Exporting Deflation?
Chinese Exports and Japanese Prices

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The spectacular growth of China in the last two decades has caused China to replace Japan as the major new source of US imports and destination for our exports. This perception has not gone unnoticed by Japanese who often bemoan the relative decline of the perceived importance of Japan with the phrase, "Japan Passing". Much less well known in the US is how the rapid growth of trade with China is affecting the world's second largest economy. The explosion of trade between Japan and China has had profound impacts on the Japanese economy and is frequently seen as a source of Japan's persistent deflation. For example, in a now famous article in the *Financial Times* the Vice Minister and Deputy Vice Minister for International Affairs at the Japanese Ministry of Finance wrote,

> "The entry of emerging market economies - such as China and other east Asian nations - into the global trading system is a powerful additional deflationary force. Their combined supply capacity has been exerting downward pressure on the prices of goods in industrialised economies…. China is exporting deflation and its effects are not limited to neighboring Hong Kong and Taiwan."[1]

This notion that China was exporting deflation by exporting goods at low prices was repeated by market analysts and policymakers both inside and outside of Japan.[2]

In this paper, we assess the impact that Chinese exports have had on Japanese prices in the years between 1992 and 2005. We start by showing that while the official Japanese import price index has fallen over this period, an import price index computed using the same methodology as the consumer price index would have resulted in substantial *inflation* over this period. This suggests that while the export of individual countries might have exerted deflationary pressures on Japanese prices, at the aggregate level (when measured using the same

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[1] Kawai, Masahiro and Haruhiko Kuroda, "Time for a switch to global reflation," *Financial Times*, London, December 2, 2002, p. 23.

[2] The idea that the presence of China might be reducing prices is also popular in the US. Broda and Romalis (2008) estimate the impact that China has had on the prices of goods paid by different income groups in America. Bergin and Feenstra (2007) argue that the rise in China's share of US imports may explain the lower pass-through of exchange rates to US import prices.

methods) this pressure fades away as import prices have risen as fast as consumer prices. The fact that index number problems are sufficiently large in Japanese import price data to bias the numbers downwards by one percentage point per year could easily have confused policymakers and economists alike about how trade was affecting price movements in Japan.

Despite this aggregate pattern, the notion that China might be exporting deflation may be warranted given the importance of China in Japan's trade and the perception that Chinese products are falling in price. The rise in importance of China in Japan's import and export structure over this period has been dramatic and has happened simultaneously with a sharp decline in the importance of the US. In 1992 the US exported three times as much to Japan as China; by 2005, China was exporting twice as much as the US. Moreover, between 1992 and 2005, the number of new imported varieties entering Japan rose by 32 percent and China played an enormous role in this expansion – accounting for 11 percent of the total. This is more than twice the level we observed in the US over a similar period. The fact that the US and China have traded places, or at least traded trade shares, is not a fact that is well-known in the US and is likely to dramatically alter Japanese-US relations in the future.

Understanding the price impact of the expansion of Chinese exports is more complex. Although China plays a large role in Japanese imports, we find no evidence that import prices from China fell faster than those from other countries. In those categories where China already had a presence in 1992, we do not find that Chinese prices fell more rapidly than those of other exporters to Japan. Moreover, the impact of Chinese competition to other exporters is also small. There is no evidence that the entry of Chinese firms into new markets has any significant impact on the pricing behavior of other exporting countries.[3] Clearly what is driving the rapid expansion of Chinese exports into Japan is not lower prices for existing goods.

Given the large growth of varieties coming from China, it is possible that the popular belief that China is exporting deflation is being driven by the constant introduction of cheap Chinese products in Japanese markets. It is important to notice that the introduction of new products would not be captured in existing price indexes which usually ignore product entry and exit.[4,5] In order to identify the impact that a new product has on prices we need to understand its welfare implications. Intuitively, the introduction of a new product reduces the cost-of-living for consumers (i.e., the true price index) if the *price per unit quality* of the new product is *lower* than that of existing products (i.e., higher quality or lower price than existing products) or if the new product is sufficiently different from existing products that consumers value the additional choice. Lower price per unit quality and higher variety of Chinese products could also explain the large increase in Chinese shares in the recent period.

We use a CES aggregator to back out the implied impact of new products on the Japanese cost-of-living. We find that there has been a remarkable decrease in the price per unit quality of Chinese exports. Price per unit quality of Chinese exports halved during this period due largely to quality upgrading. This is one of the most dramatic increases in quality that we observe in the

[3] The impact of Chinese imports on the pricing of *domestic* competitors is beyond the scope of this paper. This might be an important channel through which Chinese imports affect Japanese prices, but a clean match between trade data and data on domestic prices is hard to obtain.

[4] This is a problem in the computation of most price indexes around the world, not only the Japanese import price index.

[5] To confirm that this is true in the Japanese case, we show that one can replicate the official import price index very closely using unit value data for the set of imports that are common throughout the period. This is strong evidence that the impact of new and better products is not captured in official statistics.

data. In other words, while prices of Chinese products as computed in official statistics are not falling by more than those of other exports to China, the quality of Chinese products is rising relative to those of other countries. However, we find the quantitative significance of this quality growth to be small. If the Japanese were to correct for the increase in quality in Chinese products in the import price index then the quality-adjusted import price inflation would only be 1 percentage points smaller than the actual import inflation over the 1992-2004 period.

While the specific price impact of new products from China is small, the impact of all new and higher quality imports can account for a fall in Japanese import prices of as much as 10 percentage points over the 1992-2004 period. This is smaller than the impact that new products had in the US and several other developed countries (see Broda and Weinstein, 2006) but still important given that the official import price index has been relatively flat over this entire period. However, given that imports are such a small share of Japan's overall consumption the deflationary impact of new imported goods in Japan's is still small, at around 1 percentage point throughout the entire period.[6]

In sum, China is not placing a strong deflationary impact on the actual Japanese import price index either directly through lower inflation of existing Chinese products or through competition to other Japanese exporters. Moreover, the magnitude of the effect of new goods from China in Japanese import prices is clearly deflationary, but the effect is small. Taking into account all of Japan's new imported products, this effect can explain part of the perception that globalization is reducing import prices in Japan. Despite the large impact of new and better

[6] This number is roughly coming from the fact that the import share of Japan is around 10 percent.

products in the quality-adjusted import price index, the low level of imports in consumption suggest that the impact of globalization on consumer prices is still small in Japan.[7]

I. Japan's Trade with China

I. a. Overview

We first provide an overview of Japanese exports and imports. For our initial overview of Japanese import and export data, we rely on the aggregates provided by the Japanese Ministry of Finance.[8] Between 1988 and 2006, Japanese imports rose by 181 percent and Japanese exports rose by 122 percent in nominal terms. Interestingly, imports from and exports to the US rose at rates that were only a third as fast (46 and 47 percent respectively). By contrast exports to China rose by 454 percent and imports from China rose by a whopping 810 percent. These numbers do not simply reflect rapid growth from a low base. Of the 84 trillion yen worth of total new trade that arose during this period, over one third was due to trade with China.

