Volume Title: Macroeconomic Linkage: Savings, Exchange Rates, and Capital Flows, NBER-EASE Volume 3

Volume Author/Editor: Takatoshi Ito and Anne Krueger, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-38669-4

Volume URL: http://www.nber.org/books/ito_94-1

Conference Date: June 17-19, 1992

Publication Date: January 1994

Chapter Title: Cost Externality and Exchange Rate Pass-Through: Some Evidence from Taiwan

Chapter Author: Bih Jane Liu

Chapter URL: http://www.nber.org/chapters/c8535

Chapter pages in book: (p. 247 - 272)

10 Cost Externality and Exchange Rate Pass-Through: Some Evidence from Taiwan

Bih Jane Liu

10.1 Introduction

The depreciation of U.S. dollars relative to New Taiwan (NT) dollars during the second half of 1980s did not seem to solve the U.S. trade deficit problem with Taiwan. Failure by Taiwanese exporters to pass exchange rate changes through to export prices, i.e., incomplete exchange rate pass-through, is often mentioned as one of the main reasons for sluggish adjustment in the trade balance between the two countries. Recently, a number of papers have tried to explain incomplete pass-through from both theoretical and empirical perspectives. However, different studies used different models and thus obtained different conclusions.

Some attributed this incompleteness to the contract relationship prevailing in international trade, under which delivery lags behind the time when a contract is signed (e.g., Moffett 1989). Demand and supply elasticities were shown to be another main determinant of the degree of exchange rate pass-through (e.g., Feenstra 1987; Knetter 1989). Mann (1986) and Froot and Klemperer (1989) argued that in order to maintain foreign market share while domestic currency appreciates, exporters may absorb part of the appreciation by reducing their profit margins. Similarly, if exporters must incur sunk costs in order to open foreign markets and cannot recoup these costs once they exit, they tend to be reluctant to raise their prices abroad when foreign currency depreciates (e.g., Dixit 1989). However, since profit margins can be reduced only when market structure is imperfectly competitive, Krugman (1987), Dornbusch (1987), and Fisher (1989b) further showed how market structure affects the degree of exchange rate pass-through. In addition to market structure, the num-

Bih Jane Liu is professor of economics at National Taiwan University.

The author thanks Serguey Braguinsky, John Helliwell, Rachel McCulloch, and Won-Am Park for their helpful comments.

ber of firms (Dornbusch 1987), the type of exchange rate shock (Krugman 1987; Baldwin 1988a), and the exchange rate regime (Fisher 1989b) will also affect the degree of pass-through.

Although the above studies contributed significantly to the explanation of incomplete exchange rate pass-through, they might not be exhaustive. In this paper, we will provide an alternative explanation, i.e., cost externality, for the phenomenon of incomplete or over pass-through. In practice, exporters often export differentiated goods to different markets. These differentiated goods are of similar quality designed for different markets and thus produced in different product lines under which cost-saving or cost-enhancing externality exists. The existence of cost externality will affect the true marginal cost of exports and therefore affect the degree of exchange rate pass-through. As a matter of fact, negative pass-through, which is somehow not that intuitive but may happen in reality,[1] may be explained by the existence of strong cost-saving externality.

The static model developed in section 10.2 is of a conjectural variation type. Under this model, three types of exchange rate pass-through (i.e., over, incomplete, and negative) can be theoretically derived. The model also shows that cost externality, in addition to market structure, the elasticities of demand curves, and the number of firms, as discussed in various papers (e.g., Feenstra 1987; Dornbusch 1987), will play an important role in determining the degree of exchange rate pass-through. In order to test the theoretical results derived from section 10.2, an econometric model is laid out in section 10.3 for empirical analysis. Section 10.4 presents the empirical results. The conclusions are given in the final section.

10.2 The Model

There are three countries, H, F, and ROW (the rest of the world). Assume that M firms in the country H produce differentiated goods X and Y, while N firms in country F produce good Z. Goods X and Y are exported to countries F and ROW, respectively. For simplicity, we assume that X and Z, sold in country F, are homogeneous goods and compete with each other.[2]

Since X and Y are like products designed for different markets and produced in different product lines, there exists cost-saving or cost-enhancing externality between X and Y. Any change in the production of either good will affect the cost of the other good and hence its level of production. Let $C_x(x,y)$ and $C_y(x,y)$ be the cost function of X and Y expressed in H-currency for a representative firm in country H. When $\partial C_y/\partial x$ or $\partial C_x/\partial y$ is greater than zero, there exists

1. That is, export prices expressed in foreign currency increase even though foreign currency appreciates. See the definition of the degree of pass-through in section 10.2.

2. One rationale for the assumption of homogeneous goods here is that goods sold in the same country (e.g., X and Z in this model) tend to be more homogeneous than those sold in different countries (e.g., X and Y). To simplify the analysis, we therefore assume that X and Y are differentiated goods while X and Z are homogeneous goods.

cost-enhancing externality. On the other hand, if $\partial C_y / \partial x$ or $\partial C_x / \partial y$ is less than zero, there is cost-saving externality.

Let γ be the exchange rate expressed as H-currency per unit of F-currency. Let $P(Q)$, $Q = X + Z$, be the price of X and Z denominated in F-currency, where $X = \sum_{i=1}^{M} x_i$, $Z = \sum_{j=1}^{N} z_j$. $P_y(Y)$ be the price of Y denominated in ROW currency. For simplicity, the exchange rate between the currencies of H and ROW is set to be one. The profit function for a representative firm i in country H can thus be written as

$$\pi = \gamma P(Q)x + P_y(Y)y - C_x(x,y) - C_y(x,y),$$

where subscript i is omitted for notational simplicity.

The profit function for a representative firm in country F can be written as

$$\pi^* = P(Q)z - C_z(z)$$

where C_z is the cost function denominated in F-currency.

Assume that each firm in making its production and sale decisions will take the reaction of other firms into account. Let $\rho_x (\equiv \partial Q / \partial x)$[3] indicate the variation of Q perceived by a representative firm in country H when its exports of x change. Let $\rho_y (\equiv \partial Y / \partial y)$ indicate the conjectural variation of Y perceived by a representative firm when y changes. Similarly, $\rho_z (\equiv \partial Q / \partial z)$ denotes the conjectural variations of Q perceived by a representative firm in country F when its sales of z change.

