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Chapter Author: Richard C. Marston

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4 Price Behavior in Japanese and U.S. Manufacturing

Richard C. Marston

In the past 20 years, the manufacturing sectors in Japan and the United States have undergone major transformations. Both countries have experienced technological changes that have shifted production from traditional sectors, such as textiles and steel, to more sophisticated products. At the same time, the relative position of the two countries has changed substantially because Japan's aggregate productivity growth has exceeded U.S. productivity growth by a large margin. Japan has replaced the United States as the leading exporter in one product after another despite the fact that over the period as a whole the yen has appreciated in value. During this period of rapid change, the two countries have been continually buffeted by exchange rate fluctuations that have shifted one country's costs relative to the other's. Although these fluctuations are often soon reversed, in the meantime they disrupt normal trading relationships between two countries. Thus productivity growth and exchange rate fluctuations have combined to produce major changes in the relative competitiveness of the two countries' manufacturing sectors. This study attempts to explain some of these changes.

Most studies of international competitiveness in manufacturing rely on aggregate price comparisons even though there are many changes in relative prices at the sectoral level.[1] Productivity growth varies widely across sectors of manufacturing, with higher productivity growth holding down price in-

Richard C. Marston is professor of finance and economics at the Wharton School of the University of Pennsylvania and a research associate of the National Bureau of Economic Research.

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1. Even studies of purchasing power parity that distinguish between traded and nontraded goods, such as Balassa (1964) and Officer (1976), fail to look at individual sectors of manufacturing.

creases in some sectors relative to others. In Japan's electrical manufacturing sector, in fact, productivity growth is so high that Japan's prices in that sector have remained competitive despite the sizable real appreciation of the yen. Many studies of competitiveness, moreover, examine broad trends in relative prices over a decade or more without examining how manufacturing firms cope with short-run changes in exchange rates. Studies of purchasing power parity (PPP) have suggested that exchange rate changes induce large changes in relative prices in the short run.[2] But only recently have economists examined how firms set prices in the short run in response to changes in exchange rates. Such studies emphasize pass-through and pricing-to-market behavior in attempting to understand why price changes occur at different rates depending upon the manufacturing sector.[3]

This paper uses sectoral data for Japanese and U.S. manufacturing to study secular trends in relative prices between the two countries. Because productivity growth varies widely across manufacturing sectors as well as between countries, the prices of U.S. goods relative to Japanese goods change at widely different rates depending upon the sector of manufacturing. The first section of the paper examines these secular changes in prices. Then the paper turns to short-term changes in relative prices induced by fluctuations in exchange rates. Two types of price changes are distinguished depending upon the degree to which the exchange rate fluctuations are sustained. The last section of the paper then examines how manufacturing firms cope with exchange rate fluctuations. Using sectoral data for export and domestic prices, the paper examines pass-through and pricing-to-market behavior. In each country, a period of currency appreciation is studied to determine whether firms in that country follow pricing practices designed to neutralize the effects of appreciation on their relative competitiveness.

4.1 Principal Determinants of Relative Competitiveness

The relative competitiveness of manufacturing in Japan and the United States depends primarily on two factors: secular trends in productivity and changes in relative prices driven by variations in exchange rates. Over periods of a decade or more, trends in productivity can lead to relatively large changes in relative prices within the manufacturing sector as well as between countries. But in the shorter run, changes in exchange rates exert a dominating influence on relative prices between countries. This is true whether relative prices are measured month to month or over periods as long as three to five years. This section of the paper will compare secular trends with these shorter term movements in relative prices.

2. See, e.g., studies of PPP by Kravis and Lipsey (1978) and Frenkel (1981).
3. Recent studies of currency pass-through and pricing to market include Baldwin (1988), Cumby and Huizinga (1989), Feenstra (1987), Froot and Klemperer (1988), Giovannini (1988), Hooper and Mann (1989), Knetter (1989), Mann (1986), Marston (1990), and Ohno (1989).

4.1.1 Secular Trends in Competitiveness

In the past two decades there has been a major shift in production within manufacturing in both countries. These shifts have been accompanied by surprisingly large changes in relative prices, both across industries within each country and between countries in the same industry. Just how large these shifts in production have been can be indicated by a few examples. In 1970, 29.6 percent of Japanese manufacturing output (GDP in manufacturing) was in the machinery and equipment sectors (which include electrical machinery and transport equipment).[4] By 1986 that share had risen to 51.5 percent. In the United States, machinery and equipment already constituted 40.2 percent of output in 1970. But by 1986, that share had grown to 50.2 percent of output. During this same period, Japanese textile production fell from 5.3 percent of manufacturing output to 2.6 percent. In the United States, textile production fell less than in Japan, but basic metal production fell from 10.1 percent to 4.7 percent.

These shifts of production were accompanied by large changes in relative prices. In the period from 1975 to 1987, Japanese producer prices in manufacturing rose by 18.2 percent.[5] But *within* manufacturing, the price changes varied widely from sector to sector. In the metal products sector, prices rose by 22.8 percent, but in the electrical machinery sector, prices *fell* by 15.1 percent. In the United States, the range of variation was also large, though less dramatic. In the U.S. chemical industry, for example, prices rose by 13.8 percent less than in manufacturing as a whole (48.7 percent vs. 62.5 percent).

When relative prices change substantially, measures of competitiveness based on aggregate price indexes can be very misleading. In some industries, a country may experience major changes in the prices of its goods relative to those of other countries even though aggregate real exchange rates between the two countries are stable. The country might gain competitiveness in some industries while losing competitiveness in others.

In the long run at least, changes in relative prices occur primarily because of changes in the cost of producing goods. Although wages can grow at different rates across industries, and some industries can experience greater increases in materials costs than others, the primary reason why costs grow at different rates across industries is that productivity gains vary widely across those industries. In industries producing electrical machinery, for example, productivity growth might be two or three times as fast as in manufacturing as a whole. As a result, the inflation rate for the electrical machinery sector is much lower than in manufacturing as a whole or in most other sectors.

If a country experiences large internal relative price changes, it might be

4. The percentage shares are calculated from real GDP data published in the OECD, *National Accounts*.

5. The price changes are calculated from producer price indexes published in the OECD, *Indicators of Industrial Activity*.

able to remain competitive in particular industries even if its currency appreciates in real terms (as measured by broad-based price indexes). In that case the change in competitiveness would be apparent only if real exchange rates were defined for individual industries. To define such sectoral real exchange rates, let R_i be the log of the real exchange rate in sector i for Japan relative to the United States. Then

$$R_i = P_i^* + S - P_i, \tag{1}$$

where P_i^* and P_i are the producer price indexes for sector i in the United States and Japan, respectively, and S is the ¥/$ spot exchange rate (all variables being expressed in logs). As defined, a rise in this real exchange rate represents a real appreciation of the dollar and a loss of competitiveness for the United States in that sector or industry.

Figure 4.1 reports percentage changes in sectoral real exchanges between the United States and Japan over the period 1975–87.[6] At the center of the figure is the percentage change for manufacturing as a whole; over this 12-year period, the dollar depreciated a total of −27.7 percent (most of the depreciation occurring at the end of the period). This depreciation, however, was exceeded in four of the industries illustrated, with the largest depreciations over 40 percent in metal products and textiles. At the other extreme, the United States lost competitiveness in one sector, electrical machinery; in that sector, U.S. prices rose by 4.9 percent relative to Japanese prices. The real exchange rate rose for electrical machinery primarily because of high productivity growth in Japan's electrical machinery sector. Japanese firms in that sector were able to lower costs sufficiently to keep prices competitive despite the real appreciation in manufacturing as a whole. In the motor vehicle sector, U.S. prices fell relative to those in Japan, but only by 4.8 percent. As in the electrical machinery sector, the differential growth in productivity kept Japanese prices from rising much in dollar terms. In two other sectors, general machinery and nonferrous metals, the real appreciation of the yen was also smaller than in manufacturing as a whole.[7] Thus trends in productivity introduced considerable variation in real exchange rates across sectors.