Figure 1 documents movements in the import structure of Japan. The figure makes clear the very rapid change in position of the US and China. Although one cannot see it in the figure, in 1975 Japan not only imported more from the US than China, it imported more from the US than all of East Asia. East Asia gradually overtook China as a source of Japanese imports in the late seventies, but the rise of imports from China did not really take off until 1990. Until 1998, the rise of imports from China did not entail any deterioration in the share of imports emanating from the US. Thereafter, the importance of the US as a Japanese trading partner entered a steep

[7] An important channel that we do not explore in this paper is the exact quantitative role that globalization has on Japan's prices through the competitive pressure that imported goods put on *domestic* producers.

[8] http://www.customs.go.jp/toukei/info/index_e.htm

decline. Interestingly, all of the increase in imports from East Asia reflects the growth in imports from China. In fact the share of imports from East Asia excluding China (and Hong Kong) actually fell from 23 percent in 1988 to 22 percent by 2006. Thus the growth in imports from China was not matched by a more general growth in imports from East Asia more broadly.

One can observe a similar pattern in the export flows emanating from Japan as shown in Figure 2. Although Japanese exports to China have not overtaken those to the US, there is clear evidence of a dramatic change in the relative positions of the two countries. Between 1988 and 2006 the share of Japanese exports going to either China or the US stood a remarkably stable 42 percent. However, in 1988, 34 percent of Japanese exports were destined for the US as compared to only 23 percent by 2006. Thus, on both the import and export side one can observe a dramatic increase in the interdependency of the Japanese and Chinese economies.

Tables 1 and 2 report changes in the importance of the top 25 exporters to Japan by aggregating up 9-digit bilateral data supplied by the Japan Tariff Association. We shift to these data because it allows us to examine Japanese trade in far more detail than the MOF data. The top 25 exporters accounted for 88 percent of all Japanese imports in both 1992 and 2005. The rise in oil prices over this time period has dramatically increased the importance of countries like Suadia Arabia, United Arab Emirates, Iran, and Qatar as a source of imports. Other than shifts due to the rise in oil prices, there do not appear to be any substantial shifts in the relative rankings of East Asian sources of supply with the major exception of Hong Kong. Hong Kong appears to have fallen dramatically as a source of supply as goods are shipped from other locations in China. Interestingly, imports from the other growing giant, India, actually fell as a share of total Japanese imports by 30 percent, indicating that the remarkable recent growth in that country has not produced a comparable increase in exports to Japan.

I. b. Growth in Varieties

There are many ways in which one can define a “variety.” In this paper we define varieties as in Broda and Weinstein (2006), i.e. the imports of a 9-digit HS good from a particular country. This definition is close to the concept first suggested by Armington (1969) and is consistent with a wide class of monopolistic competition models.

Table 3 documents that the number of varieties entering Japan rose by 32 percent between 1992 and 2005, i.e. from 71,666 varieties in 1992 to just under 95,000 varieties in 2005. There is always a question when using this definition of variety growth about how much of the growth can be attributed to an increase in the number of categories and how much is due to an increase in new varieties *per se*. As one can see from the table, the count of new varieties entering Japan rose 32 percent over this time period whereas the average number countries exporting a particular variety grew by 31 percent. Thus, virtually all of the increase in new varieties imported by Japan can be ascribed to new sources of imports of particular 9-digit goods.

In Table 4, we report the relative contributions of different exporters to Japanese import variety growth. China’s contribution is roughly double that of the next highest contributor over this time period, Vietnam. Although non-Chinese, East-Asian exporters did not expand their total exports to Japan dramatically over this time period, they did play a central role in the expansion of new varieties entering Japan. Just over a quarter of new varieties entering Japan came from these countries, and East Asia as a whole accounted for 37 percent of Japanese variety growth. By contrast, the number of varieties coming from the largest exporter to Japan over this time period, the US, actually fell slightly. Thus, the picture of what is happening with the number of varieties complements that of what happened with imports as a whole – there was a substantial expansion of varieties from East Asia, and especially from China, and a relative decline of the importance of the US.

II. Implications for Japanese Prices

The preceding data preview suggests a number of important possibilities of the impact of globalization and Chinese exports in particular on Japan. In order to examine this, it is important to keep track of impacts arising from the price movements of existing goods and those of new goods entering Japan. To the extent that exports from China have driven down the price of existing imports relative to exports, this would be reflected as a terms of trade gain in Japan statistics. By contrast the availability of new imported products would tend to drive down Japanese prices but this effect would be mostly missed by official statistics. This happens as new varieties effectively constitute a fall in price from the reservation level to the observed level, but this fall in prices is ignored by most statistical offices around the world.

A goal of this paper is to examine the importance of these forces in the case of Japan. However, before we do so, we need to delve a little deeper into the data. One possible source of Japanese import data are the official import price indexes provided by the Bank of Japan. These indexes are based on a sample of 896 prices in the 1995 base index and 1601 prices in the 2000 index [Bank of Japan (2002)]. This is between 1-2 percent of the total number of unit values reported in the Japan Tariff Association data. Thus, the sample of prices used in the official index is much smaller than that universe of import prices. We will compare the Bank of Japan data with indexes derived using the data from the Tariff Association.

II. a. The Official Import Price Index

The Japanese import price index (IPI) is not constructed as a simple Laspeyres index. The Japanese import price index uses geometric averaging at the lower level and a Laspeyres index at the upper level. Oddly enough, this is not the same way as the Japanese CPI is computed.[9,10] Therefore, it is hard to make sense even of the most simple comparisons between import prices and consumer prices in Japan without taking explicit care of the fact that methodologies differ between indexes. In this section, we will explicitly make these adjustments. Another important characteristic of the Japanese (and US) import price index is that weights are not updated annually but at longer frequencies (most recently 1995 and 2000). This will give rise to differences between what are considered best-practice indexes formulas and official Japanese indexes.[11]

Finally, it is worth noting that the IPI, like most official indexes, cannot be used to assess the importance of new varieties entering Japan. The importance of this can be seen by examining the last four rows of Table 3. Only about two thirds of the varieties that were imported in 1992 were also imported in 2005 and similarly one third of the goods imported in 2005 were not imported in 1992. This underscores the importance played of new and disappearing varieties in

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[9] The US is also inconsistent in the construction of these indexes. The US CPI uses a geometric average at the lower level and a Laspeyres index at the upper level but the US IPI uses Laspeyres indexes at both levels (see BLS Chapter 15).

[10] Probably less surprisingly, there is also little consistency across countries in how price indexes are computed. For a thorough comparison of how US and Japanese prices are computed please see Broda and Weinstein (2007).

[11] It is also worth noting that the sample of price quotations that enter the Japanese IPI is not random. Prices quotes are chosen from close to 300 commodities. These commodities are import categories that constitute at least 0.5 percent of imports; thus, smaller import categories are excluded from the sampling procedure and hence the set of prices used in the index is not representative.

import flows and suggests that an index based on a common set of goods is going to miss a lot of the implied price changes.