The optimal choices of x,y, and z for a representative firm in countries H and F must satisfy the following first-order conditions:

$$\gamma P + \gamma x \rho_x P' - C'_x - \alpha = 0, \tag{1}$$

$$P_y + y \rho_y P'_y - C'_y - \beta = 0, \tag{2}$$

$$P + z \rho_z P' - C'_z = 0, \tag{3}$$

where $C'_x (\equiv \partial C_x / \partial x)$, $C'_y (\equiv \partial C_y / \partial y)$, and $C'_z (\equiv \partial C_z / \partial z)$ indicate the marginal cost of X,Y, and Z, respectively; $P' (\equiv \partial P / \partial Q < 0)$ and $P'_y (\equiv \partial P_y / \partial Y < 0)$ are the slope of the demand curves for goods X (or Z) and good Y, respectively; $\alpha \equiv \partial C_y / \partial x$ and $\beta \equiv \partial C_x / \partial y$. A positive α (or β) indicates cost-enhancing externality, while negative α (or β) indicates cost-saving externality.

Equation (1) says that for a representative firm the marginal revenue from exports of x must be equal to the true marginal cost, i.e., the sum of marginal cost C_x and cost externality α. A similar condition holds for good y (eq.[2]).

We assume that firms in the same country are identical. Thus, $X = Mx$, $Y = My$, and $Z = Nz$. We aggregate equation (1) over M firms and divide it by γ to obtain the necessary condition for optimal X:

$$MP + \rho_x X P' = \frac{M(C'_x + \alpha)}{\gamma}, \tag{4}$$

3. $\rho_x \equiv \partial Q / \partial x = \partial X / \partial x + \partial Z / \partial x$.

Similarly, we aggregate equations (2) and (3) over M and N firms, respectively:

$$MP_y + \rho_y YP'_y = M(C'_y + \beta), \tag{5}$$

$$NP + \rho_z ZP' = NC'_z. \tag{6}$$

For simplicity, assume that $\rho_x = \rho_z = \rho$. We then add equations (4) and (6) to derive equation (7):

$$(M + N)\,P + \rho QP' = \frac{M(C'_x + \alpha)}{\gamma} + NC'_z. \tag{7}$$

Equations (5) and (7) are necessary conditions for optimal Y and Q and can be solved simultaneously to derive the reduced-form equations for Y and Q as functions of all exogenous variables, i.e., exchange rate γ, market structures ρ, and demand elasticities.

To examine the effects of a change in exchange rate on total sales when holding other exogenous variables constant, we totally differentiate equations (5) and (7) with respect to Q, Y, and γ to derive the comparative static results:

$$\frac{dQ}{d\gamma} = -\frac{M(C'_x + \alpha)V_y}{\gamma^2 \Delta}, \tag{8}$$

$$\frac{dY}{d\gamma} = \frac{M^2(C'_x + \alpha)}{\gamma^2 \Delta}\frac{\partial \beta}{\partial Q}, \tag{9}$$

in which

$$\Delta \equiv VV_y - \frac{M^2 \partial\alpha\,\partial\beta}{\gamma\,\partial Y \partial Q},$$

$$V \equiv (M + N + \rho)P' = -\frac{(M + N + \rho)P}{\eta Q},$$

$$V_y \equiv (M + \rho_y)P'_y = -\frac{(M + \rho_y)\,P_y}{\eta_y Y}.$$

The stability conditions are $V < 0$, $V_y < 0$, and $\Delta > 0$. The notation $\eta(\equiv -\partial Q/\partial P\ P/Q)$ indicates the elasticity of the demand curve for goods X and Z, and $\eta_y(\equiv -\partial Y/\partial P_y\ P_y/Y)$ for good Y.

It is apparent from equations (8) and (9) that cost externality plays a rather important role in determining the effects of exchange rate on exports of X and Y. When $C'_x + \alpha$ is positive, appreciation of F-currency will increase exports of X, and also exports of Y if $\partial\beta/\partial Q > 0$.

The exchange rate pass-through ratio ε, which is defined to be the negative of the percentage change in export price with respect to a percentage change in exchange rate,[4] can be derived by using the comparative result from equation (8):

4. Usually, $(\gamma/P_x)(\partial P_x/\partial\gamma)$ is negative, because firms tend to lower the export price of X denominated in F-currency when F-currency appreciates.

$$\varepsilon \equiv -\frac{\gamma}{P}\frac{dP}{d\gamma} = -\frac{\gamma}{P}P'\frac{dQ}{d\gamma} = -\frac{M(C_x' + \alpha)V_y}{\gamma\eta Q\Delta}. \tag{10}$$

Thus, the larger ε, the larger a decrease (increase) in export price when F-currency appreciates (depreciates).

Equation (10) implies that the sign of the pass-through ratio will depend on the sign of $C_x' + \alpha$, since $\eta > 0$, $V_y < 0$, and $\Delta > 0$. When $C_x' + \alpha$ is positive, an appreciation of *F*-currency first lowers the true marginal cost of *X* (see eq. [4]) and thus increases the exports of *X* and lowers *P*. This in turn lowers the production of *Z*. As a result, total supply of *X* and *Z* increases (see eq. [8]) and *P* decreases. The pass-through ratio ε is therefore positive. This is the case when cost-enhancing externality (i.e., positive α) exists or cost-saving externality (i.e., negative α) is small. On the other hand, if cost-saving externality is sufficiently large that $C_x' + \alpha$ is negative, an appreciation of F-currency will shift the true marginal cost curve of *X* to the left (see [4]). The export price will therefore increase and negative pass-through will occur. Note that equation (10) implies that positive (negative) $C_x' + \alpha$ is a necessary and sufficient condition for positive (negative) ε.

Moreover, the magnitude of the pass-through ratio depends on the following variables: the magnitude of cost externality α, the conjectural variation indices ρ and ρ_y, the cost share $C_x'/\gamma P$, the elasticities of the demand curves η and η_y, and the number of firms in country *H* relative to that in country *F*, i.e., *M*/*N*.

Let us first look at the effects of α on pass-through ratio:

$$\frac{\partial\varepsilon}{\partial\alpha} > 0. \tag{11}$$

That is, the larger α, the larger the degree of pass-through. The reason for this positive relationship is as follows. A larger α implies larger cost-enhancing externality. The true marginal cost of producing *X* will increase once this externality is taken into consideration. Firms will therefore increase the degree of pass-through as their profit margins decrease.

