Policy, Research, and External Affairs

WORKING PAPERS

International Commodity Markets

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The Response of Japanese and U.S. Steel Prices to Changes in the Yen-Dollar Exchange Rate

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and
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The yen-dollar exchange rate is not fully passed through in steel prices. Changes in Japanese steel prices lag six months behind changes in U.S. prices.

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WORKING PAPERS

International Commodity Markets

This paper — a product of the International Commodity Markets Division, International Economics Department — is part of a larger effort in PRE to understand the short- and long-run behavior of primary commodity prices and the impact of movements in these prices on the developing countries. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Dawn Gustafson, room S7-044, extension 33714.

Import prices in the United States have not responded as expected to large fluctuations in the exchange rate in recent years.

In this study, Varangis and Duncan analyzed the response of Japanese and U.S. steel prices to changes in the yen-dollar exchange rate (the exchange rate pass-through, or the percentage change in import prices as a result of changes in the exchange rate or the exporter's cost of production).

The concluded that:

- The magnitude of elasticity of the pass-through depends on the elasticity of import demand, the convexity of the import demand curve, and the elasticity of the marginal cost of production with regard to output.

- In a competitive pricing market the pass-through is equal to 1 only if marginal costs are constant (supply is perfectly elastic).

- If marginal costs are increasing, the pass-through is less than 1.

- The pass-through can be greater than 1 for both competitive and noncompetitive pricing markets if marginal costs are declining and the import demand curve is very convex.

- If marginal costs are declining fast enough when production is increasing, the pass-through can be greater than 1 even if the demand curve is not convex.

- The yen-dollar exchange rate is not fully passed through in steel prices. When the exchange rate changes, both U.S. and Japanese steel prices change, but whereas U.S. steel producers adjust prices immediately, Japanese steel producers are conservative in pricing decisions. For a while, they absorb much of the dollar depreciation as reduced profits before increasing their prices in U.S. dollars. Changes in Japanese steel prices lag six months behind changes in U.S. prices.

- One implication of this analysis is that devaluation may lead to a shift of resources within the export sector, from sectors with higher pass-through to sectors with lower pass-through. The lower the exchange rate pass-through, the lower the import response may be, as well.

These results cannot distinguish between a perfectly and an imperfectly competitive market situation. To do so would require *a priori* information such as percentage mark-up over time.

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I. INTRODUCTION

1. The appreciation of the US dollar over the 1980-85 period and its depreciation after 1985 has renewed interest in the relationship between exchange rate movements and the prices of traded goods. Of particular interest has been the fact that during the period of dollar appreciation US import prices of manufactures did not fall by as much as the fall in the value of the foreign currencies denominated in dollars. Also, after 1985 import prices of manufactures in the United States did not rise by as much as the dollar depreciated. The idea of a less than complete pass-through of exchange rate changes or equivalent taxes/subsidies on import prices is not new. For example, under perfect competition and normally sloped demand and supply curves, the imposition of an ad valorem tax will result in a price increase of less than the percentage change of the tax. Recent studies have also drawn on models of imperfect competition in their efforts to explain less than complete pass-through of exchange rate changes and tariffs in terms of market concentration, product homogeneity and cost structure (Dornbusch, 1987; Feenstra, 1986, 1987; Mann, 1986; Giovannini, 1985). It has been observed that foreign producers may respond to a dollar appreciation by decreasing their prices but increase their profit margins, while in periods of dollar depreciation they may increase their prices but reduce their profit margins

and possibly also their costs, in order to keep up their sales and defend their market shares. 1/

2. For nonfuel primary commodities, exchange rate changes are often assumed to be passed-through in full to commodity prices. Despite the widespread use of this assumption, little work has been done to estimate the impact of exchange rate changes on nonfuel primary commodity price changes. Gilbert (1986) employs a rational expectations approach and estimates the elasticity of the World Bank's nonfuel primary commodity price indices with respect to changes in the value of the dollar to be around 0.9. 2/ Furthermore, Gilbert attributed a significant part of this response to be due to the impact of dollar value changes on the dollar-denominated debt of the exporting countries. 3/ Jabara and Schwartz (1987) argued that "... agricultural commodity prices may not be as flexible as commonly perceived." In estimating the import price response to changes in the exchange rate for six agricultural commodities they found a variety of response magnitudes.