However, a major advantage of using the official data is that by defining products precisely, the official index avoids the problem that movements in unit values may reflect changes in the composition of underlying goods rather than changes in the prices themselves. Certainly it is easy to find in the data examples of wild unit value movements that almost surely reflect measurement issues, but these data problems have to be set against the fact that by working with unit value data, one can have access to a vastly broader set of price data. Moreover, by working with unit values one can also use comparable quantity data.

To further assess the relative costs and benefits of unit value versus official import price data we can compare the actual import inflation that would be implied from unit-value data in the recent years. In order to deal with data problems in the unit value data, we dropped observations where the ratio of the future price to the past price exceeds 3 or is less than 0.33 or if the units reported for the quantity data changed. We built all of our indexes with base years of 1992 and 2000, so that the rebasing closely matches that of the official index, but will also sometimes refer to indexes constructed with more frequent base updating. Figure 3 presents a comparison between our Laspeyres index and the official one. Interestingly the price indexes computed using unit value data using the basic index formulas track the official index very closely. The correlation between the annual inflation rates between the unit-value index that uses a Laspeyres formula and the official index is 0.952, and 0.948 with the unit-value index that uses a geometric formula. These high correlation suggests that despite the noise in the unit values the index based on unit-values traces the official index very closely. In the rest of the paper, we will use this remarkable relationship as an important building block for understanding the impact that formula and variety changes can have on the Japanese import price index.

Given that a unit-value price index traces the official index so closely, we can derive what the import price index would look like if we were to use the same methodology as that underlying the Japanese CPI. Figure 4 shows the IPI using a Laspeyres formula and a number of other indexes –Fisher, Tornqvist, CES, Geometric, and Paasche – together with the official IPI. If the index were closer to a pure Laspeyres, like the Japanese CPI, it would have significant upward bias. All of these indexes are constructed with base years of 1992 and 2000. Between 1992 and 2005, the Laspeyres index rose 1.1 percent per year faster than the geometric index (which closely matches the official index) and 0.6 percent per year faster than the Tornqvist and Fisher indexes. These large differences underscore the importance of using the same methodology when making inferences between price indexes in a country (or across countries as in Broda and Weinstein (2007)).

According to the Bank of Japan website, between 1992 and 2002, import prices fell by 9 percent or almost 1 percent per year. Given that CPI inflation over this time period averaged 0.2 percent, it is argued that dropping import prices tended to pull down average prices in Japan. The problem with this comparison is that the CPI and the IPI use different methodologies in Japan. The surprising conclusion is that the Japanese import price index based on the same methodology as the CPI registered an average inflation rate of 0.0 percent over the same time period.[12] This suggests that the perception that import prices were falling as Japan entered into a period of deflation was driven by the fact that the CPI and IPI have different formula biases. Had

[12] This reason for this difference can be traced to what is referred in the literature as the upper level substitution bias that is not corrected using a Laspayres index, but is accounted for using a geometric index.

the IPI been constructed as a pure Laspeyres index like the CPI, the inflation rates of the two series would have been identical.[13]

The dispersion in the formula biases is also remarkable. One of the striking features of the plot is the behavior of prices between 1992 and 2002. Much of the inflation in Japanese import prices is driven by a very rapid increase in import prices at the end of the sample. If we focus on the period between 1992 and 2002, the time when MOF officials were making their statements, the drop in import prices is a bit more pronounced. Almost this entire drop occurred between 1997 and 2002. Thus, there is some evidence that import prices were falling in Japan around the time that Japan entered deflation. Once again, this entire drop base year effects. Had the BOJ been using a superlative index like the Fisher or Tornqvist which was being rebased annually, they would have found that prices had actually been rising slightly between 1992 and 2002 and even between 1997 and 2002. This type of index would have shown that between 1997 and 2002, prices didn't actually fall by 9 percent; they actually rose by 2 percent! Similarly, using superlative indexes with base years of 1992 and 2000, half of the price drop disappears. As one can see in Figure 4, superlative indexes computed with these base years suggest a fall in prices of only 5 percent. Thus formula bias may be the reason why it appeared that Japanese deflation occurred at the same time as import price deflation.

Figure 4 also provides other interesting facts. Not surprisingly, the two superlative indexes, the Fisher and Tornqvist, yield almost identical rates of inflation. Perhaps more surprising is that the CES price index is also almost indistinguishable from the superlative

[13] Similarly, the fact that the BLS's import and export price indexes are essentially pure Laspeyres indexes indicates that the different formulas used by international statistical agencies can produce substantially different pictures of what is happening to import prices.

indexes. This will be a useful fact that we will use later to argue that the variety bias using a CES aggregator is probably a reasonable approximation of the true bias.

These biases are summarized in Table 5. For each index, we express the bias in terms of the implied average annual inflation rate using that formula relative to the Tornqvist formula. Clearly, the choice of formula matters enormously. In 9 out of the 13 years between 1992 and 2005, the Tornqvist index differed from the official index in sign, this, in conjunction with the fact that the official index tracks the geometric index so closely suggests that the decision whether to use geometric averaging can qualitatively affect our understanding of what is happening to Japanese import prices. Nevertheless, no matter how we compute Japanese import price indexes using common goods, it appears that there is no clear declining trend in import prices.

II.b. Chinese Export Prices

It is possible that China is having an impact on Japanese import prices that is more subtle than what we can detect using aggregate import price indexes. China is often seen as a low cost competitor in many markets, and this is something that we can see clearly in our data. In Table 6, we report regressions in which we regress the log unit values on a dummy that equals 1 on if the source is China. We include HS-9 digit fixed effects in the first set of regressions and HS-4 digit fixed effects in the second set to control for cross product variation in prices. The coefficient on the China dummy corresponds to how much cheaper Chinese imports are than other imports in the same 9- or 4-digit category.

The results using the 9-digit dummies indicate that in 1992 Chinese exports to Japan were 0.0.92 log units cheaper than other exports in the same 9-digit category. This means that Chinese exports were 60 percent cheaper than other imports in the same narrowly defined category in 1992 and 65 percent cheaper in 2005. If we weight the observations by the share, there appears to be a bit steeper decline: weighted Chinese prices were 34 percent cheaper in 1992 and 61 percent cheaper in 2005. However, it is difficult to tell from these two cross-sectional regressions whether the drop in relative prices was due to the entry of new cheaper Chinese imports or declines in price of existing imports.

In order to examine the source of this price decline, we focus on the set of common Chinese imports. Here again we drop unit values whose relative price movements are not in the interval [0.3, 3] or if the units change and include HS-9 dummies. The data does not suggest that the prices of goods exported by China in 1992 fell at a faster rate than those exported by other countries over this time period. Essentially, the relative prices of Chinese prices show no relative decline compared to those of other countries in the same product categories. This suggests that whatever is driving the rapid expansion of Chinese exports to Japan, it is not a general decline in prices charged by Chinese producers for existing goods.

These results differ from those of Schott (2006) who found that unit values of Chinese exports to the US declined substantially. This result seems to be due to the treatment of Hong Kong. In our data, if we treat Hong Kong and China as two different countries, we obtain an analogous result with Chinese prices falling significantly, but prices from Hong Kong rising significantly. These two forces cancel each other out and may reflect that the composition of goods passing through Hong Kong is changing, but that there is no significant change in Chinese exports broadly defined.