Equation (11) can be rewritten as (11a) and (11b) by using the definitions of economies and diseconomies of scope and the twice-differentiable property of the cost function:[5]

$$\frac{\partial\varepsilon}{\partial y} < 0, \text{ if economies of scope exist,} \tag{11a}$$

$$\frac{\partial\varepsilon}{\partial y} > 0, \text{ if diseconomies of scope exist.} \tag{11b}$$

5. Economies of scope in the production of *i* and *j* exist if $d(dC_i/di)/dj < 0$ ($i, j = x$ or y, and $i \neq j$). Therefore, an increase in the production of *j* will lower the marginal cost of good *i* and thus increase the production of good *i*. On the other hand, when $d(dC_i/di)/dj > 0$ ($i \neq j$), there are diseconomies of scope. Assume that cost functions are well defined so that $\partial(\partial C_y/\partial x)/\partial y = \partial(\partial C_y/\partial x)/\partial y$. Therefore, α will vary inversely with *Y* if there exist economies of scope because $\partial(\partial C_y/\partial y)/\partial x = \partial\alpha/\partial y < 0$. However, $\partial\alpha/\partial y > 0$ if there are diseconomies of scope. For the definition of economies of scope, see Bulow, Geanakoplos, and Klemperer (1985).

The conjectural variation index, ρ, reflects behavior patterns among competing firms and can thus be used as a measure of market structure for X (or Z). The more collusive the market of X and Z is, the larger ρ will be. From equation (10), we obtain the partial effects of market structure of X (or Z) on ε:

$$\frac{\partial \varepsilon}{\partial \rho} = -\frac{M(C_x' + \alpha)PV_y^2}{\eta^2 \gamma Q^2 \Delta^2} \begin{cases} < 0, \text{ if } C_x' + \alpha > 0, \\ > 0, \text{ if } C_x' + \alpha < 0, \end{cases} \text{ and} \tag{12}$$

Thus, if cost-saving externality is not too large ($C_x' + \alpha > 0$), the result obtained in Dombusch (1987) will hold. That is, collusive firms will pass through less of the changes in exchange rate to export prices (denominated in foreign currency) than will competitive firms. However, if $C_x' + \alpha < 0$, collusive firms will have a larger pass-through ratio than competitive firms.

Differentiating equation (10) with respect to cost share[6] ($C_x'/\gamma P$) and ε, holding other variables constant, we obtain

$$\frac{\partial \varepsilon}{\partial (C_x'/\gamma P)} = -\frac{MPV_y}{\eta Q \Delta} > 0. \tag{13}$$

Equation (13) thus implies that the larger the own-cost share relative to its export price, the larger the degree of pass-through.

In addition to γ, ρ, and C_x'/γP, the pass-through ratio also depends on demand elasticities (η and η_y) and the number of home firms relative to the number of foreign firms (M/N):

$$\frac{\partial \varepsilon}{\partial \eta} = \frac{MV_y Q \gamma (C_x' + \alpha)(\Delta - VV_y)}{\gamma^2 \eta^2 Q^2 \Delta^2} \begin{cases} > 0, \text{ if } C_x' + \alpha > 0, \\ < 0, \text{ if } C_x' + \alpha < 0, \end{cases} \tag{14}$$

$$\frac{\partial \varepsilon}{\partial \eta_y} = \frac{M\eta V_y Q \gamma (C_x' + \alpha)(\Delta - VV_y)}{\eta_y \gamma^2 \eta^2 Q^2 \Delta} \begin{cases} > 0, \text{ if } C_x' + \alpha > 0, \\ < 0, \text{ if } C_x' + \alpha < 0, \end{cases} \text{ and} \tag{15}$$

$$\frac{\partial \varepsilon}{\partial (M/N)} = \frac{(C_x' + \alpha)PV_y^2 N^2}{\gamma \eta^2 Q^2 \Delta^2} \begin{cases} < 0, \text{ if } C_x' + \alpha < 0, \\ > 0, \text{ if } C_x' + \alpha > 0, \end{cases} \text{ and} \tag{16}$$

where $V_y < 0$ and $(\Delta - VV_y) < 0$.[7]

Equations (14), (15), and (16) show that the sign of $C_x' + \alpha$ also plays an important role in determining the effects of η, η_y, and M/N on pass-through ratios. When $C_x' + \alpha > 0$, the effect of η, η_y, or M/N on ε is positive. That is when the demand for Q or Y becomes more elastic or the number of home

6. In the absence of cost externality, own-cost share ($C_x' / \gamma P$) and the behavior pattern among competing firms, ρ, have the same economic implications. However, the existence of cost externality makes these two variables different from each other (see eq. [1]).

7. The assumption of identical firms implies that $\partial X = M\partial x$ and $\partial Y = M\partial y$. This assumption together with $\partial(\partial C_y/\partial y) / \partial x = \partial(\partial C_y/\partial x) / \partial x$ ensure that $(\Delta - VV_y) = -M^2 / \gamma \, \partial\alpha / \partial Y \, \partial\beta / \partial Q < 0$, where $\partial\alpha / \partial Y \, \partial\beta / \partial Q = \partial\alpha / M\partial y \, \partial X / \partial Q \, \partial\beta / M\partial x > 0$.

firms relative to that of foreign firms increases, home firms will respond to an appreciation of F-currency primarily by lowering their prices and increasing their exports.[8]

When η or η_y is sufficiently large and $C'_x + \alpha > 0$, it is likely that the pass-through ratio will exceed one. That is, over pass-through will occur. In such a case, firms will raise export prices more than the extent of the appreciation of F-currency.

