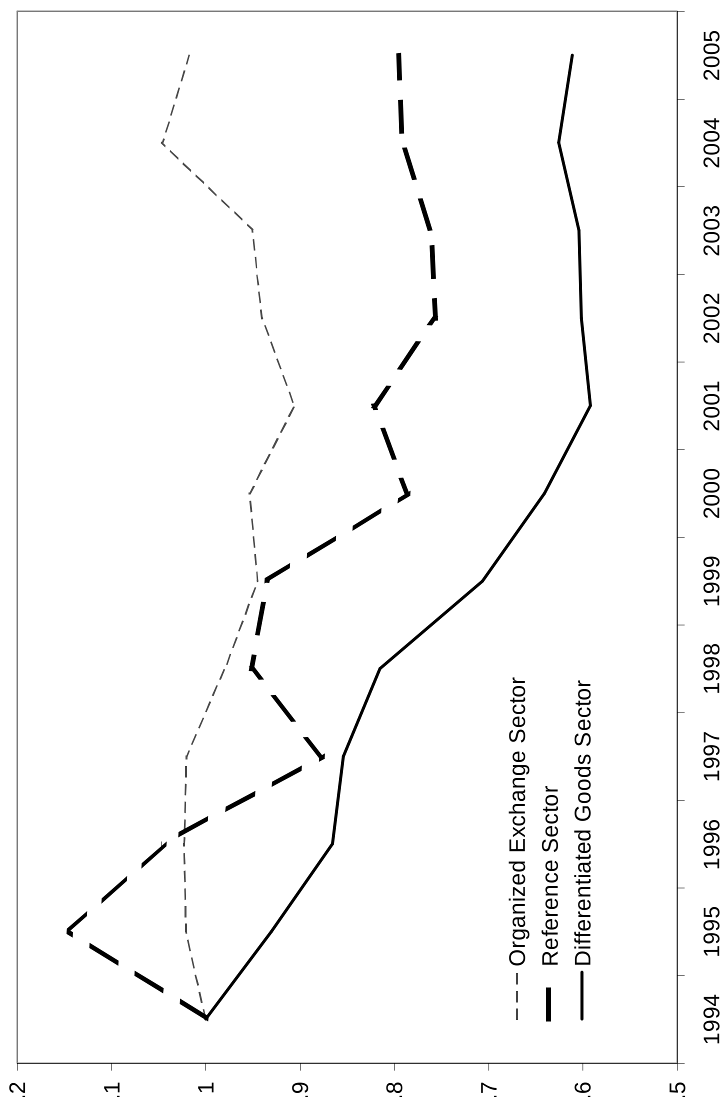

Figure 6: Time trend in Probability of Price change across organized, reference and differentiated categories. The initial point is normalized to 1 for all categories.

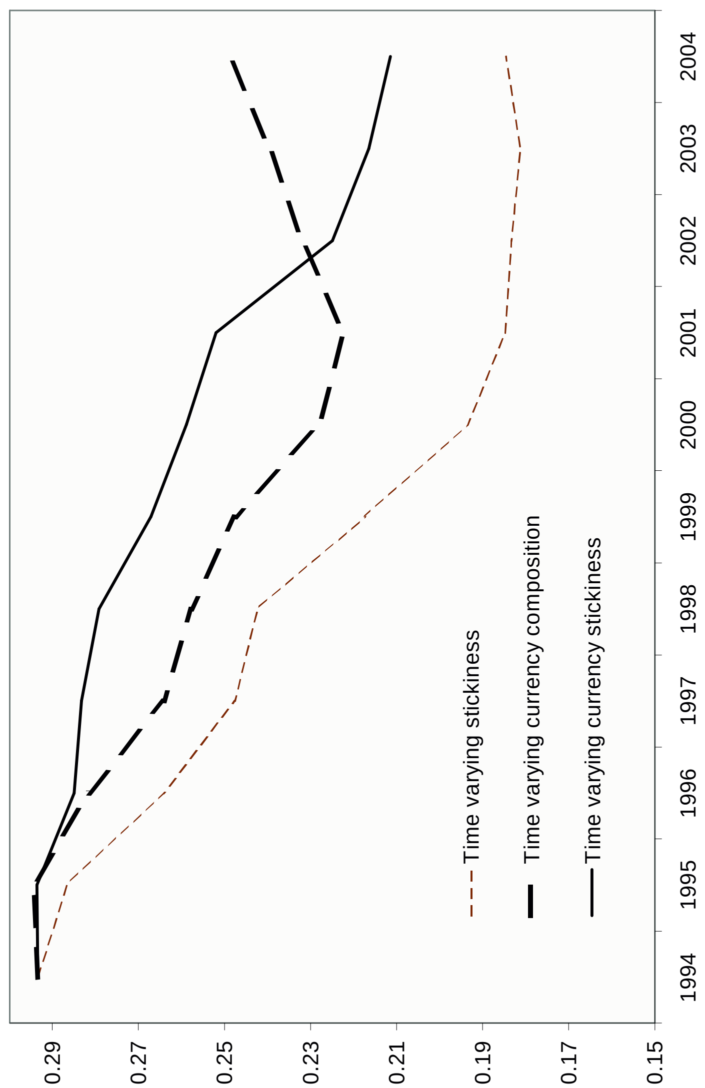

Figure 7: Decomposition of the Time trend in Probability of Price change across goods invoiced in dollars and those invoiced in a non-dollar currency. The line 'Time varying stickiness' plots the average probability of price change by year. 'Time varying currency composition' plots the yearly probability of price change assuming that probabilities within dollar invoiced and non-dollar invoiced categories stay unchanged at their level in 1994. 'Time varying currency stickiness' plots the yearly probability of price change assuming that the fraction of goods invoiced in each currency stays unchanged at the level in 1994.