We have already seen that China has been playing a major role in the expansion of new varieties into Japan. One possible implication of this is that the entry of new Chinese products is that they are driving down the prices of other competing exporters. In order to examine this, we regressed the change in the log of the average price of the other exporters in a HS-9 digit category on whether a Chinese firm entered that sector or exited. We also include year-HS-4 interaction dummies to control for industry level variation that might be correlated with Chinese entry or exit.

In the first three columns of Table 7, we report the results from this exercise. When we do not include HS-4 year effects, we find that the entry of a Chinese exporter into a new market is associated with an 0.8 percent decline in the prices charged by other firms. However, when we include HS-4-year effects, this relationship looses statistical significance. Moreover, the exit of China from a Japanese import market is not associated with any increase in the relative prices of the other goods. In order to see whether the effect of Chinese entry or exit might take some time to have an impact on the prices of other producers, we also ran specifications in which we included one- and two-year lags of the entry and exit variables. Neither of these variables was significantly associated with a price change of imports of the other goods changed.

Our results from these exercises indicate that Chinese exports do not appear to have a differential impact on Japanese import prices when examined through conventional approaches. Chinese export prices into Japan are not falling faster than prices of other comparable 9-digit goods. Moreover, the entry or exit of a Chinese firm in a 9-digit sector does not tend to cause any significant movement in the prices of other firms.

III. The Variety Effect

The results from the previous section suggest that China has been a major contributor to the expansion in new varieties that have been entering the Japanese market over the last 15 years.

In particular, China and other exporters that have entered the Japanese market could have an impact on inflation in Japan through the expansion of exported varieties. Common goods price indexes cannot measure the impact of new varieties on prices by definition. However, if we think about the entry of new goods as unmeasured price drops, and consumption goods are produced using these inputs, it is possible that consumer prices might be falling as a result of the entry of new producers into the market.

We now turn to understanding this effect more clearly. Our estimation framework is identical to that of Broda and Weinstein (2006), and we repeat some of their underlying theory here in an abbreviated format.

We begin by assuming that consumers purchase and derive utility from a final good U_t that is produced using domestic and foreign varieties.

(1) $$U_t = \left(D_t^{\frac{\kappa-1}{\kappa}} + M_t^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}} ; \kappa > 1 ,$$

where M_t is the composite imported good to be defined below, D_t is the domestic good, and κ is the elasticity of substitution between both goods. Moving to the second tier, we define the composite imported good as:

(2) $$M_t = \left(\sum_{g \in G} M_{gt}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} ; \gamma > 1$$

where M_{gt} is the sub-utility derived from the consumption of imported good *g* in time *t*, γ denotes the elasticity of substitution among imported goods, and G is the set of all imported goods. This sub-utility function can be represented by

(3) $$M_{gt} = \left(\sum_{c \in C} d_{gct}^{\frac{1}{\sigma_g}} \left(m_{gct} \right)^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}} ; \sigma_g > 1 \, \forall g \in G \ ,$$

where σ_g is the elasticity of substitution among varieties of good *g*, which is assumed to exceed unity; for each good, imports are treated as differentiated across countries of supply, *c* [as in Armington [1969]]; m_{gct} corresponds to the imports of good *g* from country *c* in time *t*, that is, we identify varieties of import good *g* with their countries of origin; C is the set of *all* countries; and d_{gct} denotes a taste or quality parameter for good *g* from country *c*.

We will work with the main proposition of Broda and Weinstein (2006) which is an extension of one found in Feenstra (1994). Let *I* be the set of goods available at some time, I_t be set of goods available in time *t*, and I_g be the set of varieties in good *g* that are available in two time periods. We denote the price and quantity vectors by $\mathbf{p}_t$, and $\mathbf{x}_t$ and individual prices of varieties by p_{gct}.

PROPOSITION (Broda and Weinstein (2006)): If $I_g \neq \varnothing \ \ \forall g \in G$ and $d_{gct} = d_{gct-1}$ for $c \in I_g$ $\forall g \in G$, then the exact *aggregate* import price index with variety change is given by,

(4) $$\Pi^M \left(\mathbf{p}_t, \mathbf{p}_{t-1}, \mathbf{x}_t, \mathbf{x}_{t-1}, I \right) = CIPI(I) \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{w_{gt}}{\sigma_g - 1}} ,$$

where CIPI refers to the conventional CES import price index:

$$CIPI\left(I\right) = \prod_{g \in G} P_g \left(I_g \right)^{w_{gt}} \text{ and } P_g \left(\mathbf{p}_{gt}, \mathbf{p}_{gt-1}, \mathbf{x}_{gt}, \mathbf{x}_{gt-1}, I_g \right) = \prod_{c \in I_g} \left(\frac{p_{gct}}{p_{gct-1}} \right)^{w_{gct}} ,$$

w_{gt} are log-change ideal weights, and

$$\lambda_{gt} \equiv \frac{\sum_{c \in I_g} p_{gct} x_{gct}}{\sum_{c \in I_{gt}} p_{gct} x_{gct}} \text{ and } \lambda_{gt-1} \equiv \frac{\sum_{c \in I_g} p_{gct-1} x_{gct-1}}{\sum_{c \in I_{gt-1}} p_{gct-1} x_{gct-1}}.$$

In order to compute the impact of new varieties on the Japanese economy given by equation 12. We estimate the following system of import demand and export supply equations:

(5) $$\Delta^{k_{ig}} \ln s_{igvt} = -\left(\sigma_{ig} - 1\right) \Delta^{k_{ig}} \ln p_{igvt} + \Delta^{k_{ig}} \varepsilon_{igvt}$$

(6) $$\Delta^{k_{ig}} \ln p_{igvt} = \frac{\omega_{ig}}{1 + \omega_{ig}} \Delta^{k_{ig}} \ln s_{igvt} + \Delta^{k_{ig}} \delta_{igvt}$$

where $\Delta^{k_{ig}} x_{igvt} = \Delta x_{igvt} - \Delta x_{igk_{ig}t}$ (i.e., differencing across two different varieties of a given *i*-*g* pair), *i* denotes the import source country, *g* a 4-digit good, and *v* (for variety) a particular variety of good *g*, and $s_{igvt} = p_{igvt} x_{igvt}$. ε_{igvt} are taste or quality shocks to variety *v* of good *g* in country *i* and δ_{igvt} are shocks to the supply of the same variety. Our identification strategy is identical to that in Broda and Weinstein (2006).