10.3 The Empirical Specification

This section presents an empirical framework which will be used to test the theoretical results of equations (11)–(15) in section 10.2, i.e., to test whether cost externality, market structure, cost share, and elasticities of demand curves have significant effects on the pass-through ratio, when other variables are kept constant.[9]

We assume that there are I products exported to J countries. For each product i ($i = 1, 2, \ldots, I$), its exports to different countries are treated as differentiated goods. In order to study the statistical significance of the determinants of pass-through ratios, data consisting of the pass-through ratios ε_i^j for product i ($i = 1, \ldots, I$) exported to country j ($j = 1, \ldots, J$) must first be derived from price equations. The price equation P_i^j, derived in its reduced form in section 10.2, is a function of all exogenous variables, i.e., exchange rate γ^j, market structure ρ_i, and demand elasticities of good i to market j (η_i^j) and to other markets (η_i^y). Since demand elasticities (η_i^j and η_i^y) and market structure (ρ_i) are assumed to be rather stable over the sample period studied here, each reduced-form price equation will thus be a function of exchange rate only. However, in order to capture the effects of inflation and quality changes on the export price over time, we also include the wholesale price index (WP) of that product as a proxy in each price equation (17):

$$\ln P_{it}^j = F(\ln \gamma_t^j, \ln WP_{it}), \tag{17}$$

where subscript t denotes time, P_{it}^j is denominated in j-currency, and γ_t^j is nominal exchange rate expressed as NT dollars per unit of j-currency.[10] A polynomial distributed lag model will be used to run equation (17), as the effects of exchange rates on export prices often exhibit an inverted-V shape (see, e.g., Hooper and Mann 1989; Moffett 1989; Khosla and Teranishi 1989). We will

8. This result is consistent with that from Dornbusch (1987, 97).

9. We will not consider the effect of the number of firms in country H relative to the number in country F on the degree of pass-through because of lack of data and the heterogeneity of firms in reality. In fact, part of the effect of the number of firms is already reflected in the market structure variable.

10. Alternatively, we can use nominal exchange rates adjusted for changes in the price level in the destination market (see e.g., Knetter 1989) to run equation (20). But the result of such an analysis is that more than half (107 out of 186) of the pass-through ratios are negative, which seems unreasonable. We therefore do not report the results here.

use the negative of the sum of the current and lagged coefficients of exchange rates as a proxy for the degree of exchange rate pass-through ε_i^j.

In addition to the derivation of pass-through ratios, the types of cost externality and the demand elasticities have to be identified and derived before proceeding to test the statistical significance of the determinants of pass-through equation (10).

For cost externality, as implied by equations (11a) and (11b), a continuous variable, such as exports to other markets (Y), cannot be used alone to capture cost externality for both cases with economies of scope and those with diseconomies of scope. However, by the definition of scope economies, marginal cost will be a function of exports to other markets. The following cost equation will thus be run over time and across destinations to identify the type of scope economies for each product i:

$$C_{it}^j = G(Y_{it}^j), \tag{18}$$

where C_{it}^j is the marginal cost of good i exported to destination j[11] and Y_i^j is the total sales of good i exported to destinations other than j. Therefore, product i will have economies of scope if the estimator of the coefficient of Y_i^j is negative, and diseconomies of scope if it is positive. By defining the dummy variable DY to be one if economies of scope exist (i.e., if Y_i^j has a negative coefficient) and zero if diseconomies of scope exist (i.e., if Y_i^j has a positive coefficient), we can distinguish two types of cost externalities by including both Y_i^j and the interaction term of Y_i^j with DY in the pass-through equation.

As to the derivation of demand elasticities, we will run the following export demand equation in log-linear form:

$$\ln Q_{it}^j = H(\ln P_{it}^j, \ln I_t^j, \ln AP_{it}^j), \tag{19}$$

where Q is export volume, I^j is importing country j's national income, and AP_i^j is the price of other goods in country j. The estimator of the coefficient of $\ln P_i^j$ will be used as demand elasticity η_i^j. The weighted average demand elasticities in all markets other than j will be used as the demand elasticity of differentiated goods (i.e., η_i^y).

Moreover as discussed in the previous section, the partial effects of market structure and demand elasticities depend crucially on the sign of $C_x' + \alpha$ (see eqq. [12], [14], and [15]). And from equation (10), positive (or negative) $C_x' + \alpha$ is a necessary and sufficient condition for positive (or negative) ε. Thus, the sign of $C_x' + \alpha$ can be derived from the sign of ε. Define the dummy variable DS to be one if ε is positive and zero if ε is negative. Including the interaction of DS with market structure and demand elasticities in the pass-through equation will then indicate the additional effects of these variables for the case of positive $C_x' + \alpha$ relative to the case of negative $C_x' + \alpha$.

11. Here, we assume constant marginal cost with respect to its own sales, i.e., $\partial C^j / \partial X_i^j = 0$.

After obtaining all the data needed, we run the following pass-through equation to test the statistical significance of the determinants of the degree of pass-through:[12]

$$(20)\ \varepsilon_i^j = \alpha_o + \alpha_1 SY_i^j + \alpha_2 (SY_i^j * DY) + \alpha_3 DS + \alpha_4 CR_i + \alpha_5 (CR_i * DS) + \alpha_6 SC_i + \alpha_7 \eta_i^j + \alpha_8 (\eta_i^j * DS) + \alpha_9 \eta_i^y + \alpha_{10} (\eta_i^y * DS) + u_i^j.$$

Since equation (20) is run cross-sectionally, we use the export share of good i to markets other than j (i.e., SY_i^j), rather than the export level Y_i^j, because the SY_i^j are comparable across products and destinations. The variable DY is the dummy used to distinguish the type of cost externality, while DS is the dummy used to separate the case of positive ε (or positive $C_x' + \alpha$) from that of negative ε (or negative $C_x' + \alpha$). The variable CR_i indicates the market structure for good i; SC_i indicates the cost share ($C_x'/\gamma P$) for good i; η_i^j and η_i^y indicate the demand elasticities of good i exported to destination j and to destinations other than j, respectively.

The expected signs of coefficients in equation (20) are as follows: a_1 and $a_1 + a_2$ measure the impact of cost externality on the degree of pass-through when there are diseconomies and economies of scope, respectively. By equations (11a) and (11b), we expect a_1 to be positive and $a_1 + a_2$ (if both are statistically significant) to be negative. This implies a negative a_2. From equation (10), a_3 is expected to be positive. Since the direct effect of market structure on pass-through ratios is positive for the case of negative $C_x' + \alpha$ (see eq. [12]), a_4 is expected to be positive. However, the effect will be negative for the case of positive $C_x' + \alpha$, and $a_4 + a_5$ is expected to be negative. Thus, a negative a_5 is expected. Similarly, by (13), a_6, which is the partial effect of cost share on the degree of pass-through, is expected to be positive. For the case of negative $C_x' + \alpha$, demand elasticities to destination j and to the rest of the markets, i.e., η_i^j and η_i^y, have negative impacts on pass-through ratios, thus a_7 and a_9 are expected to be negative (see eqs. [14] and [15]). On the other hand, a_7, a_8, and $a_9 + a_{10}$ are expected to be positive for the case of positive $C_x' + \alpha$.