7.1.2 Effects of Exchange Rate Variability

The overall trend in real exchange rates for manufacturing as a whole is governed by macroeconomic factors. Productivity performance in a particular

6. The complete titles of the sectors are provided in table 4.1 below. The percentage changes are measured as changes in the logs of the real exchange rates between the years 1975 and 1987. The underlying price data are from the OECD, *Indicators of Industrial Activity* (WEFA data base), and the U.S. Department of Commerce, *Business Conditions Digest* (for the motor vehicle PPI for the United States). The exchange rates are from the International Monetary Fund's *International Financial Statistics* (WEFA data base).

7. The 27.7 percent real depreciation for manufacturing as a whole overstates the actual gain in competitiveness for the United States, since Japanese exports are concentrated in sectors like electrical machinery and motor vehicles where Japan has remained competitive despite the nominal appreciation of the yen.

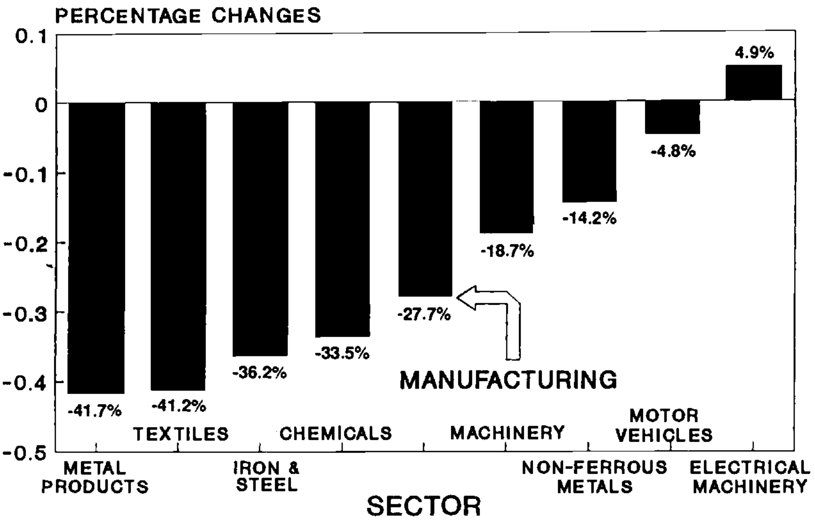

Fig. 4.1 Sectoral real exchange rates changes in real exchange rates, 1975–87

sector can *mitigate* the effects of this overall trend in real exchange rates but cannot insulate that sector from exchange rate developments. The relative competitiveness of countries is even more sensitive to exchange rate movements in the short run than in the long run.

Two types of exchange rate movements can be distinguished in the data. The first type is day-to-day or month-to-month *volatility.* Because exchange rates are determined primarily by financial transactions, they exhibit the same variability that is characteristic of prices in financial markets. The second type of exchange rate movement is longer in duration, typically lasting from three to five years. These medium-term swings in nominal exchange rates, referred to as *misalignments,* can lead to changes in real exchange rates by over 40 percent, as they did in the case of the pound sterling in the early 1980s and in the case of the dollar in the mid-1980s. Each type of exchange rate variability is considered in turn.

Volatility

The volatility of exchange rates has been assessed in previous studies by comparing the variances of exchange rates with the variances of goods prices, on the one hand, and financial asset prices, on the other hand. In Marston (1988), for example, the variances of exchange rates for the major industrial countries are shown to be far greater than the variances of goods prices as measured by the wholesale price index and are comparable in magnitude to the variances of asset prices. But such a comparison fails to show clearly enough the extent to which the volatility of exchange rates breaks the link between the prices of identical or similar goods originating in different countries. If exchange rates were stable, the prices of similar goods from different countries would be closely related when expressed in a common currency unless international trade barriers inhibited international competition. But under flexible exchange rates, highly volatile exchange rates are used to convert goods prices into foreign currencies, so the prices of these goods may fluctuate substantially relative to the prices of goods originating in foreign countries.

This study uses prices disaggregated to the sectoral level in manufacturing to examine the following question: Has the randomness of flexible exchange rates so reduced the integration of different national markets in any one sector of manufacturing that internal price adjustment *between* sectors is more complete than external price adjustment in the same sector? In that case prices in sector *i* in the United States would be more closely linked to those in sector *j* in the United States than those in sector *i* in Japan. That is, the random movement in nominal exchange rates would have made the prices of American "apples" more closely linked to those of American "oranges" than to those of Japanese "apples."

To compare internal with external price adjustment, month-to-month variations in producer price indexes are examined over the 1975–87 period. In the case of internal prices, the correlations are between prices in industry *i* and manufacturing prices as a whole. In the case of external prices, the correlations are between prices in industry *i* in Japan and those in industry *i* in the United States. The prices in industry *i* in Japan are converted into dollars before calculating the correlation coefficients. Table 4.1 reports the correlations by industry for the two countries. For each country, internal price corre-

Table 4.1 Internal and External Price Correlations, 1975–87, Monthly PPI

	$r(i,m)$		
Sector	United States	Japan	$r(i,i^*)$
Textiles, clothing, and leather	.47*	.36*	−.12
Industrial chemicals	.57*	.80*	.06
Iron and steel	.39*	.52*	−.02
Nonferrous metals	.35*	.46*	.55*
Metal products	.44*	.46*	.00
Machinery (except electrical)	.56*	.54*	−.07
Electrical machinery	.59*	.47*	−.06
Motor vehicles	.33*	.02	.02

Sources: OECD, *Indicators of Industrial Activity* (WEFA data base); U.S. Department of Commerce, *Business Conditions Digest* (for the motor vehicle series for the United States).

Note: $r(i,m)$: correlation between (percentage) changes in prices in sector *i* and in manufacturing as a whole; $r(i,i^*)$: correlation between changes in U.S. prices in sector *i* and Japanese prices in sector *i*, where both prices are expressed in dollars.

*Indicates that correlation is significantly greater than zero at the 5 percent level.

lations are reported first. Then external price correlations are reported between prices in Japan (expressed in dollars) and the corresponding sectoral prices in the United States.

In both countries, correlations between *internal* prices are generally quite high. In the case of the United States, for example, the correlations between sectoral prices and prices in manufacturing range from 0.33 to 0.59. In the case of Japan, the correlations range from 0.36 to 0.80 except in the motor vehicle sector, where the correlation is only 0.02. Of the 16 internal price correlations for the two countries, all but one is significantly greater than zero at the 5 percent level. The correlations are high primarily because there are common cost factors influencing all sectors of manufacturing in any economy. Changes in wages, for example, tend to be highly correlated across sectors. Changes in energy prices and raw materials prices affect all sectors simultaneously, although these price changes have greater impact on some sectors than others. The demand side of the economy may also help to keep the correlations high, although substitutibility between products from different manufacturing sectors should be much smaller than between products of the same sector produced in different countries.

The *external* correlations are almost invariably smaller than the corresponding internal correlations for the same sector. This should not be surprising given the well-known variability of nominal exchange rates over periods as short as one month. In eight of the sectors, the correlations across countries range from −0.12 in textiles, clothing, and leather to 0.06 in industrial chemicals. In only one sector is the correlation between Japanese and U.S. prices higher than between that sector's prices and prices in manufacturing as a whole. In the nonferrous metals sector the external price correlation is surprisingly high at 0.55. Unlike other products, the prices for nonferrous metals seem to be determined in internationally integrated markets. All other external price correlations are statistically insignificant at the 5 percent level.