IV. Results

IV. a. The Quality of Chinese Exports

Before we turn to estimating the bias in the Japanese import price index due to new varieties entering Japan, it is useful to examine what has been happening to the quality of imports by country. The first point to realize is that with the CES approach we have adopted, we can measure both the relative quality of new varieties as well as quality upgrading of existing varieties. The former is standard from earlier work, but the latter is new. To see how to measure quality upgrading of existing goods in the CES framework consider the CES demand function:

(7) $$s_{igvt} = \left(\frac{p_{igvt} / d_{igvt}}{P_{gt}} \right)^{1-\sigma_g} E_{gt}$$

where s_{igvt} is the share of expenditures on variety v in time t and E_{gt} is aggregate expenditure on good g in time t. If we take logs of equation (17), we obtain

(8) $$\ln s_{igvt} = \left(1-\sigma_g\right) \ln\left(\frac{p_{igvt}}{d_{igvt}} \right) + \ln\left(\frac{E_{gt}^{\frac{1}{1-\sigma_g}}}{P_{gt}} \right)^{1-\sigma_g} .$$

We can rewrite this as

(6) $$\ln s_{igvt} = \phi_{gt} + \left\{ \left(1-\sigma_g\right) \ln\left(\frac{p_{igvt}}{d_{igvt}} \right) - \left[\overline{\left(1-\sigma_g\right) \ln\left(\frac{p_{igvt}}{d_{igvt}} \right)} \right] \right\},$$

where the terms with bars over them indicate the average for a good in time *t*.

In this case the term in curly brackets can be thought of as how movements in price per unit quality have been affecting market shares. In particular, if the price per unit quality is high for a given variety in a moment in time, this term will be positive. This suggests that if we regress the shares of products on HS-9 digit-year fixed effects, the residuals can be interpreted as how price per unit quality has been affecting the market share of that country.[14] If we think that price per unit quality of the common exports have remained relatively constant over time, we should expect that this residual should not demonstrate any trend. However, if price per unit quality is falling, then we should expect to see this residual rise.

[14] An alternative interpretation is that the residual captures the number of sub-varieties of the product. However, to the extent that one can think of expansions sub-varieties of a good (e.g. increasing the number of car models) as a rise in quality, this interpretation is isomorphic to a quality story.

In order to see what was happening to these residuals, we estimated equation (18) and included country dummies so that each country's residuals would be normalized around 0.[15] We then plotted the mean and median residuals for the 9 largest non-oil exporters to Japan (see Figure 5). The results are quite striking. For most countries, there is little movement in the mean or median residuals, however Chinese residuals exhibit a dramatic rise over time. Of the 100 largest exporters to Japan, China exhibits the highest increase in market share due to quality adjusted price movements. Chinese market share rose by a factor of 3.3 (1.2 log units) due to quality upgrading. By contrast of the 50 largest exporters to Japan, most experienced market share shifts due to quality adjusted price movements of less than plus or minus 26 percent. This suggests that a major reason for the increase in the intensive margin of Chinese exports is lower price per unit quality.

We can do a back-of-the-envelope calculation to get some sense of how much price per unit quality needed to fall in order to produce this rise in market share. If the quality of the remains unchanged, then we can rewrite equation (6) as

$$\Delta \ln\left(\frac{p_{igvt}}{d_{igvt}}\right)=\frac{\Delta \ln s_{igvt}}{\left(1-\sigma_g\right)}.$$

The median change in the log share of a Chinese variety during this period was 1.45, and the median elasticity estimate was 2.9. Substituting these values into the above equation suggests that the price per unit quality of the typical Chinese good fell by 54 percent over this time period. This suggests substantial quality upgrading by Chinese manufacturers.

[15] Because of the size of the dataset, we limited our analysis to the 100 largest exporters to Japan in 1992.

IV. b. Globalization and Japanese Prices

In order to estimate the impact of new varieties on Japanese prices as indicated by equation (12), we need to compute the lambda ratios and estimate the elasticities. To simplify the analysis, we define "goods" as HS-4 digit categories, which divides Japanese imports into just over one thousand categories.

Table 8 documents the summary statistics for the lambda ratios. In the typical sector the lambda ratio is 0.96. This implies that if all varieties entered utility symmetrically, then the number of varieties would have increased by about 4 percent over this time period. Most of the ratios are distributed relatively narrowly around this value however the distribution reveals that there are more sectors with substantial drops in the lambda ratio than sectors with substantial increases. This is consistent with the evidence we presented earlier indicating that on net there has been an increase in new varieties entering Japan.

The median lambda ratio for Japan is extremely close to Broda and Weinstein's (2006) computation of the lambda ratio for the US between 1990 and 2001 (0.95). Moreover the distribution of lamda-ratios is also quite similar. The 5th percentile in Japan is 0.35 compared to 0.34 in the US, and the 95th percentiles are 1.7 and 1.8 respectively. This suggests that the importance of new sources of supply have been approximately the same for the two economies. In particular, it suggests that even though China only accounted for one half the amount of net new variety growth in the US as in Japan, this did not change overall growth in new varieties in the two countries.

The distribution of elasticities of substitution is also quite similar to that obtained on US data. The median elasticity for Japanese imports is 2.9, which is the same value found in Broda and Weinstein (2006). However, the distribution of sigmas is somewhat more spread out for

Japan with more elasticities taking on both large and small values. If we apply this elasticity estimate to the results of the previous section, then this implies that the price per unit quality fell by 0.63 (=1.2/1.9) log units or 47 percent over this time period. This suggests that the reason for the dramatic rise in Chinese exports is not price drops but rapid quality upgrading.

When we compute the magnitude of the new good bias as indicated by equation (12), we find it to be 6.1 percent between 1992 and 2005 or about 0.48 percent per year. This is actually somewhat smaller than Broda and Weinstein's (2006) estimate for the US between 1990 and 2001 (0.8 percent per year). This suggests that the impact of variety growth in Japan was, if anything, less than that in the US. In addition, the relatively small impact of variety growth on Japanese import prices indicates that the entry of low cost Chinese exporters cannot be having a substantial impact on Japanese prices. Given that Japan's imports of goods and services to GDP ratio averaged only 9 percent over this time period, the impact of a 0.5 percent per year bias in import prices on Japanese deflation is only 0.04 percent per year. To the extent that new imported varieties simply replaced domestic ones, this may be an overestimate. Moreover, if we were to assume that the growth in varieties in services imports did not match that of goods, the impact would be smaller still. This indicates that there cannot be a large effect of new imported varieties in general, and China's entry into Japanese markets in particular, on aggregate Japanese prices.

V. Conclusion

The paper highlights the importance of using the same methodology across price indexes when making economic comparisons between them. Between 1992 and 2002, the Japanese Import Price Index registered a decline of almost 9 percent and Japan entered a period of deflation. However, we show that much of the difference in the behavior of import prices and domestic prices was due to formula biases. Had the IPI been computed using a pure Laspeyres index like the CPI, the IPI would have hardly moved at all over the same time period indicating that formula bias accounts for much of the difference in the behavior of the two indexes. A Laspeyres version of the IPI would have risen 1 percentage point per year faster than the official index.

Second we show that Chinese prices did not behave differently from the prices of other importers. Although Chinese prices tended to be substantially lower than the prices of other exporters, they do not exhibit a differential trend. However, we estimate that the typical price per unit quality of a Chinese exporter fell by half between 1992 and 2005. Thus the explosive growth in Chinese exports is attributable to growth in the quality of Chinese exports and the increase in new products being exported by China.