1/ See Washington Post article of February 16, 1987 on how Toyota sacrificed profits and increased its productivity in order to keep up sales in the US market in the face of a strong yen.

2/ Specifically it was found to be 0.8 for agricultural nonfood commodities, 0.9 for food and 1.1 for metals and minerals. It is not clear whether the differences between these estimates and unity are statistically-significant.

3/ According to this argument a dollar appreciation will reduce the dollar import prices and also will increase the value of the dollar-denominated debt. The latter will induce the indebted exporting countries to increase their exports which will further reduce the import commodity prices in dollars. However, Chang (1987) did not find evidence to support the argument that indebted developing countries have expanded their exports in response to the increase in their indebtedness.

These variations were attributed to trade policy intervention, insulating price policies and price stickiness by exporters/importers. In both studies mentioned above, it was argued that when exchange rate changes are not fully passed-through to import prices it is an indication of imperfections in market behavior. Furthermore, it was argued that the smaller the pass-through the higher the market imperfection; but both studies failed to explain what may be happening if exchange rate changes are more than fully passed-through to import prices (pass-through greater than one).

3. The purpose of this paper is to estimate the price response to changes in the exchange rate using Japanese and US steel data. The analysis presented is in line with the recent theoretical models discussed in the previous paragraphs. The paper is structured as follows. Section II outlines the methodology and provides the data description. Section II presents the estimation methods and results. The summary and conclusions can be seen in Section IV.

II. METHODOLOGY AND DATA

4. The model used draws on previous models of imperfect competition used by Feenstra (1987, 1986). A brief discussion of this model follows. We are assuming that Japanese and U.S. steel producers act as Bertrand competitors. Furthermore, we are assuming that firms are price takers in the factor market and that exchange rate changes do not affect factor prices. Our approach is a partial equilibrium approach in the sense that exchange rates are determined exogenously. 1/

5. Let p be the Japanese export price of steel and $x = F(p,q,I)$ be the U.S. import demand of Japanese steel, where q is the U.S. producer price of steel and I is an income variable. Furthermore, let the Japanese steel industry maximize its expected profits from sales into the U.S. market in yen,

$$\max_{p} E\left(\varepsilon . p . x(p,q,I) - c(x) . w^{*}\right) \qquad (1)$$

where ε is the yen/U.S. dollar exchange rate; w^{*} is a scalar or a vector of Japan's factor price in yen; and $c(x).w^{*}$ represents the cost function.

6. We assume that prices are announced in dollars. In this case expression (1) takes the form

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1/ As Dornbusch (1987) has pointed out, although this assumption is open to criticism, it is considered a useful hypothesis for investigating relative price issues.

$$\max_{p} \left[e.p.x(p,q,I) - c(x).w^{*}\right] \tag{2}$$

where $e = E(\varepsilon)$. This form would not have resulted if prices were announced in domestic currency (yen). 1/

7. By solving the first-order condition of (2) with respect to p, we obtain the following expression

$$MC \equiv \frac{c'.w*}{e} = p(1 - \frac{1}{h}) \equiv r(p,q,I) \equiv MR \tag{3}$$

where n is the positive elasticity of U.S. demand for imported Japanese steel, and c' is the partial derivative of c with respect to x. Assuming that $c''x_p(w*/e) - r_p \neq 0$ we can invert (3) and derive the following pricing equations for the Japanese producers

$$p = f(w,q,I) \tag{4}$$

where $w = w^{*}/e$ is the Japanese factor price in U.S. dollars.

8. Furthermore, let us assume that the U.S. steel producers maximize their profits from sales into the U.S. market. Then, following the same procedure as above, we can derive the pricing equation for the U.S. producers:

1/ See Baron (1976) and Giovannini (1985).

$$q = g(v,p,I) \qquad (5)$$

where v is a scalar or vector of U.S. factor prices in U.S. dollars.

9. What we propose to estimate are the reduced forms of equations (4) and (5); that is, because we are interested explicitly in estimating the direct effect of the yen/U.S. dollar exchange rate on Japanese and U.S. prices. The reduced forms of equations (4) and (5) take the following forms:

$$p = \phi\,[w,g(v,p,I),I] = \; = f'(w,v,I) \qquad (4')$$

$$q = \psi\,[v,f(w,q,I),I] \quad = g'(w,v,I) \qquad (5')$$

10. Equations (4') and (5') are homogeneous of degree one since (4) and (5) are also homogeneous of degree one. To see the latter, note that the U.S. demand for domestically-produced and imported Japanese steel must be homogeneous of degree zero in their arguments. The homogeneity property of the reduced-form equations will be empirically tested.