10.3.1 The Data

Monthly exchange rates for different destinations for the period 1981–88 were obtained from the *Financial Statistics Monthly*, published by the Economic Research Department, Central Bank of Taiwan. Cross-sectional and time-series data on export value and quantity by product category and country of destination are available from the *Monthly Statistics of Exports and Imports of the Republic of China*, published by the Department of Statistics, Ministry of Finance. Export unit value, which equals the quotient of value and quantity,

12. We use structural equation (20) is because equation (10) is structural. For the justification of using this structural equation rather than the reduced-form equation, see the path analysis in Wonnacott and Wonnacott (1990, 417–25).

is used as the export price (P_i^j) in this paper. This may introduce measurement error, as product quality may change over time or across destinations. The measurement error from quality change over time can be reduced by including the wholesale price index in price equation (17). The measurement error from different qualities across destinations will not appear in this paper, as the pass-through ratios of each product are obtained for each country of destination.

Time-series data of wholesale price indices by product used in equation (17) are obtained from the *Commodity-Price Statistics Monthly, Taiwan Area,* published by the Directorate General of Budget, Accounting, and Statistics (DGBAS), Executive Yuan. The wholesale price indices used as a proxy for prices of other goods (AP) in equation (19) are drawn from *International Financial Statistics,* published by the International Monetary Fund. The same source is used for national income data.

Data for the cost variable in equation (18) for the period 1981–88 are derived from the *Reports on the Reexamination of Factories*, published by the Department of Statistics, Ministry of Economic Affairs. The cost variable here includes wages, material cost, electricity, and other expenditures. The cost share for equation (20), which is defined as the average cost per dollar of revenue, is calculated from the same source.

Concentration ratios for different products, which are defined as the total sales of the largest four ($CR4$) or eight firms ($CR8$) over industrial sales, are used as proxies for market structure ρ. These ratios are calculated from the *Industrial and Commercial Survey* for 1986, published by DGBAS, Executive Yuan. These ratios are classified by a 4-digit code that is different from the one used for trade data. Thus, the trade data are aggregated to concord with the classification of concentration ratios.

Twenty-one products exported to nine countries are investigated in this paper. These products are listed in table 10.1. The nine countries studied are Australia, Canada, West Germany, Hong Kong, Japan, the Netherlands, Singapore, the United States, and the United Kingdom, the nine largest trading partners for Taiwan.

10.4 The Empirical Results

Monthly data for 1981–88 are used to run equation (17), in which seasonal dummies are also included to capture seasonal fluctuations of prices. Following Kmenta's suggestion (1971, 492–95), we use the highest value of adjusted R^2 as the criteria to choose the length of lags and the degree of the polynomial. The length of lags and degree of polynomial chosen therefore vary across products and destinations. They range from 12 to 36 months for the length of lags, and from two to three for the degree of polynomial. The exchange rate pass-through ratios derived here are thus long-run pass-through ratios.

The total number of pass-through ratios obtained from equation (17) is 186, which is less than the theoretical maximum 189 (ie., 21×9) because data is

Table 10.1 Description of Product Categories

Product Item	Description
2022	Canned foods
2023	Frozen foods
2113	Soft drinks and carbonated water
2201	Cotton textiles
2204	Regenerated and synthetic fiber textiles
2205	Knitting apparel mills
2301	Wearing apparel
2409	Other leather products
2512	Plywood
2706	Synthetic resin and plastic materials
3001	Tires
3409	Other fabricated metal products
3541	Textile and garment-producing machinery
3613	Wires and cables
3619	Electronic products
3623	Electronic parts and components
3711	Ship building and repairing
3751	Bicycles and parts
3804	Watches and clocks
3905	Toys

Source: Industrial and Commercial Survey (Taipei: DGBAS, various issues).

Note: Product 2201 is divided into two parts, 2201A and 2201B, for different measuring units (kilometers and metric tons, respectively).

insufficient to run regression equation (17) in three cases.[13] Table 10.2 reports exchange rate pass-through ratios for Taiwanese exports by product and country. Three types of exchange rate pass-through—over, incomplete, and negative—are observed. Over, incomplete, and negative pass-through occur when the negative of the sum of the current and lagged estimators of exchange rates, respectively, exceeds one, is between zero and one, and is negative. Table 10.2 shows that more than half of the products (13 out of 21) have incomplete average pass-through, and 6 out of 21 products have over pass-through. Products 2113 and 3623 have negative pass-through, which implies that these two products have strong cost-saving externality. The average degree of pass-through also varies across countries of destination. For instance, pass-through is incomplete for Canada, West Germany, Hong Kong, Japan, and the United States, the five largest export markets for Taiwan. For other countries, the degree of pass-through exceeds one by a small margin. It seems that Taiwanese exporters tend to pass through to their export prices less than the full changes in exchange rate in order to maintain their competitiveness, especially in Canada, West Ger-

13. These three cases are product 2023 for Singapore, 2113 for West Germany, and 2201 for the Netherlands.

Table 10.2 **Exchange Rate Pass-Through Ratios by Product and Country**[a]