Finally, the increase in new imported products entering Japan is only associated with relatively small price movements. The import price index adjusted for new imports rose only 0.5 percentage points per year slower than the unadjusted index. This suggests that the very substantial changes in quality and expansion of China in new markets do not appear to have produced much of an impact on aggregate Japanese prices. In short, China does not seem to be exporting deflation to Japan.

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Figure 1: Share of Japanese Imports by Source Country or Region

Notes: East Asia is defined to be Cambodia, China, China (Hong Kong), China (Taiwan), Korea, Dem. PP. Rep., Korea, Rep. of, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka, Thailand, Viet Nam, Indonesia; China is defined to be China and China (Hong Kong).

Figure 2: Share of Japanese Exports by Source Country or Region

Notes: East Asia is defined to be Cambodia, China, China (Hong Kong), China (Taiwan), Korea, Dem. PP. Rep., Korea, Rep. of, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka, Thailand, Viet Nam, Indonesia; China is defined to be China and China (Hong Kong).

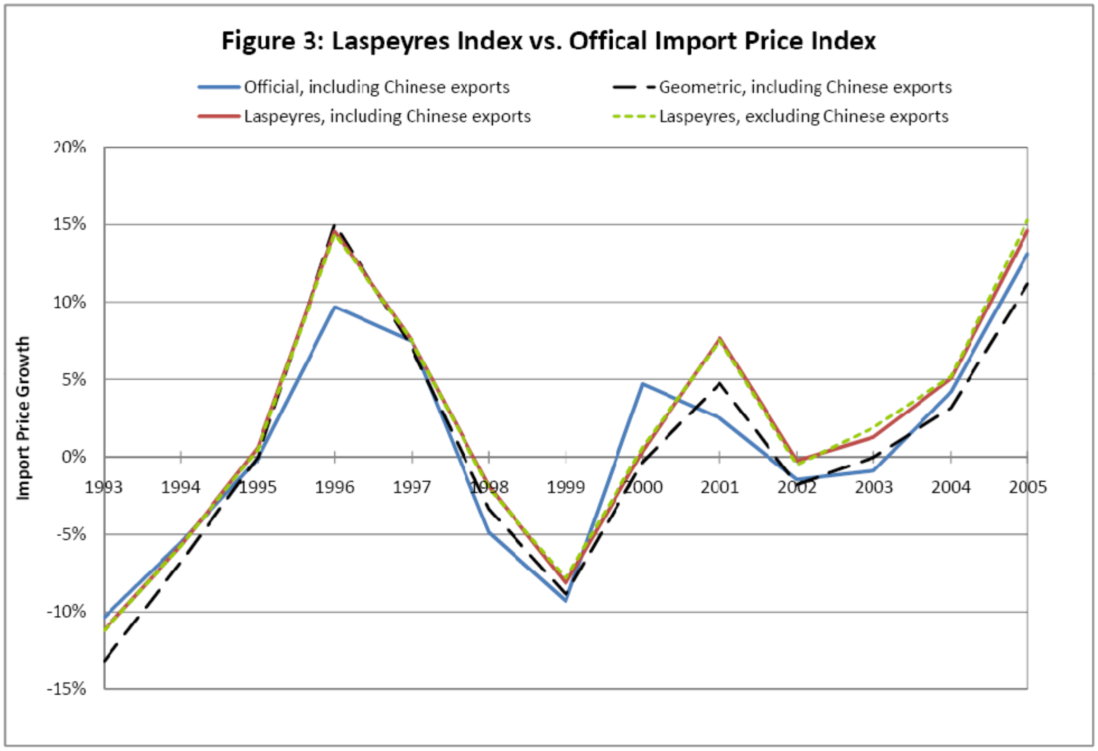
Figure 3: Laspeyres Index vs. Offical Import Price Index
Official, including Chinese exports
Geometric, including Chinese exports
Laspeyres, including Chinese exports
Laspeyres, excluding Chinese exports
Import Price Growth
20%
15%
10%
5%
0%
-5%
-10%
-15%
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

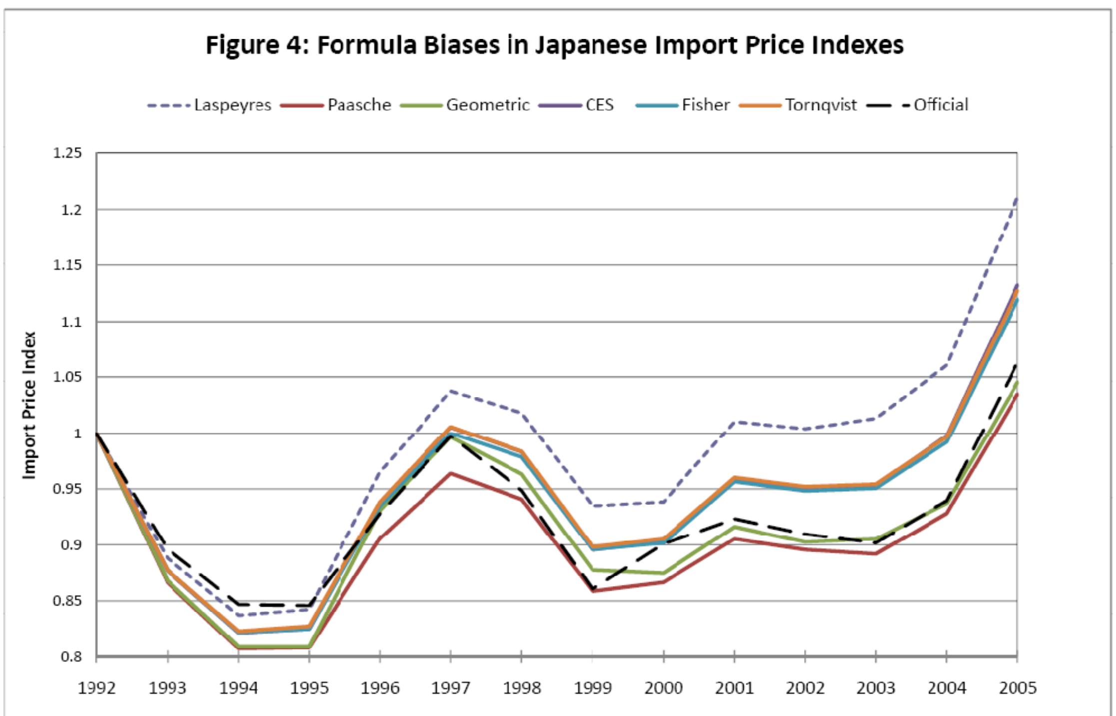
Figure 4: Formula Biases in Japanese Import Price Indexes
Laspeyres
Paasche
Geometric
CES
Fisher
Tornqvist
Official
Import Price Index
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.85
0.8
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005

Figure 5: Mean Residuals for Goods Exported to Japan in All Years from 1992 to 2005
Top 9 Exporters to Japan in 1992 (Excluding OPEC Countries)