11. Sufficient conditions to establish the signs and the magnitudes of changes in w,v, and I on p and q are obtained in Section III. 1/ These conditions depend on the underlying demand and cost functions. The "normal"

1/ See also Feenstra (1987).

case occurs when a change in the yen/dollar exchange rate (or Japanese factor prices) is less than fully passed-through in prices. 1/ Equations (4') and (5') will be estimated by using the OLS method after correcting (if there is) for serial correlation.

12. The data are quarterly from 1972 first quarter to 1981 fourth quarter. We chose that to be our sample size because during these years there was no U.S. import quota for steel from Japan. As Feenstra (1987) has pointed out, the existence of import quotas or "voluntary export restraints" (VERs) changes the nature of the optimal pricing decisions, so equations (4') and (5') no longer apply. Note that during the period 1972 to 1981 the yen/dollar exchange rate fluctuated quite widely, including a substantial dollar depreciation.

13. Japanese export prices, U.S. domestic producer prices for steel, and steel production cost data for the United States and Japan were obtained from World Steel Dynamics published by Paine Webber. For the income variable the U.S. GDP was taken.

1/ The sufficient conditions for that are for the U.S. and Japanese marginal costs to be increasing and the U.S. demand for domestic and imported Japanese steel to be close to linear with income elasticities positive but less than one.

III. MAGNITUDE AND PROPERTIES OF THE EXCHANGE RATE PASS-THROUGH

A. The Magnitude of the Pass-Through

14. By totally differentiating pricing equation (3) and using the relationship $w.c'=r$ we obtain

$$(dp/dw).(w/p) = 1/(z.n + r_p.p/r) \qquad (6)$$

where $z = (c''.x)/c'$ is the elasticity of marginal cost with respect to output. Recalling that $w = w^*/e$, expression (6) shows the elasticity of change in the import price p due to changes in the exchange rate or foreign factor costs, i.e., the pass-through. Expression (6) is positive since its denominator is always positive as is implied by the second-order conditions of profit maximization. 1/

1/ Recall that the first-order condition of (2) for profit maximization was $r(p,q,I) - c'(x)w = 0$. The second-order condition is then $r_p - c''(x).X_p w > 0$. By multiplying the above expression by p/r we obtain $r_p.(p/r) - c''(x).X_p.(p/r).w > 0$, which after substitution for $w = r/c'(x)$ yields $r_p.(p/r) + [c''(x).x/c'(x)].n > 0$, which also can be written as (6) > 0.

15. The magnitude of (6) depends on the elasticity of the marginal cost with respect to output (z), the import demand elasticity from country i (n), and the elasticity of marginal revenue with respect to price ($r_p.p/r$). Note that n is the market elasticity at the point where the producer operates. The less rapidly increasing the marginal cost, the higher the pass-through will be. However, it is not very clear what happens to the pass-through when n changes. 1/

16. The elasticity of marginal revenue with respect to price can be further expressed as

$$r_p.p/r = 1 + (p/r).(n_p.p/n^2)$$

if $n_p \lesseqgtr 0$ then $r_p.p/r \lesseqgtr 1$

1/ For the case where firms face a downward sloping curve, but firms still set their prices equal to the marginal cost (we call this the competitive pricing case) equation (3) becomes:

$$c'.w^*/e = p \text{ or } c'.w = p$$

and by total differentiation we obtain:

$$c''.x_p.d_p.w + c'.dw = dp \text{ or } (dp/dw).(w/p) = 1/[(c''.x/c').n+1]$$

So, even in the case of competitive pricing, unless marginal cost is constant the pass-through is less than one. That means an increase of the dollar marginal costs (as with a dollar depreciation) will lead to a smaller increase in the import price. However, the pass-through elasticity in the competitive case is smaller than the pass-through elasticity in the imperfectly competitive case (6) if $n_p < 0$.

Along a linear demand curve n_p is positive. 1/ The sign of the elasticity of the marginal revenue with respect to output (2) depends on the sign of c".