The general conclusion must be that exchange rate volatility imparts so much variability to the prices of these countries' goods in foreign currency that it disrupts the links between the prices of similar goods across countries. Yet if it were the case that changes in relative prices across countries had no discernible trends, manufacturing firms could learn to cope with this type of variability, just as they cope with other forms of uncertainty. On the other hand, if exchange rate movements persist in one direction or another over the medium term, adjustment by firms is much more difficult. That is the case with misalignments of exchange rates.

Misalignment

The term "misalignment" refers to medium-term swings in real exchange rates away from long-run equilibrium. Thus misalignments involve real rather than nominal exchange rates, and medium-term rather than short-term changes in exchange rates. Not all swings in real exchange rates are necessarily misalignments, since real disturbances such as supply shocks can lead to changes in equilibrium real exchange rates. For example, the appreciation of sterling in the late 1970s has been attributed, at least in part, to the discovery of oil and gas in the North Sea. But the swings in the dollar relative to the yen (as well as other currencies) have been so large that it is difficult not to regard them as misalignments, especially in the absence of any real disturbances affecting the dollar comparable to the North Sea discovery.[8]

The swings in real exchange rates from one extreme to another are at least as large as the long-run trends previously discussed. Table 4.2 measures the swings in the dollar relative to the yen from the trough of the dollar in 1978 to its peak in 1984 and then to the end of the period in 1987. The figures are based on average exchange rates and prices in these three years. According to the table, the real exchange rate of the dollar rose by 35.7 percent from 1978 to 1984 in manufacturing as a whole. Then the dollar fell sharply by 41.7 percent in the following three years ending in 1987. Similar swings were experienced in each of the sectors of manufacturing, although in the nonferrous metals sector, the swing was only half as large. In the last two sectors, electrical machinery and motor vehicles, the underlying trends in real exchange rates led to a larger real appreciation of the dollar in the earlier period than in manufacturing as a whole and a smaller real depreciation in the later period.

The large swings experienced across manufacturing can hardly be attributed solely to changes in long-run equilibrium exchange rates. Instead, these swings must have involved substantial misalignments of exchange rates. And even to the extent that equilibrium rates changed, manufacturing firms still had to cope with changing relative prices requiring many forms of adjustment.

Defensive Actions by Firms

A firm may have difficulty coping with misalignments because it knows neither the size nor the duration of any swing in real exchange rates. The firm's exports rise and fall with real depreciations and appreciations. And so also do the firm's employment and production at home. In response to a real appreciation, the firm may elect to transfer production abroad. But since the duration of the real appreciation is usually unknown, the firm may find that its transfer of production abroad is accomplished only after the home currency begins depreciating back to normal levels.

An alternative strategy is to follow pricing policies designed to keep the firm competitive in foreign markets despite an appreciation of the home currency. Partial "*pass-through*" refers to the case where the firm increases the *foreign currency* price of its exports less than the appreciation of the home currency. In order for pass-through to be partial, the firm must lower the domestic currency price of its exports. The firm may be able to lower the domestic currency prices of its goods simply because the appreciation lowers the

8. For further discussion, see Williamson (1985).

Table 4.2 Swings in Sectoral Real Exchange Rates between the Dollar and Yen (Based on Average Real Exchange Rates in Years Indicated)

Sector	% Movement in Dollar: Appreciation, 1978–84	% Movement in Dollar: Depreciation, 1984–87
Manufacturing	35.7	−41.7
Textiles, clothing, and leather	28.5	−37.8
Industrial chemicals	32.1	−38.9
Iron and steel	36.9	−41.0
Nonferrous metals	18.3	−22.4
Metal products	29.2	−43.2
Machinery (except electrical)	42.1	−42.8
Electrical machinery	52.7	−30.5
Motor vehicles	51.8	−39.6

Sources: See table 4.1.
Note: The percentage changes are measure as changes in the logs of the real exchange rates.

prices of imported materials and fuel. Thus partial pass-through may occur even though the firm charges the same price, in domestic currency, for goods sold to both export and domestic markets.

"*Pricing to market*," in contrast, is an active policy designed to defend the export market of the firm. Pricing to market occurs when the firm lowers the price of its exports in *domestic* currency *relative to* the price of goods for the domestic market.[9] The next section studies both of these pricing phenomena.

4.2 Pass-through and Pricing to Market

With the competitive position of exporting firms shifting so sharply in response to changes in exchange rates, it is not surprising that these firms take defensive actions. As suggested above, one of the primary ways firms defend their market position is by limiting the pass-through of exchange rates into the foreign currency prices of their exports. But by limiting pass-through, these firms may open a gap between the prices of products sold domestically and the prices of their exports expressed in domestic currency.

4.2.1 Different Types of Pricing Behavior by Firms

To be more precise about the behavior involved, it is necessary to distinguish between three prices (for the case of the Japanese good):

9. The terminology is due to Krugman (1987). Recent empirical studies of pricing to market include Froot and Klemperer (1988), Knetter (1989), Giovannini (1988) and Marston (1990).

P_{dit} = the price of product i in the domestic market (in yen);
P_{xit} = the price of product i in the export market, but expressed in *domestic* currency (in yen),
$P^{\$}_{xit}$ = the price of product i in the export market, but expressed in *foreign* currency (in dollars).

A firm faced with a large appreciation of the domestic currency may decide to charge different prices in the domestic and export markets. If the firm is Japanese, it will lower the yen price of its export (P_{xit}) in order to limit the rise in the dollar price of the export ($P^{\$}_{xit}$). So the pass-through of the exchange rate change is only partial.

Why should firms vary the price of an export relative to the price of the domestically sold good? This behavior can be rationalized by appealing to simple profit maximization. The appreciation of the domestic currency raises the marginal costs of the export (calculated in foreign currency) proportionally. If the markup of price over marginal cost were constant, the price of the export in foreign currency would also have to rise proportionally to the exchange rate. Under a wide range of demand conditions, however, a rise in the price of a good leads to a fall in the markup of price over marginal cost. So the price in foreign currency increases less than the rise in the marginal cost, and the pass-through is, therefore, only partial. With partial pass-through into the export price in foreign currency, the price of the export in domestic currency must fall relative to the price of the same good sold in the domestic market. So "pricing to market" occurs.

Other rationales have been offered for limited pass-through and pricing to market. Krugman (1987) shows that, in a model of Cournot oligopoly, the price of the export in foreign currency rises less than proportionally to the appreciation even when the demand curve has a constant elasticity. (If the demand curve has a constant elasticity, the markup is constant when there is a monopoly rather than oligopoly in the industry). Froot and Klemperer (1988) specify a dynamic model in which the future demand for a product depends on current market share. In that model, a firm facing an appreciation that it perceives to be temporary may limit increases in the prices of its exports in order to maintain market share for the future. So there are several reasons why firms might modify the degree of currency pass-through by pricing to market.

The degree of pass-through can be measured by the pass-through elasticity, β_i, defined as follows:

$$(2) \qquad \beta_i = \frac{dP^{\$}_{xit}/P^{\$}_{xit}}{dS_t/S_t} = \frac{dP_{xit}/P_{xit}}{dS_t/S_t} - 1 < 0.$$

This elasticity measures the percentage rise in the dollar export price in response to a 1 percent fall in the yen price of the dollar. If the pass-through is complete, the coefficient will be equal to minus one. With incomplete pass-through, in contrast, the coefficient will be between zero and minus one.