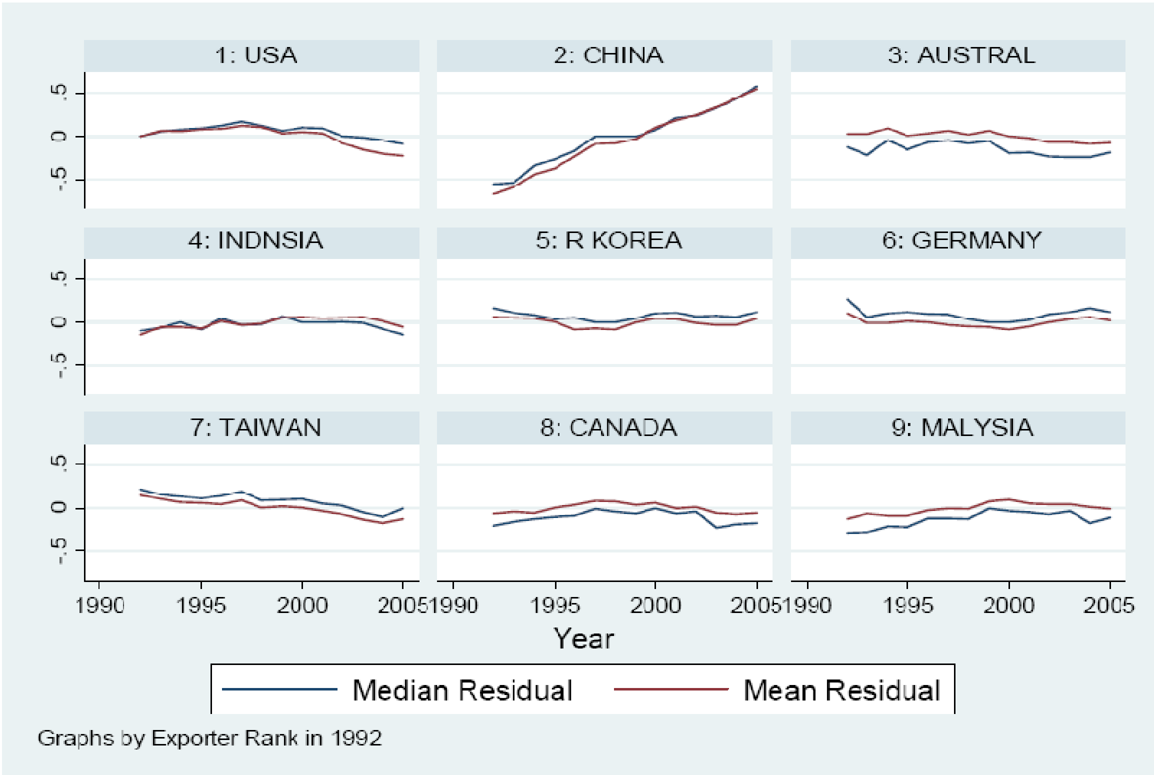

Table 1: Ranking in Terms of Goods Imported by Japan

Country	Ranking in Year: 1992	1995	2000	2005	Change 1992-2005
USA	1	1	1	2	-1
CHINA	2	2	2	1	1
AUSTRAL	3	4	7	5	-2
INDNSIA	4	6	5	7	-3
R KOREA	5	3	3	6	-1
GERMANY	6	7	10	9	-3
SU ARAB	7	12	9	3	4
U ARB E	8	10	6	4	4
TAIWAN	9	5	4	8	1
CANADA	10	8	12	14	-4
MALYSIA	11	9	8	11	0
THAILND	12	11	11	10	2
FRANCE	13	15	16	15	-2
U KING	14	13	14	19	-5
ITALY	15	16	19	18	-3
SWITZLD	16	18	23	24	-8
SNGAPOR	17	14	15	20	-3
BRAZIL	18	19	25	26	-8
IRAN	19	23	18	13	6
RUSSIAN	20	17	21	21	-1
PHILPIN	21	20	13	16	5
QATAR	22	31	17	12	10
HG KONG	23	25	36	39	-16
INDIA	24	22	29	28	-4
OMAN	25	34	33	29	-4

Table 2: Share of Total Japanese Imports
of the Top 25 Exporters in 1992

Country	Share of Japanese Imports in Year: 1992	1995	2000	2005	Change 1992-2005
USA	0.224	0.224	0.190	0.124	-0.100
CHINA	0.073	0.107	0.145	0.210	0.138
AUSTRAL	0.053	0.043	0.039	0.048	-0.006
INDNSIA	0.052	0.042	0.043	0.040	-0.012
R KOREA	0.050	0.051	0.054	0.047	-0.002
GERMANY	0.046	0.041	0.034	0.035	-0.012
SU ARAB	0.044	0.029	0.037	0.056	0.012
U ARB E	0.042	0.030	0.039	0.049	0.007
TAIWAN	0.041	0.043	0.047	0.035	-0.006
CANADA	0.033	0.032	0.023	0.017	-0.016
MALYSIA	0.028	0.031	0.038	0.028	0.000
THAILND	0.026	0.030	0.028	0.030	0.005
FRANCE	0.023	0.020	0.017	0.017	-0.007
U KING	0.021	0.021	0.017	0.013	-0.008
ITALY	0.018	0.019	0.014	0.013	-0.005
SWITZLD	0.014	0.012	0.009	0.010	-0.004
SNGAPOR	0.013	0.020	0.017	0.013	0.000
BRAZIL	0.012	0.012	0.008	0.009	-0.004
IRAN	0.011	0.008	0.014	0.020	0.009
RUSSIAN	0.010	0.014	0.012	0.012	0.002
PHILPIN	0.010	0.010	0.019	0.015	0.005
QATAR	0.009	0.006	0.015	0.021	0.011
HG KONG	0.009	0.008	0.004	0.003	-0.006
INDIA	0.009	0.009	0.007	0.006	-0.003
OMAN	0.008	0.006	0.005	0.005	-0.003

Table 3: Variety in Japan's Imports (1992 - 2005)

	Year	Total number of varieties (country-good pairs)	Median number of exporting countries	Average number of exporting countries	Share of total U.S. imports in year
All 1992 goods	1992	71666	15.0	17.0	1.00
All 2005 goods	2005	94707	19.0	22.2	1.00
Common 92-05	1992	58641	15.0	17.4	0.67
Common 92-05	2005	75519	21.0	23.2	0.69
1992 not in 2005	1992	13025	12.0	15.1	0.33
2005 not in 1992	2005	19188	15.0	18.2	0.31