Product	Australia	Canada	West Germany	Hong Kong	Japan	Netherlands	Singapore	United States	United Kingdom	Average
2022	0.214	2.424	0.867	0.464	−1.82	0.941	1.965	0.265	−0.67	0.515
2023	1.495	−0.21	1.023	0.960	0.347	1.404	—	0.932	1.279	0.903
2113	0.735	0.150	—	0.429	2.698	−2.15	−0.44	−0.14	−3.19	−0.24
2201A	0.859	0.479	1.670	1.090	0.194	—	0.178	0.89	0.880	0.780
2201B	0.342	0.447	0.418	0.717	0.964	−0.35	1.171	1.372	−0.91	0.462
2204	0.022	−0.55	−3.64	−1.27	1.396	3.639	0.577	0.249	4.416	0.536
2205	0.700	0.057	0.529	0.656	1.544	0.510	2.861	−1.14	0.283	0.666
2301	0.737	0.985	0.350	−0.47	1.408	0.854	4.248	0.640	1.809	1.173
2409	1.052	−0.74	1.454	1.414	−0.63	1.305	0.777	−0.38	2.62	0.762
2512	1.212	1.563	−2.23	1.737	1.696	0.656	0.694	0.352	1.443	0.791
2706	0.831	−0.65	1.730	1.147	0.322	1.228	1.337	0.670	0.418	0.781
3001	1.433	1.070	0.266	1.123	0.912	0.536	2.245	1.161	0.721	1.052
3409	1.210	1.330	1.750	1.654	1.186	1.142	2.163	1.955	1.841	1.581
3541	1.375	1.797	0.815	6.264	1.110	1.853	0.072	−0.34	1.195	1.571
3613	1.266	1.608	0.752	1.021	−0.65	0.261	3.696	1.339	1.960	1.250
3619	5.314	2.050	4.415	−2.15	3.943	4.780	−2.97	2.378	6.407	2.684
3623	3.325	−6.62	−0.11	−2.61	0.790	2.997	−8.17	−0.86	3.345	−1.06
3711	0.730	−2.35	1.268	0.081	1.431	−0.07	5.697	−2.66	0.026	0.460
3751	1.150	0.466	0.018	0.383	0.208	1.162	1.591	2.591	0.228	0.866
3804	−1.09	2.603	−3.76	−1.77	3.138	0.928	5.036	0.953	−2.26	0.417
3905	1.349	−0.21	1.100	1.197	0.757	1.657	1.964	−0.40	1.559	0.996
Average	1.155	0.270	0.433	0.573	0.997	1.163	1.234	0.467	1.113	

[a]Exchange rate pass-through ratios are derived from equation (17).

many, the United States, and Hong Kong. Thus, incomplete pass-through may be one of the factors that cause sluggish adjustment in the trade balance, especially between the United States and Taiwan.

Table 10.3 reports the types of cost externality for each product, obtained from equation (18). Six out of 21 products—2022, 2201A, 2201B, 3619, 3711, and 3804—have diseconomies of scope, while the rest have economies of scope (see table 10.1 for product descriptions). Table 10.4 reports the price elasticities of demand curves (η_i^j) from equation (19).

The empirical results for equation (20) are summarized in table 10.5. In order to test whether pass-through ratios vary across destinations, country dummies are also added, and the United States is used as the base for country dummies. All variables reported in table 10.5 show the signs predicted by the theoretical model in the previous section. In terms of statistical significance, the coefficients of cost externality for the case of economies of scope ($SY * DY$), the dummy variable DS, demand elasticities for the case of positive pass-through ($\eta * DS$), and demand elasticities for other markets (η^y and $\eta^y * DS$) are significantly different from zero at the 5 or 10 percent level. The coefficients for market structure, though correct in sign, are not statistically significant at the 10 percent level for all cases in table 10.5 except case (1) where $CR4$ is used. The above results imply that cost externality does not have significant impact on the degree of pass-through for products with diseconomies of scope, while significant negative impact exists for products with economies of scope. Moreover, the results also imply that for the case of positive pass-through, demand elasticities ($\eta * DS$ and $\eta^y * DS$) play a rather important role in determining the degree of exchange rate pass-through for Taiwanese exports, while for the case of negative pass-through, only demand elasticities for other

Table 10.3 **Types of Cost Externality**[a]

Economies of Scope	Diseconomies of Scope
2023	2022
2113	2201A
2204	2201B
2205	3619
2301	3711
2409	3804
2512	
2706	
3001	
3409	
3541	
3613	
3623	
3751	
3905	

[a]Derived from equation (18).

Table 10.4 Price Elasticities of Demand Curves by Product and Country[a]

Product	Australia	Canada	West Germany	Hong Kong	Japan	Netherlands	Singapore	United States	United Kingdom
2022	−1.43	0.4	−1.00	1.18	1.32	−0.58	0.07	0.26	1.01
2023	0.52	−1.1	0.28	0.07	0.02	−0.93	—	0.52	0.21
2113	0.94	0.31	—	0.63	−0.12	−2.12	0.52	0.94	0.65
2201A	0.67	1.89	−1.21	1.15	0.46	—	−0.43	−1.66	−0.08
2201B	0.76	2.17	0.95	−0.03	0.59	0.14	0.37	1.12	0.77
2204	1.00	0.97	1.04	0.92	1.32	0.99	1.08	1.01	1.02
2205	2.21	0.41	0.44	0.55	0.1	1.24	1.34	1.3	0.44
2301	0.35	0.94	1.26	0.45	0.59	0.37	1.42	0.28	0.64
2409	0.6	0.46	0.84	1.00	0.9	0.38	0.35	0.51	1.12
2512	0.35	0.57	0	−0.29	0.03	0.72	1.17	0.51	−0.05
2706	0.73	−0.1	0.04	0.1	0.53	0.34	1.31	0.12	1.8
3001	−0.49	1.4	0.86	2.32	0.75	0.85	1.63	1.05	−0.06
3409	0.14	1.32	0.62	1.32	1.2	1.96	0.56	−0.01	1.26
3541	0.68	1.5	1.29	1.38	1.17	0.9	0.77	−0.99	−0.06
3613	0.08	0.57	0.7	−0.07	1.18	0.71	0.07	−0.09	1.22
3619	0.63	0.69	0.64	0.97	0.98	0.68	0.96	0.85	0.48
3623	1.26	1.08	0.86	0.74	1.04	0.93	0.37	0.72	0.92
3711	1.33	1.92	1.69	0.41	0.85	0.38	0.62	1.05	1.35
3751	0.02	0.35	−0.08	0.43	0.14	0.91	1.05	0.72	0.71
3804	0.04	0.06	0.02	−0.13	0.14	−0.23	0.66	1.17	1.03
3905	0.86	−0.03	0.42	0.35	0.5	0.45	0.5	−0.14	0.15

[a]Price elasticities are derived from equation (19).

markets (η^y) play an important role. However, market structure is not the main determinant of exchange rate pass-through. Table 10.5 also shows insignificant coefficients for all country dummies, which implies that the degree of pass-through for the other eight markets is not significantly different from that for the U.S. market. This result in turn implies that differences in pass-through ratios across countries stem mainly from different levels of cost externality (SY) and demand elasticities (η and η^y).