Pass-through effects are difficult to identify in practice because there are so many other factors that can change the prices of exports. Consider the example of the yen's appreciation beginning in the first quarter of 1985. Suppose that it is found that the appreciation led to increases in the prices of Japanese exports, measured in dollars, which were smaller than the change in exchange rates (measured as an absolute value). The pass-through may be incomplete because Japanese firms are pricing to market, lowering their export prices in yen relative to their domestic prices. But alternatively, the pass-through may be incomplete for reasons having nothing to do with defensive actions taken by Japanese manufacturing firms. It may be the case that Japanese costs of production fell because the prices of imported materials fell when the yen appreciated.[10] (The price index for imported commodities measured in yen fell in half between February 1985 and December 1988.) Or it may be the case that costs fell for reasons totally unrelated to the appreciation. In order to identify pass-through effects, it would be necessary to measure these cost factors for each of the sectors of manufacturing studied. Instead, this paper looks at pricing-to-market behavior where changes in costs are unlikely to be so important.

To determine how firms react to exchange rate changes, it is more useful to examine directly how firms change export prices *relative to* the domestic prices of the same product. Most countries do not report separate price indexes for domestic goods and exports, but Japan and the United States have developed export price indexes to match their producer price indexes for many of their important exports. This makes it possible to calculate pricing-to-market elasticities that directly measure the pricing behavior of these countries' firms.

The pricing-to-market elasticity involves the relative price of exports to domestic goods, or

$$X_{it} = P_{xit}/P_{dit}.$$

This elasticity measures the percentage change in this relative price in response to a 1 percent change in the real exchange rate, R_t:

$$\alpha_i = \frac{(dX_{it}/X_{it})}{(dR_t/R_t)}. \quad (3)$$

10. Consider the following equation relating (percentage changes in) the price of the export in yen to the markup of price over marginal cost, M_{xit}, and to marginal cost, C_{it}:

$$dP_{xit} / P_{xit} = dM_{xit} / M_{xit} + dC_{it} / C_{it}.$$

In response to the appreciation of the yen, the price of exports (in yen) could fall because markups are reduced, as a result of pricing to market, or because marginal costs fall.

The real exchange rate rather than the nominal exchange rate is used because nominal changes matched by offsetting changes in general price levels are unlikely to induce pricing-to-market behavior. If firms vary the relative price of exports to domestic goods, then the pricing-to-market elasticity will lie between zero and one. If firms do not price to market, then of course the coefficient is equal to zero.

The advantage of looking at the ratio of export to domestic prices rather than export prices alone is that changes in marginal costs are likely to have less influence on the former. That is, even though changes in marginal costs normally affect export prices and domestic prices individually, they need not affect the *ratio* of the two prices. As Marston (1990) shows, changes in marginal costs leave this ratio unaffected as long as the markups of prices over marginal costs in the export and domestic markets are equally sensitive to price changes.[11] In such cases, changes in the ratio of export to domestic prices can be attributed to exchange rate changes alone. Even if markups respond differently in the two markets, the price ratio changes only in proportion to the difference in the elasticities of the markups with respect to prices. So cost factors are not a major influence on the price ratio except to the extent that markup elasticities differ substantially in the export and domestic markets.

To illustrate the difference between pass-through effects and pricing to market effects, consider table 4.3, where the effects of a yen appreciation are illustrated for two cases. The first case is one in which the markup of prices over marginal costs is constant, so there is no pricing-to-market behavior. The pass-through of the appreciation of the yen into the dollar price of the export is only partial because marginal costs have fallen as demand for the export falls, thus permitting the yen price of the export to fall. Since there is no pricing-to-market behavior, the yen price of the export remains equal to the yen price charged in the domestic market.

The second case is one in which pricing to market breaks the link between the export price and domestic price. In response to the appreciation, exporting firms reduce the yen price of their exports relative to the domestic price of that same good. So there is again partial pass-through into the dollar price of the export, but this time the partial pass-through is due to changes in markups rather than just changes in marginal costs. It is this second case which is of particular interest.

11. If export and domestic prices are tied to the same marginal cost, but are influenced by different markup factors (M_{xit} and M_{dit}, respectively), then changes in X_{it} can be related to these markup factors as follows:

$$dX_{it} / X_{it} = dM_{xit} / M_{xit} - dM_{dit} / M_{dit}.$$

In order for marginal cost to affect X_{it}, it must have a greater impact on one markup than on the other. If the elasticities of these markups with respect to prices are equal, then X_{it} is unaffected by changes in marginal cost.

Table 4.3 Illustration of Pass-through and Pricing-to-Market Effects in Two Cases

Case 1: Partial pass-through, but no pricing to market (constant markup of prices over marginal costs; variable marginal costs)

	←	S_{it}	Yen appreciates
$-1 < \beta_i < 0$	P_{xit}/S_{it}	→	$ price of export rises less than proportionally
	←	P_{xit}	¥ price of export falls (marginal cost lower)
$\alpha_i = 0$	←	P_{dit}	¥ price of domestic good falls

Case 2: Pricing to market (variable markup of prices over marginal costs; variable marginal costs)

	←	S_{it}	Yen appreciates
$-1 < \beta_i < 0$	P_{xit}/S_{it}	→	$ price of export rises less than proportionally
	←	P_{xit}	¥ price of export falls
$0 < \alpha_i < 1$	←	P_{dit}	¥ price of domestic good falls (MC lower)

4.2.2 Evidence on Pass-through and Pricing-to-Market Behavior

In this section, Japanese and U.S. pricing behavior is studied in detail. For each country, pricing-to-market elasticities are calculated by comparing changes in the ratio of export to domestic prices with changes in exchange rates. For Japan, pass-through elasticities are also calculated in order to illustrate the difference between pass-through and pricing to market. For each country, a period of currency appreciation is studied because pricing-to-market behavior is more likely to be found when firms are losing competitiveness in export markets.

Japanese Pricing Behavior

For Japan, the period of appreciation begins at the peak of the dollar's rise in February 1985 and ends in December 1988. This period is long enough so that any observed changes in export prices measured in yen can be attributed to pricing decisions by Japanese firms rather than to the translation into yen of export prices set in dollars. (If export prices are set in dollars, then *unanticipated* changes in exchange rates can lead to variations in export prices translated into yen. But since export prices are unlikely to be set more than a few months ahead, observed changes in prices over the period studied must reflect equilibrium pricing decisions rather than translation effects.)

The Bank of Japan provides export and domestic prices for a number of sectors of manufacturing with significant exports. The export prices are free-on-board (FOB) prices for exports expressed in yen, while the domestic prices are those reported at the primary wholesale level for sale in Japan. Nine sectors are studied in this paper, ranging from textiles to precision instruments. The sectors are listed in table 4.4.

Although the United States accounts for a large share of Japanese exports in these sectors, the products are exported to a number of different countries. So the nominal and real exchange rates appearing in expressions (2) and (3) above should be *effective* exchange rates defined over prices and exchange rates for a number of countries that import Japanese products. The United Nations reports export shares by product in its *Commodity Trade Statistics*. Export shares for 1986 are used to form weights for *sector-specific* series for the nominal and real exchange rates. For example, there are nominal and real effective exchange rates for the textile sector based on export shares for textiles.

To form the nominal exchange rate series for each sector, the export shares for that sector are used to weight the corresponding bilateral exchange rates forming a nominal effective exchange rate for that sector (S_{it}). To form the real exchange rate for each sector (R_{it}), wholesale prices are first converted into dollars using monthly average exchange rates. When wholesale prices are not available, consumer prices are used instead. The series for prices and bilateral exchange rates are drawn from the International Monetary Fund, *International Financial Statistics*.[12] The real effective exchange rate is defined as the weighted average of foreign prices converted from dollars into yen and deflated by the Japanese wholesale price index. Twenty-three countries in all are represented in the exchange rate series.