17. Given the above, the sufficient conditions to establish the magnitude of (6) are:

$$n_p > o,\ c'' > o \quad \Rightarrow \quad o < (dp/dw).(w/p) < 1 \qquad \text{(i)}$$

$$n_p < o,\ c'' < o \quad \Rightarrow \quad (dp/dw).(w/p) > 1 \qquad \text{(ii)}$$

Case (i) is the so-called "normal" case in which a change in the exchange rate and/or foreign factor costs is not totally passed-through in import prices. This case occurs when marginal costs are rising and the import demand elasticity is increasing with price. Case (ii) is the unusual case where a change in the exchange rate and/or foreign factor costs is more than totally passed-through in import prices. The latter case can occur if marginal costs are declining and the import demand elasticity decreases with price.

18. In establishing the magnitude of the pass-through we have treated q, the import price from the other country j, as endogenous. What if q is endogenous and its pricing equation is like (4')?

1/ In general, $n_p > 0$ characterizes the class of demand curves that is more linear (less convex) than the constant-elasticity curves, and $n_p < 0$ characterizes the class that is more convex. See also the appendix.

19. By substituting (4') into (4) we obtain the following reduced-form expression for p:

$$p = h[w,q(v,p,I),I] \qquad (7)$$

By totally differentiating (7) we derive the effect of an exchange rate/factor cost change on the import price of country i (p), when the import price from country j (q) is endogenous

$$(dp/dw).(w/p) = h_w.(w/p)/[1-hq.(\partial q/\partial p)] \qquad (8)$$

In expression (8) hw.(w/p) is the partial effect of the exchange rate/foreign factor cost change on the import price given by (6). If $o < hq.(\partial q/\partial p) < 1$, 1/ then the pass-through treating q as endogenous will exceed the pass-through treating q as exogenous. This is what one should expect, since an increase in dollar marginal costs w (caused by an increase in exchange rate and/or factor costs) will initially increase p, which will cause q to rise, which will cause a further increase in p, and so on. Eventually both p and q will converge to their estimated values.

20. Summing up, there are few unqualified statements that one can make about the magnitude of the pass-through. In general, the pass-through elasticity is always positive but its magnitude depends on the output

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1/ This is true if the partial elasticity of p with respect to q (hq.p/q) is between zero and one; a similar conclusion holds for q.

elasticity of import demand, the convexity of the import demand curve and the elasticity of the marginal cost with respect to output. If the import demand curve is reasonably convex, that is, less convex than a constant elasticity curve, then two further statements can be made. First, that the pass-through elasticity is less than one, given also that marginal costs are not decreasing; and second, that the pass-through elasticity of the competitive pricing case is higher than the pass-through elasticity under the imperfectly competitive case.

21. The pass-through elasticity can be less than one even for a competitive pricing market. Further, there can be cases where the pass-through elasticity under competitive pricing is lower than under imperfectly competitive pricing, depending on the convexity of the demand curve, ceteris paribus. In a competitive pricing market the pass-through is equal to one only if marginal costs are constant, i.e., supply is perfectly elastic. 1/

22. The pass-through elasticity can be greater than one for both competitive and noncompetitive pricing markets if marginal costs are declining and the demand curve is very convex. If marginal costs are declining sufficiently fast when production is increasing, the pass-through can be greater than one even if the demand curve is not very convex.

23. Finally, however, even the statements made above are uncertain when the prices of the other producers are considered to be endogenous.

1/ For explanation, see footnote at the bottom of page 9.

24. In the empirical estimation the models of imperfect competition do not place any restrictions on the parameter estimates that would distinguish between a perfectly competitive and an imperfectly competitive case. That is, given the empirical estimates alone there is no way that one can tell whether the market is imperfect without having additional information concerning, for example, the magnitude of the mark-up. However, if in the case of a producer with a flat marginal cost curve the exchange rate pass-through is less than full, this is an indication of imperfectly competitive pricing behavior and any additional information on market behavior is not necessary. 1/

B. The Effect of Changes in Income on Import Prices

25. By differentiating equation (3) the following expression is obtained,

$$(dp/dI)(I/p) = \left[(c''.x/c').\gamma - (r_I.I/r)\right]/\left[(c''.x/c').n + (r_p.p/r)\right] \qquad (9)$$

where $\gamma = x_I.I/x$ is the income elasticity of import demand. Expression (9) shows the elasticity of import price with respect to income. In order to distinguish the sign of the effect we need to determine the sign of the numerator and denominator of (9). The denominator of (9) is always positive because of the second-order profit maximization conditions described earlier. In order to examine the sign of the numerator, consider the following case.