One may note that the effects of market structure on the degree of pass-through derived from equation (20) do not include indirect effects through other endogenous variables, e.g., cost externality and cost share. Thus, the insignificant direct effects of market structure from equation (20) may not imply insignificant total effects (the sum of direct effects and indirect effects). In order to find the total effects, we run the pass-through equation in its reduced form. The results are reported in table 10.6, which shows the same conclusions as table 10.5. That is, market structure does not have significant impact on the degree of pass-through even when total effects are considered. One reason for this result is that Taiwanese exporters face stiff competition in international markets and therefore cannot exert monopoly power in setting export prices even when the industrial concentration ratio is high.

So far, we have used long-run pass-through ratios. But what happens if

Table 10.5 **Determinants of Long-run Exchange Rate Pass-Through (from structural form of equation [20])**

	Estimated Coefficient (*t*-ratio)			
Variable	(1)	(2)	(3)	(4)
Constant	−2.99 (−0.93)	−2.99 (−0.97)	−2.81 (−0.85)	−2.76 (−0.88)
SY	0.78 (1.15)	0.77 (1.13)	0.82 (0.82)	0.82 (0.82)
*SY*DY*	−0.55 (−2.12)	−0.55 (−2.15)	−0.54 (−2.07)	−0.55 (−2.11)
DS	2.49 (4.20)	2.54 (3.77)	2.41 (3.97)	2.42 (3.50)
*CR*4	0.01 (0.56)		0.01 (0.41)	
*CR*8		0.004 (0.36)		0.002 (0.17)
*CR*4**DS*	−0.02 (−1.30)		−0.02 (−1.13)	
*CR*8**DS*		−0.01 (−1.17)		−0.01 (−0.95)
SC	1.81 (0.57)	1.86 (0.62)	1.71 (0.53)	1.76 (0.58)
η	−0.25 (−0.84)	−0.24 (−0.81)	−0.23 (−0.76)	−0.23 (−0.74)
η**DS*	0.48 (1.39)	0.46 (1.34)	0.45 (1.27)	0.44 (1.23)
η_y	−2.45 (−3.09)	−2.45 (−3.08)	−2.51 (−3.06)	−2.52 (−3.06)
η_y**DS*	2.62 (3.12)	2.60 (3.10)	2.70 (3.08)	2.69 (3.07)
Australia			−0.19 (−0.33)	−0.20 (−0.34)
Canada			−0.28 (−0.48)	−0.27 (−0.47)
West Germany			−0.33 (−0.59)	−0.35 (−0.62)
Hong Kong			−0.03 (−0.06)	−0.05 (−0.09)
Japan			−0.19 (−0.36)	−0.20 (−0.37)
Netherlands			0.14 (0.24)	0.14 (0.25)
Singapore			0.22 (0.38)	0.21 (0.37)
United Kingdom			0.17 (0.30)	0.16 (0.27)
R^2	0.5100	0.5115	0.5206	0.5220
Adjusted R^2	0.4820	0.4836	0.4689	0.4705
df	175	175	167	167

short-run pass-through ratios are used? Will they be affected significantly by the same factors as the long-run pass-through ratios? To study this, we derive short-run exchange rate pass-through ratios from equation (17) using lag length 12 and polynomial 3. The results from the pass-through equation are summarized in tables 10.7 and 10.8 for both the structural and reduced-form equations. Table 10.7 shows that cost externality and demand elasticities η are not the main determinants of short-run pass-through. And only the dummy variable *DS* and demand elasticities for other differentiated products (η * *DS* and/or η^y) have significant impact on both the structural and reduced-form equations.

10.5 Concluding Remarks

This paper focuses on the effects of cost externality on the degree of exchange rate pass-through from both theoretical and empirical perspectives. In the theoretical model, we show that the degree of pass-through depends crucially on the extent of cost externality. The larger the cost-enhancing exter-

Table 10.6 **Determinants of Long-run Exchange Rate Pass-Through (from reduced form of equation [20])**

	Estimated Coefficient (t-ratio)			
Variable	(1)	(2)	(3)	(4)
Constant	−0.91 (−1.72)	−0.88 (−1.45)	−0.88 (−1.49)	−0.80 (−1.22)
DS	2.50 (4.25)	2.56 (3.84)	2.40 (3.98)	2.42 (3.53)
*CR*4	0.004 (0.33)		0.003 (0.19)	
*CR*8		0.002 (0.20)		0.0001 (0.01)
*CR*4**DS*	−0.02 (−1.27)		−0.02 (−1.11)	
*CR*8**DS*		−0.01 (−1.17)		−0.01 (−0.94)
η	−0.22 (−0.75)	−0.22 (−0.73)	−0.20 (−0.67)	−0.20 (−0.67)
η**DS*	0.38 (1.12)	0.36 (1.07)	0.35 (0.99)	0.33 (0.95)
η_y	−2.22 (−3.05)	−2.22 (−3.04)	−2.33 (−3.01)	−2.34 (−3.01)
η_y**DS*	2.66 (3.22)	2.63 (3.18)	2.76 (3.19)	2.74 (3.16)
Australia			−0.05 (−0.12)	−0.06 (−0.13)
Canada			−0.12 (−0.29)	−0.11 (−0.26)
West Germany			−0.21 (−0.49)	−0.23 (−0.52)
Hong Kong			−0.09 (0.20)	0.08 (0.18)
Japan			−0.08 (−0.18)	−0.08 (−0.18)
Netherlands			0.27 (0.61)	0.27 (0.62)
Singapore			0.37 (0.86)	0.37 (0.85)
United Kingdom			0.31 (0.74)	0.30 (0.71)
R^2	0.4967	0.4977	0.5079	0.5088
Adjusted R^2	0.4769	0.4780	0.4645	0.4654
df	178	178	170	170

nality, the larger the degree of pass-through. However, when the cost-saving externality is sufficiently large, degree of pass-through may turn out to be negative. Moreover, the partial effects of market structure, elasticities of demand curves, and number of firms on the degree of pass-through will also depend on the extent of cost externality.

By using Taiwan's exports as a case study, we derived, in addition to the usual expected incomplete pass-through, over and negative pass-through from both the theoretical model (section 10.2) and the empirical study (section 10.4). We then tested the statistical significance of the determinants of exchange rate pass-through and found that the theoretical conclusions are supported by the empirical results. To be more specific, we obtained the expected signs for all the variables studied and showed that cost externality, in addition to demand elasticities, has significant impact on the degree of long-run pass-through. However, the determinants of short-run pass-through are somewhat different. That is, demand elasticities for differentiated goods are the main variables which significantly affect short-run pass-through. For both short-run and long-run pass-through, market structure—one of the main focuses of the pass-through literature—was shown not to have significant impact on the degree of pass-through for Taiwanese exports.