Table 4.4 reports pass-through and pricing-to-market elasticities obtained by calculating the percentage changes in prices and exchange rates over the 34-month period from February 1985 to December 1988. (The percentage changes are calculated as the change in log values between the beginning and ending months).

The upper part of the table reports pass-through elasticities obtained by taking the ratio of the percentage change in the export price to the percentage change in the yen spot rate.[13] Notice first that the changes in nominal effective

12. In the case of Hongkong, export prices from WEFA's Inline Data Base are used in place of wholesale prices. In the case of Taiwan, the prices and exchange rates are drawn from the Taiwanese publication, *Financial Statistics*.

13. Since export prices are reported in yen rather than foreign currency, the table presents the percentage change in the yen price. As eq. (2) indicates, the pass-through elasticity can be obtained by subtracting one from the ratio of the change in the export price in yen to the change in the nominal exchange rate.

Table 4.4 Pass-through and Pricing-to-Market Behavior in Japan, February 1985 to December 1988

Pass-through Effects for Japanese Manufacturing

Sector	% Change: Export Price (in ¥)	% Change: Nominal Effective Exchange Rate	Pass-through Elasticity
Textiles	−25.8	−60.0	−.57
Chemicals	−47.8	−52.4	−.09
Iron and steel	−31.5	−63.0	−.50
Nonferrous metals	−10.4	−61.7	−.83
Metal products	−24.1	−60.9	−.60
General machinery	−20.8	−56.9	−.63
Electrical machinery	−45.0	−57.0	−.21
Transport equipment	−20.4	−63.3	−.68
Precision instruments	−15.4	−53.7	−.71

Pricing-to-Market Effects for Japanese Manufacturing

Sector	% Change: Export/Domestic Price	% Change: Real Effective Exchange Rate	Pricing-to-Market Elasticity
Textiles	−14.9	−37.5	.40
Chemicals	−34.9	−32.0	1.09
Iron and steel	−24.2	−41.6	.58
Nonferrous metals	−4.0	−42.6	.09
Metal products	−23.5	−38.6	.61
General machinery	−18.7	−34.6	.54
Electrical machinery	−22.4	−35.6	.63
Transport equipment	−16.5	−40.2	.41
Precision instruments	−13.2	−31.7	.41

Sources: See data appendix.

exchange rates are very similar across sectors, ranging from a 52.4 percent appreciation of the yen in the chemicals sector to a 63.3 percent appreciation in the transport equipment sector. Unlike in the case of the United States, all of the sectors studied have fairly similar export patterns. The changes in the export prices, in contrast, range widely from −10.4 percent in the nonferrous metals sector to −47.8 percent in the chemicals sector. The pass-through elasticities similarly range widely from one sector to another. In the chemicals sector, the pass-through is only 9 percent, while in the nonferrous metals sector it is 83 percent.

The interpretation of the pass-through elasticities is straightforward. In the case of textiles, for example, the elasticity of −0.57 means that a 10 percent appreciation of the yen leads to a rise in the export price in foreign currency by 5.7 percent. Since the nominal appreciation was 60.0 percent, the export price rose by 34.2 percent in foreign currency (a partial pass-through made possible by a decline in the export price in yen by 25.8 percent). As noted above, the low degree of pass-through in this and other sectors may reflect a reduction in markups by exporters, but it may also reflect reductions in costs that lower prices in the domestic as well as export markets.

The bottom half of the table reports pricing to market effects. In this case, price changes are compared with changes in real rather than nominal exchange rates. The first column of the table reports percentage changes in the ratio of export to domestic prices. Since both of these prices are expressed in yen, any change in the ratio is evidence of pricing to market. The changes range from only 4.0 percent in nonferrous metals to 34.9 percent in chemicals. To evaluate the size of these changes, it is necessary to form a pricing-to-market elasticity obtained by dividing the relative price change by the change in the real effective exchange rate. Changes in real effective exchange rates range from 31.7 percent in the precision instruments sector to 42.6 percent in the nonferrous metals sector. The pricing-to-market elasticities, in turn, range from 0.09 in nonferrous metals to 1.09 in the chemicals sector.

Consider the case of textiles again. An elasticity of 0.40 means that a 10 percent real appreciation of the yen is followed by a 4 percent fall in the ratio of export to domestic prices. In response to a real appreciation for that sector of 37.5 percent the ratio of export to domestic prices falls by 14.9 percent.[14] The fall in this ratio dampens substantially the increase in the foreign currency price of the exports.

In general, pricing to market plays a major role in Japanese manufacturing. In the three export sectors representing 70 percent of exports, general machinery, electrical machinery, and transport equipment, the pricing-to-market elasticities range from 0.41 to 0.63. So roughly one-half of the yen's real appreciation has been neutralized by changing export prices relative to domestic prices. In a fourth sector, chemicals, the pricing-to-market elasticity is a little over 1.0. In only one sector, nonferrous metals, is the elasticity negligible in size.

American Pricing Behavior

To examine pass-through and pricing to market in U.S. manufacturing, producer price indexes (PPIs) and export price indexes from the Bureau of Labor Statistics were used. These data are disaggregated by sectors like the Japanese data, but not all of the sectors have export prices. Neither textiles nor metal products have export prices for the period studied, and in place of separate

14. The table indicates that the export price for textiles expressed in yen falls by 25.8 percent. To determine how much the domestic price changes, simply subtract the percentage change in the export/domestic price ratio from the percentage change in the export price, since all variables are expressed in logs. Thus, for textiles, the percentage change in the domestic price is $-25.8\% - (-14.9\%) = -10.9\%$.

Table 4.5 Pricing-to-Market Behavior in the United States, December 1981 to December 1984 (except as indicated)

Sector	% Change: Export/Domestic Price	% Change: Real Effective Exchange Rate	Pricing-to-Market Elasticity
Chemicals (from March 1983)	−3.0	−11.3	.26
Primary metals (March 1982)	−12.5	−11.1	1.13
General machinery	−1.5	−18.9	.08
Electrical machinery	−3.9	−16.5	.23
Transport equipment	9.3	−6.3	−1.46
Precision instruments	−1.4	−21.1	.07

Sources: See data appendix.

series for iron and steel and for nonferrous metals, there is a single series for primary metals. Nonetheless, the most important sectors have export prices available, including chemicals, general machinery, electrical machinery, transport equipment, and precision instruments.[15] As in the case of Japan, series for effective exchange rates were developed based on U.S. export flows.

Because pricing-to-market behavior is more likely to emerge in a period when a currency appreciates rather than depreciates, U.S. behavior was examined over the three-year period prior to rather than following the dollar's peak in February 1985. Some export price series are available for shorter periods only, so the sample period December 1981 to December 1984 applies to only four out of the six sectors studied.[16]

Table 4.5 reports pricing to market elasticities for six manufacturing sectors. The elasticities are quite low with the exception of the one for primary metals. In the chemical sector, for example, the elasticity is 0.26, indicating that an 11.3 percent real appreciation of the dollar leads to a fall in the ratio of export to domestic prices by 3.0 percent. In four other sectors the pricing-to-market elasticities are even lower.