Table 4: Country Contribution to Growth in Japanese Varieties

	1992-1998		1999-2005		1992-2005	
Country	Contribution	Average Share of Japanese Imports	Contribution	Average Share of Japanese Imports	Contribution	Average Share of Japanese Imports
CHINA	9.3%	10.5%	11.8%	17.8%	11.2%	14.2%
VIETNAM	5.3%	0.5%	6.6%	0.8%	6.2%	0.6%
THAILND	4.0%	2.8%	4.9%	3.0%	4.6%	2.9%
INDIA	3.2%	0.9%	5.1%	0.6%	4.4%	0.7%
INDNSIA	4.8%	4.6%	2.6%	4.2%	4.3%	4.4%
R KOREA	4.2%	4.7%	2.7%	4.9%	4.2%	4.8%
PHILPIN	3.6%	1.2%	1.5%	1.8%	3.0%	1.5%
MALYSIA	3.5%	3.1%	1.4%	3.4%	2.9%	3.3%
MEXICO	2.9%	0.5%	2.4%	0.5%	2.7%	0.5%
ITALY	2.3%	1.8%	3.3%	1.5%	2.6%	1.7%
SPAIN	2.4%	0.4%	2.7%	0.4%	2.5%	0.4%
BELGIUM	2.4%	0.6%	2.3%	0.5%	2.2%	0.5%
ISRAEL	2.3%	0.3%	1.5%	0.2%	1.9%	0.3%
BRAZIL	0.7%	1.1%	4.0%	0.8%	1.9%	1.0%
CANADA	3.4%	3.1%	-0.3%	2.1%	1.8%	2.6%
AUSTRAL	2.4%	4.7%	-0.1%	4.2%	1.4%	4.4%
AUSTRIA	1.3%	0.3%	1.7%	0.3%	1.3%	0.3%
FINLAND	1.8%	0.3%	1.0%	0.3%	1.3%	0.3%
TAIWAN	1.8%	4.0%	0.8%	4.0%	1.2%	4.0%
NETHLDS	1.8%	0.6%	-0.2%	0.5%	0.9%	0.6%
FRANCE	2.2%	2.0%	-0.5%	1.8%	0.9%	1.9%
RUSSIAN	0.1%	1.2%	2.2%	1.2%	0.8%	1.2%
DENMARK	0.9%	0.6%	1.4%	0.6%	0.8%	0.6%
S AFRCA	0.7%	0.8%	1.4%	0.9%	0.7%	0.8%
U ARB E	0.7%	3.5%	0.7%	3.8%	0.7%	3.6%
SNGAPOR	1.1%	1.7%	-0.5%	1.5%	0.7%	1.6%
NEWZELD	0.6%	0.7%	0.7%	0.6%	0.7%	0.6%
PERU	0.5%	0.1%	0.6%	0.1%	0.6%	0.1%
ARGENT	0.1%	0.2%	1.1%	0.1%	0.5%	0.1%
SWEDEN	0.8%	0.7%	-0.2%	0.6%	0.5%	0.6%
IRAN	0.5%	1.0%	0.2%	1.6%	0.5%	1.3%
NORWAY	1.2%	0.3%	-0.8%	0.3%	0.5%	0.3%
CHILE	0.3%	0.8%	0.5%	0.8%	0.4%	0.8%
IRELAND	1.4%	0.6%	-0.5%	0.9%	0.4%	0.8%
COLMBIA	0.3%	0.1%	0.2%	0.1%	0.3%	0.1%
PAKISTN	0.3%	0.2%	0.4%	0.1%	0.2%	0.1%
PRTRICO	0.2%	0.1%	0.0%	0.2%	0.2%	0.2%
GERMANY	0.9%	4.0%	0.1%	3.6%	0.1%	3.8%
U KING	2.0%	2.1%	-1.5%	1.6%	0.1%	1.9%
OMAN	0.2%	0.6%	0.0%	0.6%	0.1%	0.6%
BRUNEI	0.1%	0.5%	0.0%	0.4%	0.1%	0.4%
QATAR	0.0%	0.8%	0.1%	1.6%	0.1%	1.2%
KUWAIT	0.2%	0.8%	-0.2%	1.2%	0.1%	1.0%
PAP NGA	-0.1%	0.2%	0.2%	0.1%	0.1%	0.1%
NIGERIA	0.1%	0.0%	0.0%	0.2%	0.0%	0.1%
SU ARAB	0.4%	3.3%	-0.4%	3.8%	0.0%	3.6%
VENEZLA	0.0%	0.1%	-0.1%	0.1%	0.0%	0.1%
USA	2.1%	22.8%	-2.9%	16.8%	-0.1%	19.8%
SWITZLD	-0.3%	1.1%	1.1%	1.0%	-0.2%	1.1%
HG KONG	-0.5%	0.8%	-0.7%	0.4%	-0.8%	0.6%

Note: Countries are ranked by average share of Japanese imports from 1992 to 2005.

Table 5: Formula Biases of Import Price Indexes

	Laspeyres	Paasche	Geometric	CES	Fisher	Official
Median Bias of Index Relative to Tornqvist	0.4	-0.6	-0.7	0.0	-0.1	-0.6
Standard Dev. of Measurement Error	0.6	0.6	0.8	0.2	0.1	2.1

Table 6: Regressions of Prices and Price Variation Against a Dummy Variable Indicating China's Presence in the Market

	Unweighted Regressions				Weighted by Share in Year or Average Share in Both Years			
Dependent Variable:	$LN(P_{92})$	$LN(P_{05})$	$LN(P_{05}/P_{92})$	P_{05}/P_{92}	$LN(P_{92})$	$LN(P_{05})$	$LN(P_{05}/P_{92})$	P_{05}/P_{92}
China Dummy	-0.92	-1.04	0.013	0.014	-0.413	-0.948	0.056	0.048
	[0.021]	[0.018]	[0.012]	[0.014]	[0.012]	[0.008]	[0.008]	[0.009]
Observations	63690	86766	25423	25423	63690	86766	25423	25423
9 digit HS Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.8	0.77	0.22	0.22	0.97	0.95	0.60	0.61

Standard errors in brackets

Table 7: Fixed Effects Regressions of Year-on-Year Log Price Change of Non-Chinese Exports to Japan Against Dummy Variables Indicating China's Entry or Exit from the Market (1992-2005)

China Entry$_t$	-0.008	-0.004	-0.002	-0.006	-0.002	0.000
	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]
China Exit$_t$	-0.004	-0.004	-0.004	-0.002	-0.004	-0.004
	[0.003]	[0.004]	[0.004]	[0.004]	[0.004]	[0.005]
China Entry$_{t-1}$		0.000	0.001		0.006	0.006
		[0.004]	[0.004]		[0.004]	[0.004]
China Exit$_{t-1}$		0.000	0.003		0.002	0.003
		[0.004]	[0.004]		[0.004]	[0.005]
China Entry$_{t-2}$			0.002			0.004
			[0.004]			[0.004]
China Exit$_{t-2}$			-0.004			-0.001
			[0.004]			[0.004]
Constant	-0.006	0.001	0.009			
	[0.001]	[0.001]	[0.001]			
Observations	89717	79317	70200	89717	79317	70200
Number of Years	13	12	11	13	12	11
Number of Year-HS Code Combinations	0	0	0	15500	14123	12798
R-squared	0.00	0.00	0.00	0.00	0.00	0.00

Standard errors in brackets

Table 8: Distribution of Lambda Ratios and Sigmas

Percentile	Lamda Ratio	Sigma
1%	0.07	1.25
5%	0.35	1.48
10%	0.57	1.64
25%	0.84	2.07
50%	0.96	2.93
75%	1.03	4.76
90%	1.27	11.43
95%	1.68	25.03
99%	5.18	108.19
N. Obs.	1074	1074