1/ Constant marginal costs can arise if producers can easily substitute domestic sales for exports or if there is excess capacity.

Let the commodity not be an inferior good $[\gamma > 0]$ and also let γ be positive and constant for all prices. This case implies that the demand curve can be written as $x(P,I) = \phi(P).I^{\gamma}$, which means that the import demand elasticity is independent of income, $n = -\phi_p.P/\phi$. Thus, marginal revenue is independent of income and $r_I = 0$. Under this scenario, the sign of (9) depends on whether the marginal costs are increasing or declining.

γ positive and constant, $c'' > 0 \Rightarrow (dP/dI).(I/p) > 0$

γ positive and constant, $c'' < 0 \Rightarrow (dP/dI).(I/p) < 0$

Note that expression (9) treats q as exogenous. In order to find the effect of income changes on import prices when q is endogenous, the reduced-form equation (7) is differentiated with respect to income to obtain

$$(dP/dI).(I/p) = \left[h_I.(I/p) + h_q.(q/p).(\partial q/\partial I).(I/q)\right] / \left[1-h_q.(\partial q/\partial p)\right]$$

where $h_I.(I/p)$ is the partial effect of income change on the import price given by (9), $hq.(q/p)$ is the partial effect of change in the import price due to a change of the price of a competitor (q) as expressed by (10), and $(\partial q/\partial I).(I/q)$ is the effect of the income change on the import price of a competitor.

C. Changes in the Import Price of a Competitor

26. Since function f in (4) is homogeneous of degree one, its elasticities must sum to one.

$$(dp/dq)(q/p) = 1-(dp/dw)(w/p) - (dp/dI)(I/p) \Rightarrow$$

$$(dp/dq)(q/p) = \left[(c''.x/c')(n-\gamma) + (p.n_p/n^2)(P/r) + (r_I.I/r)\right] / \left[(c''.x/c').n + (r_p.P/r)\right] \quad (10)$$

The magnitude of (q) can be established by using earlier results. Since $n > 1$ to satisfy that MR is positive in (3), for the term $(c''.x/c)(n-\gamma)$ to be positive γ has to be less than or equal to one. The sufficient conditions to establish the sign of (q) can be expressed as follows:

γ positive and constant, $c'' > 0$, $n_p > 0$ and

$$\gamma \leq 1 \Rightarrow 0 < (dp/dq).(q/p) < 1$$

γ positive and constant, $c'' < 0$, $n_p < 0$ and $\gamma \leq 1 \Rightarrow (dp/dq).(q/p) < 0$

In the first case an increase (decrease) in the price of the other competitor (country j) will not be fully matched by an increase (decrease) of the import price from country i. The second case shows that the import prices from the two different sources (countries i and j in our case) are inversely related. The second case may arise when prices are a constant markup over marginal costs ($n_p = 0$) and marginal costs are declining with rising imports.

IV. ESTIMATION AND EMPIRICAL RESULTS

27. For estimation purposes we use a log-linear specification for equations (4') and (5').

$$\ln p_t = a_o + a_1 \ln w_t + a_2 \ln v_t + a_3 \ln I_t + u_t \tag{11}$$

$$\ln q_t = \beta_o + \beta_1 \ln w_t + \beta_2 \ln v_t + \beta_3 \ln I_t + z_t \tag{12}$$

28. Before we proceed in the estimation of equations (11) and (12) we must specify how expectations concerning the exchange rate are formulated, since the $w_t = w_t^*/e_t$ term depends on the expected exchange rate e_t. Let us assume that the expected rate e_t is a log-linear function of the current and past spot rates,

$$e_t = \sum_{i=0}^{n} \theta_i \, \varepsilon_{t-i} \tag{13}$$

where θ_i are the weights of current and past spot rates in forming the expectations and depend on the time-series properties of exchange rates. For example, if the yen/dollar exchange rate follows a random walk, the rationally-expected exchange rate e_t will be equal to ε_{t-1} which implies that $\theta_1 = 1$ and $\theta_i = 0$ for $i \neq 1$. By substituting (13) into (11) and (12) we obtain:

$$\ln p_t = a_o + \sum_{i=0}^{n} \gamma_i \ln(w_t^*/\varepsilon_{t-i}) + a_2 \ln v_t + a_3 \ln I_t + u_t \quad (11')$$

$$\ln q_t = \beta_o + \sum_{i=0}^{n} \delta_i \ln (w_t^*/\varepsilon_{t-i}) + \beta_2 \ln v_t + \beta_3 \ln I_t + z_t \quad (12')$$

where $\gamma_i = \theta_i a_1$, and $\delta_i = \theta_i b_1$, and $\sum_{i=o}^{n} \theta_i = 1$ is assumed.