Two sectors have unusual price patterns. The high elasticity in the primary metals sector is probably attributable to the fact that this sector combines iron and steel and nonferrous metals, the latter having a highly volatile price. The negative pricing-to-market elasticity in the transport equipment sector is a reflection of the unusual pattern of auto trade between Canada and the United States. Notice that the 6.3 percent appreciation of the dollar is much smaller than in other sectors because of the relative stability of the Canadian dollar/U.S. dollar exchange rate. The movement of the export/domestic price ratio

15. There is no PPI for precision instruments, so the domestic inflation rate for electrical machinery had to be used in its place.

16. Export prices are available for the third month of each quarter only, so it was not possible to end the sample period in February 1985, the month that the dollar peaked in value.

in this sector is more a reflection of the particular auto models shipped between the United States and Canada than more general pricing behavior.

If these two sectors are ignored, pricing-to-market behavior appears to be less pronounced than in the case of Japan. In Japan, pricing-to-market coefficients are generally around 0.50, while in the United States, the coefficients are between 0.07 and 0.26.

To investigate U.S. pricing behavior further, more disaggregated (four-digit) data were obtained for three sectors where much of U.S. trade occurs: general machinery, electrical machinery, and precision instruments. In these three sectors, there are 10 four-digit products with both export and domestic PPI data available beginning in December 1982 or earlier. These 10 products are listed in table 4.6 together with the sample period for each product. (No disaggregated data were available for chemicals or primary metals over this period.) The table presents the percentage change in the ratio of export to domestic prices, the percentage change in the real effective exchange rate, and the pricing-to-market elasticity. For each product, the real effective exchange rate is defined for the corresponding two-digit sector.

The table shows that seven of the 10 products have pricing-to-market elasticities smaller than 0.30, three of which are even negative (though close to

Table 4.6 Pricing-to-Market Behavior in the United States, Products in the General Machinery, Electrical Machinery, and Precision Instrument Sectors

Products		Period[a]	% Change: Export/Domestic Price	% Change: Real Effective Exchange Rate	Pricing-to-Market Elasticity
3523	Farm machinery and equipment	D82–D84	1.4	−11.8	−.12
3533	Oil-field and gas-field machinery and equipment	D81–D84	−2.7	−18.8	.14
3537	Industrial trucks and tractors	D81–D84	−1.8	−18.8	.09
3546	Power driven hand tools	D81–D84	−5.1	−18.8	.27
3555	Printing trades machinery	D82–D84	.5	−11.8	−.04
3585	Refrigeration and heating equipment	D82–D84	−4.5	−11.8	.38
3643	Current-carrying wiring devices	D81–D84	−3.4	−16.5	.20
3651	Radio and TVs, phonographs, and related equipment	D81–D84	2.4	−16.5	−.15
3679	Electronic components NEC	J82–D84	−10.5	−10.4	1.02
3841	Surgical and medical instruments and supplies	J82–D84	−4.6	−13.9	.33

Sources: See data appendix.
[a]D = December; 82 = 1982; J = January, etc.

zero). Those products exhibit little if any pricing-to-market behavior. For example, in the case of product 3533, oil-field and gas-field machinery and equipment, the pricing-to-market elasticity is only 0.14; a real appreciation of the dollar by 18.8 percent leads to a fall in the ratio of export to domestic prices of only 2.7 percent. Three other products have larger elasticities, but only one product, miscellaneous electronic components, has an elasticity greater than 0.40 percent. So this table, based on disaggregated data, confirms the earlier evidence that U.S. firms appear to price to market less than Japanese firms.

Why do American firms price to market less than Japanese firms? It may be because pricing to market is more difficult for American firms to carry out without encouraging grey markets for the products. Third parties in the U.S. market may be better able to take advantage of arbitrage opportunities, which are created when different prices are charged for exports and domestic products. Or it may be because American firms have diversified their production facilities enough so that pricing to market is less necessary to preserve export markets. Many large American firms have production facilities in a variety of countries from which they can export, so an appreciation of the dollar may lead to a shift in export production from the United States to a plant or plants abroad. If this is the case, then the recent diversification of production facilities by Japanese firms may lead to less pricing to market there in the future.

4.3 Conclusion

This paper has provided a variety of evidence on pricing behavior in Japanese and U.S. manufacturing. Relative price movements are dominated by real factors such as productivity growth in the longer run, but, in the short-run, changes in exchange rates can disrupt normal relationships between prices.

Since 1975, the yen has appreciated relative to the dollar when measured in real terms using prices in the manufacturing sector as a whole. But the aggregate figures hide considerable variation in the relative performance of individual sectors of manufacturing. Japan has had such high productivity growth in one sector, electrical manufacturing, that the real appreciation has been reversed by the relative decline of Japanese prices in that sector.

These secular trends in relative competitiveness, however, are overshadowed by fluctuations in exchange rates in the short run. The paper has shown that the month-to-month volatility of exchange rates makes prices in the same sector less correlated across countries than prices in different sectors within either economy. Even medium-term movements in exchange rates have major effects on prices, since misalignments are large enough to offset any secular movements in relative prices.

Faced with swings in real exchange rates, firms adopt defensive measures to defend their export markets. The paper presents estimates of pricing-to-market elasticities that suggest that firms lower their export prices relative to their domestic prices in order to limit the effects of currency appreciations. There is evidence that firms in both countries pursue such pricing to market, but Japanese firms appear to change their export prices more than American firms.

Data Appendix
(for pass-through and pricing to market tables)

Japanese export prices and domestic prices: The export prices are FOB prices expressed in yen, while the domestic prices are those reported at the primary wholesale level for sale in Japan. The indexes are calculated using the Laspeyres formula. *Source:* Bank of Japan, *Price Indexes Annual,* various issues.

U.S. export prices and domestic prices: The export prices are from unpublished worksheets compiled by the U.S. Department of Labor, Bureau of Labor Statistics (BLS). The domestic prices are from the BLS's *Producer Price Indexes,* various issues.

Product-specific real effective exchange rates: For Japan, this is the ratio of the weighted average foreign price in yen to the Japanese wholesale price index (WPI). For the United States, it is the ratio of the weighted average foreign price in dollars to the U.S. WPI. The weights used in forming these series are export shares from the United Nations, *Commodity Trade Statistics,* 1986. The countries represented in the series were as follows: United States (in the Japanese series), Japan (in the U.S. series), Canada, Panama, Hong Kong, Korea, Singapore, Taiwan, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, Malaysia, India, Saudi Arabia, and Australia. The underlying price series are WPIs (monthly averages) for most countries, CPIs for France, Panama, Saudi Arabia, Malaysia, and Portugal. The exchange rates are monthly averages. Sources for prices and exchange rates: IMF, *International Financial Statistics,* except for Hong Kong and Taiwan. For Hong Kong, exchange rate and export price series were taken from WEFA's Intline Data Base. For Taiwan, exchange rate and wholesale price index series were taken from its *Financial Statistics.*

Product-specific nominal effective exchange rates (for Japan): These are weighted averages of nominal exchange rates using same weights as the real effective exchange rate series above.

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Comment Catherine L. Mann

Marston's paper contributes in three ways to the literature on international pricing behavior. The first section of the paper bolsters the argument that issues relating to international competitiveness cannot be discussed without reference to disaggregated data. The second section raises the ante in policy discussions about exchange rate volatility and misalignments by arguing that exchange rate variability and the differential responsiveness of exporters to it is importantly responsible for changes in international competitiveness. The

Catherine L. Mann is an economist at the Federal Reserve Board.

third section gives an initial presentation of the important link between the pass-through (PT) literature and the pricing-to-market (PTM) literature and examines these coefficients for specific industries for both U.S. and Japanese exporters.

I will focus on the last section in my comment, developing the linkage between PT and PTM somewhat further analytically and showing that using both PT and PTM reveals more information about exporters' pricing behavior. The results of other empirical work are reexamined in light of this analysis. My comment concludes with a discussion of how different policy questions can be better answered using one, the other, or both methodologies.