The estimates of the weights θ_i are implicitly derived when estimating the γ_i and δ_i.

29. In order to reduce the erratic behavior of the γ's and δ's, we propose the use of a second-order Almon lag of eight periods so that $\gamma_i = b_o + b_1 i_t + b_2 i_t^2$, and similarly $\delta_i = c_o + c_1 i_t + c_2 i_t^2$.

30. Of secondary interest will be to test whether equations (11) and (12) are homogeneous of degree one. This restriction for a second degree, eight period Almon lag takes the form of,

$$\sum_{i=0}^{8} \gamma_i + a_2 + a_3 = 1 \quad \text{for (11') and}$$
$$\sum_{i=0}^{8} \delta_i + \beta_2 + \beta_3 = 1 \quad \text{for (12')} \quad (14)$$

By noting that $\sum_{i=0}^{8} \gamma_i = 9 + 36\ b_1 + 204\ b_2$ and $\sum_{i=0}^{8} \delta_i = 9 + 36\ c_1 + 204\ c_2$ and substituting these expressions into (14) we can test the homogeneity restriction.

31. Table 1 presents the estimates of the regression coefficients of (11) and (12) after correcting for serial correlation. We tested for homogeneity and the computed F-statistics were 0.67006 and 0.7193 for equations (11) and (12), respectively; these values are much lower than the critical F-statistic and show that homogeneity cannot be rejected.

32. The results presented in Table 1 show that the full pass-through of the yen/dollar exchange rate was 26.3% for the U.S. domestic producer price and 59.2% for the Japanese export price. What this means is that given a dollar depreciation, Japanese dollar export prices will increase by about 60%--which implies that Japanese export prices in yen have fallen. In other words, a fall in the price of the dollar vis-a-vis the yen will not deter Japanese steel imports from the U.S. market as much as if steel were a flex-price commodity.

33. The time profile of the pass-through as shown by the two estimated equations is quite interesting. The impact of a yen/dollar change on the U.S. domestic producer price is felt immediately, but then moves at a diminishing pace towards the new price level. However, during the first six months following an exchange rate change, Japanese steel export prices stay almost the same. For instance, given a 100% devaluation of the dollar vis-a-vis the yen, Japanese export prices will fall by an estimated 2.94%--a negligible change. However, after the first six months, Japanese export prices will