Marston begins with a discussion of international competitiveness. He presents data that shows quite strikingly that aggregate data, even when aggregated only over manufactured goods, masks substantial changes in international competitiveness across different manufacturing sectors. Much discussion in policy circles of international competitiveness revolves around the state of key industries, those that offer "good jobs at good wages." Export-oriented U.S. industries apparently pay a wage premium over that expected based on qualifications alone.[1] Export-oriented industries accounted for less job growth in the United States in 1985 when the dollar was at its peak and increased their contribution to job growth in 1987 after the substantial depreciation. Remember that, in 1985, some policymakers (who measured international competitiveness using exchange-rate adjusted export prices at the industry level) decried the deindustrialization of America, while at the same time, other policymakers (looking at the aggregate dollar exchange rate) lauded the strong value of the dollar as indicative of the international attractiveness of the United States as a location for investment. Clearly, a balance of aggregate and industry-specific data is needed to develop a clear picture of U.S. international competitiveness.

The literatures on "pass-through" and "pricing to market" have existed somewhat separately, perhaps because the pass-through literature has a significantly longer history and one with less of the connotation of "strategic" pricing behavior than that which is associated with pricing to market. The two phenomena are closely related, however, as demonstrated below. Moreover, estimating and using both PT and PTM elasticities reveal more information about the pricing strategies of exporters.

Pass-through is usually defined as the coefficient of proportionality between an exporter's price expressed in destination currency terms (the mirror import price, expressed in home-currency terms) and changes in the nominal exchange rate. Equations (1*a*) and (1*b*) below develop the PT concept for exporters, using the variable conventions in Marston (dropping the i subscript).

1. See Lawrence F. Katz and Lawrence H. Summers, "Can Inter-industry Wage Differentials Justify Strategic Trade Policy?", *Trade Policies for International Competitiveness*, ed. Robert C. Feenstra (Chicago: University of Chicago Press, 1989), pp. 85–116.

Here, P_x is the exporter's own currency price for good i, C is its marginal cost, and M_x is its markup.

Dividing by the good-specific nominal exchange rate S yields the price of the export in destination-currency terms, $P_x^\$$. Taking the total derivative through yields a pass-through elasticity β, which will lie between 0 and -1.

$$(1a) \qquad P_x^\$ = P_x / S = C\, M_x / S,$$

$$(1b) \qquad d\ln P_x^\$ / d\ln S = \beta = d\ln P_x / d\ln S - 1.$$

The closer β is to -1, the greater the pass-through of an exchange rate change into the price of the good sold in the destination-market currency, and the less of a change in the export price in domestic currency terms. Little international data are available for bilateral trade flows, so we would not expect, even for individual products, that the elasticity with respect to the export price obtained from the exporter (P_x) to equal that elasticity with respect to the import price ($+1$) obtained from the importer ($P_x^\$$); the first incorporates flows to many destinations while the second incorporates flow from many sources. Nevertheless, there is a clear relationship.

However, interpreting this measure of pass-through as an estimate of the strategic change in markups associated with exchange rate movements is incorrect. Early investigations of pass-through, including mine in 1986, implied this, and Marston continues using this method in table 4.4, although he points out its faults. Equation (1c) shows that β is composed to two parts, only one of which measures "strategic" behavior. The other component measures how costs "naturally" change with exchange rate movements. Thus, β will be closer to zero the more costs change and "naturally" offset exchange rate movements.

$$(1c) \qquad \beta = d\ln C / d\ln S + d\ln M_x / d\ln S - 1.$$

Thus the direct calculation of β as the ratio of changes in export prices to nominal exchange rates overemphasizes "strategic" behavior to the extent that costs fall as the exporter's currency appreciates.

An alternative empirical approach can separate these two components. As shown in equation (2), a_2 is the least squares estimate of β when changes in the effect of costs on prices are accounted for (and measured by coefficient a_1).

$$(2) \qquad \ln P_{xt}^\$ = a_0 + a_1 \ln C_t + a_2 \ln S_t + \mu_t.$$

Most recent investigations of PT (including Hooper and Mann 1989, Baldwin 1988, and Knetter 1989; see references in Marston) use the least squares approach to estimating pass-through and therefore should not overestimate the effect of strategic effect of exchange rate changes on export prices.

By contrast, Marston defines the PTM elasticity as the coefficient of proportionality between the ratio of domestic and export prices expressed in local currency terms and changes in the real exchange rate.

$$\alpha = d\ln (P_x / P_d) / d\ln R, \tag{3a}$$

where P_x is the export price in local currency of good i, P_d its price in the domestic market, and R is the product-specific real exchange rate. Expanding (3a) and rearranging as (3b) isolates the components of α for easy comparison to the components of β shown in (1c).

$$\alpha = [(d\ln C_x - d\ln C_d) + (d\ln M_x - d\ln M_d)] / d\ln (S + P^{us} - P^{jp}), \tag{3b}$$

where the subscript x denotes the export and d denotes the product sold into the domestic market and $P^{us} - P^{jp}$ is the inflation differential used to form the real exchange rate from the spot rate.

Suppose that costs of producing for different markets move the same, then the important information imparted by movements in α is that the markups on domestic and export prices vary given any exchange rate movement. But from a policy standpoint, we really want to know how each markup is moving when the exchange rate changes, not just that there is evidence of price discrimination. Using the least squares estimate of pass-through shown in (3), and assuming that changes in real and spot exchange rates are the same (as has been suggested by aggregate data[2], although not corroborated by Marston's table 4.4), we can separate the two components of α and thus obtain information about exporter's pricing behavior in both home and foreign markets. Equation (4) shows the relationship between α and the components of the least squares estimates of PT.

$$\alpha = a_2 + 1 - \sigma, \tag{4}$$

where $\sigma = d\ln P / d\ln R$.

Since α and a_2 can be calculated and estimated, σ can be derived. Comparing $(a_2 + 1)$ and σ reveals which price (export or domestic) is changing more with exchange rate movements. Coefficient a_1 estimates the effect on export prices of changes in costs. Assuming the same cost structure yields estimates of the changes in domestic and export margins, given a change in the exchange rate.

The empirical examination of the data in Marston's paper does not give quite enough information to calculate the elasticity of the margins since he presents calculations of β, not estimated coefficients a_1 and a_2. Moreover, real and nominal exchange rates apparently have not moved by the same amount. However, suppose we retain the assumption that the elasticity of a producer's response to real or nominal exchange rate changes is the same. Suppose again that $\beta + 1$ is an adequate measure of $a_2 + 1$. Given these assumptions, σ can be calculated from the information in table 4.4.

2. See International Monetary Foundation, "Exchange Rate Volatility and World Trade," IMF Occasional Paper no. 28 (1984).

Sector	α	$\beta + 1$	σ
Textiles	.40	.43	.03
Chemicals	1.09	.91	−.18
Iron and steel	.58	.50	−.08
Non-ferrous metals	.09	.17	.08
Metal products	.61	.40	−.21
General machinery	.54	.37	−.17
Electrical machinery	.63	.79	.16
Transport equipment	.41	.32	−.09
Precision instruments	.41	.29	−.12

Given an appreciation of the yen, a positive $\beta + 1$ implies a reduction in the export price in yen terms, while a negative σ implies an increase in the domestic price of the product. These calculations suggest more than simple price discrimination across markets. These data suggest that for all industries except textiles, nonferrous metals, and electrical machinery, domestic price increases cross-subsidized export price declines. Presuming that costs in yen terms fell as the yen appreciated, margins on domestic sales clearly expanded, while those on export sales may have expanded some or contracted. To determine the movement in margins, we would need an estimate of a_1.