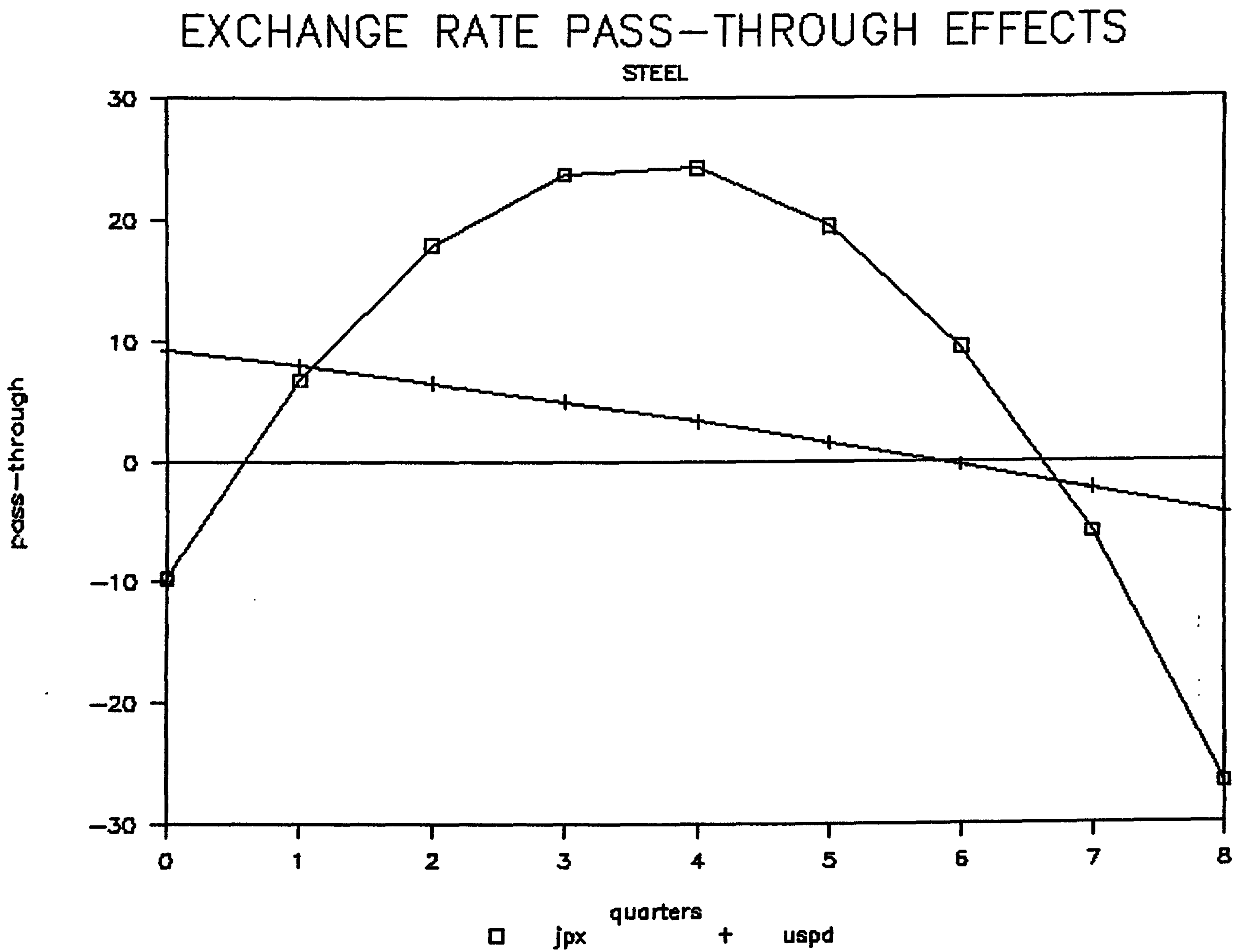
start rising (falling) in response to a yen/dollar appreciation (depreciation); prices move towards the new price level at an increasingly faster rate for three periods and then at a slower and slower rate for three periods (see the time paths graphed in the following figure). The time pattern of the estimated response by US and Japanese steel producers is consistent with their reported price behavior in the past. Also, the Japanese steel producers' behavior as estimated here is consistent with the results obtained by Feenstra (1987) in his analysis of the response of Japanese car and truck prices for exports to the United States. Both the time pattern and the magnitude of the pass-through are similar to those obtained by Feenstra.

Table 1: REDUCED-FORM REGRESSIONS

	Japanese Export Price	U.S. Domestic Producer Price
Constant	-27.70	86.69
w^*/ε_t	-9.68	9.23
$w^*\varepsilon_{t-1}$	6.74	7.90
$w^*\varepsilon_{t-2}$	17.86	6.46
w^*/ε_{t-3}	23.69	4.92
w^*/ε_{t-4}	24.23	3.27
w^*/ε_{t-5}	19.46	1.53
w^*/ε_{t-6}	9.41	-0.34
w^*/ε_{t-7}	-5.94	-2.30
w^*/ε_{t-8}	-26.57	-4.37
Full pass-through**	59.20	26.30
U.S. cost	23.66	62.34
Income	17.14	11.36
Correction of serial correlation (RHO)	0.792	0.669
$\bar{R}^2$		0.968
0.993		
Sum of squared residuals	0.0958	0.0226
Number of observations	39	39
Number of independent variables	6	6

Note: All regression coefficients have been multiplied by 100.

** Sum of all coefficients w^*/ε_{t-i}, 8= 0, 1,..,8.


EXCHANGE RATE PASS-THROUGH EFFECTS
STEEL
pass-through
30
20
10
0
-10
-20
-30
0
1
2
3
4
5
6
7
8
quarters
jpx
uspd

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