Besides relaxing the assumptions already noted above, a more careful examination of PT and PTM would attempt to account for behavioral differences across sectors on account of quantitative restraints and other characteristics of market structure.[3] Although there is insufficient information in Marston to calculate σ for U.S. industries, an important reason for their apparently lower PTM elasticity is that the share of exports in domestic production may be quite small, making separate price lists not worthwhile.[4] Moreover, the issue of currency of contracting has perhaps not been adequately treated here.[5]

The different measures of exporter's pricing behavior each have value depending on the policy issue at hand. To answer the question of how international competitiveness in foreign markets changes with exchange rate changes—for example, what may happen to the price of U.S. exports in foreign markets when the dollar appreciates—the least squares approach provides a more direct answer. For questions with a trade policy focus—for example, are Japanese producers using high domestic prices to subsidize export prices, prima facie evidence of "unfair trade"—the PTM calculation along with the estimate of cost pass-through better quantifies the ability of exporters

3. See Peter Hooper and Catherine L. Mann, "The Emergence and Persistence of the U.S. External Imbalance, 1980–1987," *Princeton Study in International Finance no. 65* (October 1989), pp. 85–91.

4. See discussion in Hooper and Mann, pp. 81–83.

5. See Catherine L. Mann, *Weltwirtschaftliches Archiv* 125, no. 3 (1989): 588–618, and references therein for more on currency of contracting.

to create and exploit a price wedge between locally sold and foreign-sold products.

Comment Bonnie E. Loopesko

The recent research of Richard Marston, including the paper presented at this conference, has served to substantially clarify the precise meanings of pass through and pricing to market. Marston shows that it is possible to go beyond simple observations about the degree of pass-through of exchange rate changes to export prices in order to determine whether those changes result from pricing-to-market motives.

One important contribution of this line of research is to isolate the pricing-to-market motive from the impact of changes in marginal cost on export prices. In particular, incomplete pass-through may have nothing to do with a strategy to defend market share by cutting profit margins, but instead may result from constant markup pricing over varying marginal costs. Marston shows how these two effects on pass-through may be disentangled empirically, allowing him to test directly for the existence of pricing-to-market behavior.

The earlier empirical work on pass-through, including my own work with Robert Johnson (published in an NBER volume that Marston edited), evaluated the degree of pass-through to Japanese export prices but did not attempt to distinguish empirically between strategic pricing goals and the influences of cost factors in explaining the observed partial pass-through. In our paper, we described some research done at MITI in Japan that showed that the marked decline in costs of imported intermediate goods explained a substantial part of the observed slowness in pass-through to Japanese export prices during the episode of prolonged yen appreciation in the mid-1980s. However, as Marston notes, this approach requires measuring these cost factors for each sector of manufacturing, which is considerably more complicated than the direct test for pricing to market that he proposes.

My comments are organized around three themes. First, I will note one question about some evidence Marston provides on internal and external price adjustment. Second, I will raise some issues regarding the interpretation of the findings on pricing to market behavior. Finally, I will note a few implications of this work for macroeconomic policy.

In the first part of the paper, Marston says his study seeks to answer the following question: "Has the randomness of flexible exchange rates so reduced the integration of different national markets in any one sector of manu-

Bonnie E. Loopesko is a senior international economist in International Capital Markets at the Federal Reserve Bank of New York.

facturing that internal price adjustment *between* sectors is more complete than external price adjustment in the same sector? . . . That is, the random movement in nominal exchange rates would have made the prices of American 'apples' more closely linked to those of American 'oranges' than to those of Japanese 'apples.'" The apples and oranges analogy suggests the reader should be surprised if "internal adjustment" occurs more rapidly than "external adjustment."

Marston's evidence, summarized in table 4.1, shows that internal price correlations across sectors of manufacturing substantially exceed the price correlations for the same goods across countries. Two rather different forces are at work. "External adjustment" requires substantial international arbitrage in the goods market in the short run, which, we know from the extensive empirical literature on PPP, does not occur. In contrast, "internal adjustment" requires a rapid response of pricing in different sectors of manufacturing to changes in common costs. This could result from commonly postulated markup pricing behavior. Thus is appears that Marston sets up something of a straw man that is easily knocked down.

Next, I would like to raise three questions about the interpretation of the findings on pricing-to-market behavior. First, given that Marston establishes the empirical importance of pricing to market behavior, it would be interesting to ask *what* provides the ability to price discriminate. The framework used in this paper is discussed in an earlier paper (NBER Working paper no. 2905, March 1989). In that paper, Marston shows that the pricing-to-market elasticity in equation (3) is a function of the elasticities of domestic and foreign markups with respect to prices. These, in turn, depend on the curvature of the respective demand curves. Thus pricing-to-market behavior appears to derive from factors on the *demand side* and is a form of price discrimination on the part of producers. Of course, in these reduced-form models, the reduced-form coefficients of the demand functions comingle factors from the supply and demand sides.

The ability to price discriminate could derive from a variety of factors relating to market structure and the cost function. It could derive from market power based on the degree of industry concentration and international competition or from the ability of the firm to create individual market power through product differentiation. It could also result from segmentation of markets caused by a combination of high transactions costs and protection. To give one example, differences in the degree of international competition in markets for different categories of manufactured goods may explain some of the differences in markup elasticities across sectors shown in table 4.4. Robert Johnson and I made a related argument in our analysis of pass-through, noting that those sectors that appeared to face increasing competition from the NICs were those that appeared to have the lowest rates of pass-through.

A second question about the interpretation of Marston's results concerns the derivation of the equations used for estimating the pricing-to-market elasticities. The assumption of static, one-period profit-maximizing behavior allows Marston (in his earlier paper) to use the usual first-order conditions to derive the two price markup functions. However, one of the implicit hypotheses of this work is that Japanese firms price to market in order to expand or maintain market share. This would appear to imply a specification that goes beyond short-run profit maximization to incorporate intertemporal effects on profitability of enlarging market share.

Another point relevant to an extension of this work to a dynamic framework is that producers' expectations about the nature of exchange rate changes will influence their pricing behavior. If producers expect an exchange rate change to be permanent, they are more likely to pass through more of that change immediately and to price to market to a lesser degree. If the exchange rate change is large enough, the location of production may be shifted as well. In contrast, if producers expect a rapid reversal of the exchange rate movement, it may be optimal to absorb the exchange rate change in profits. Thus, in a dynamic optimizing framework, expectations about the duration of exchange rate movements would affect the degree of pricing-to-market behavior.

Another possible explanation of the differences in pricing-to-market behavior between sectors of manufacturing, or even across countries, might relate to the level of profit margins. Presumably a firm has more scope to price to market if it currently has large profit margins. It is unclear how this factor fits into Marston's framework.

Finally, I would like to suggest some possible implications of this line of research for the transmission of monetary policy. Consider the case where an easing of U.S. monetary policy leads to dollar depreciation. Pricing-to-market behavior on the part of Japanese exporters would delay the impact of the dollar's decline on U.S. import prices and hence delay demand-switching effects. In this way, pricing to market can affect the *lag* with which monetary policy affects prices and the real economy.

Also, the pricing-to-market behavior of Japanese exporters should imply that monetary-policy-induced exchange rate movements will impart greater variability to Japanese profits, thereby increasing the riskiness of investment in the Japanese tradable goods sector. This should show up in the correlation between the exchange rate and stock prices in Japan. This sort of issue could be explored if pricing-to-market equations were embedded in a broader macroeconomic model.