Table 10.7 **Determinants of Short-run Exchange Rate Pass-Through[a] (from structural form of equation [20])**

Variable	Estimated Coefficient (*t*-ratio)			
	(1)	(2)	(3)	(4)
Constant	0.48 (0.10)	0.75 (0.17)	0.28 (0.06)	0.55 (0.13)
SY	0.16 (1.17)	0.15 (0.15)	0.07 (0.05)	0.05 (0.04)
*SY*DY*	0.20 (0.55)	0.23 (0.63)	0.17 (0.47)	0.21 (0.56)
DS	2.36 (3.09)	2.68 (3.03)	2.26 (2.94)	2.54 (2.85)
*CR*4	0.003 (0.27)		0.003 (0.26)	
*CR*8		0.003 (0.32)		0.003 (0.32)
*CR*4**DS*	−0.002 (−0.08)		0.002 (0.10)	
*CR*8**DS*		−0.01 (−0.48)		−0.01 (−0.28)
SC	−2.43 (−0.52)	−2.75 (−0.62)	−2.19 (−0.47)	−2.51 (−0.57)
η	−0.13 (−0.43)	−0.13 (−0.44)	−0.06 (−0.21)	−0.07 (−0.23)
η**DS*	0.50 (1.16)	0.48 (1.11)	0.49 (1.13)	0.47 (1.09)
η_y	−0.80 (−1.16)	−0.79 (−1.15)	−0.87 (−1.26)	−0.86 (−1.25)
η_y**DS*	2.73 (2.63)	2.69 (2.62)	2.84 (2.68)	2.81 (2.67)
Australia			−0.38 (−0.46)	−0.38 (−0.46)
Canada			−0.83 (−1.00)	−0.81 (−0.98)
West Germany			0.79 (0.98)	0.79 (0.98)
Hong Kong			0.13 (0.18)	0.16 (0.21)
Japan			−0.28 (−0.37)	−0.26 (−0.34)
Netherlands			0.32 (0.39)	0.32 (0.40)
Singapore			0.46 (0.55)	0.47 (0.57)
United Kingdom			0.29 (0.34)	0.28 (0.34)
R^2	0.4732	0.4738	0.5056	0.5055
Adjusted R^2	0.4431	0.4437	0.4523	0.4523
df	175	175	167	167

[a]Derived from equation (17) with lag length 12 and polynomial degree 3.

Moreover, from the results of the empirical study it seems that products with incomplete average pass-through tend to be labor-intensive goods, while those with over pass-through tend to be capital-intensive.[14] Thus, factor intensity may also be one possible determinant of exchange rate pass-through and deserves further study.

One final point which might be worth mentioning is that, in addition to the determinants of the degree of pass-through discussed above, other factors not included in this study can also explain the low degree of pass-through for some

14. According to the *Report on the Characteristic Classifications of Tradeable Commodities*, published by the Department of Statistics, Ministry of Finance, the following products have high labor intensity or low capital intensity: canned food (2022), frozen foods (2023), other leather products (2409), synthetic resin and plastic materials (2706), electric parts and components (3623), bicycles and parts (3751), watches and clocks (3804), and toys (3905). While tires (3001), other fabricated metal products (3409), textile and garment producing machinery (3541), and wires and cables (3613) have medium or low labor intensity but medium or high capital intensity.

Table 10.8 **Determinants of Short-run Exchange Rate Pass-Through[a] (from reduced form of equation [20])**

Variable	Estimated Coefficient (*t*-ratio)			
	(1)	(2)	(3)	(4)
Constant	−1.63 (−4.06)	−1.66 (−3.86)	−1.75 (−3.24)	−1.79 (−3.17)
DS	2.30 (3.04)	2.59 (2.96)	2.21 (2.91)	2.46 (2.80)
*CR*4	0.01 (0.58)		0.01 (0.55)	
*CR*8		0.004 (0.57)		0.004 (0.55)
*CR*4**DS*	0.001 (−0.04)		0.003 (0.12)	
*CR*8**DS*		−0.01 (−0.41)		−0.004 (−0.23)
η	−0.10 (−0.31)	−0.08 (−0.29)	−0.03 (−0.10)	−0.02 (−0.08)
η**DS*	0.49 (1.16)	0.47 (1.10)	0.48 (1.13)	0.46 (1.07)
η_y	−0.78 (−1.20)	−0.77 (−1.18)	−0.90 (−1.33)	−0.88 (−1.31)
η_y**DS*	2.79 (2.78)	2.75 (2.75)	2.92 (2.87)	2.88 (2.83)
Australia			−0.30 (−0.50)	−0.30 (−0.50)
Canada			−0.75 (−1.26)	−0.74 (−1.23)
West Germany			0.88 (1.45)	0.88 (1.45)
Hong Kong			0.20 (0.33)	0.22 (0.37)
Japan			−0.22 (−0.37)	−0.20 (−0.34)
Netherlands			0.40 (0.68)	0.41 (0.69)
Singapore			0.53 (0.88)	0.54 (0.90)
United Kingdom			0.36 (0.61)	0.36 (0.60)
R^2	0.4714	0.4712	0.5043	0.5038
Adjusted R^2	0.4506	0.4504	0.4606	0.4600
df	178	178	170	170

[a]Derived from equation (17) with lag length 12 and polynomial degree 3.

major Taiwanese export markets, e.g., the United States. One example, which is rather common in Taiwan, is the high proportion of imported materials used in the production of exports.[15] The other example is transfer pricing by Taiwanese subsidiaries of companies based in the United States and other countries, which may also account for the low degree of exchange rate pass-through. Including these factors in the study may produce a more complete analysis of the determinants of exchange rate pass-through for Taiwan's exports and thus deserves more studies.

References

Aizenman, Joshua. 1989. Market power and exchange rate adjustment in the presence of quotas. *Journal of International Economics* 27:265–82.

Baldwin, Richard. 1988a. Hysteresis in import prices: The beachhead effect. *American Economic Review* 78(4):773–85.

15. See, for example, the study of the Japanese case by Khosla and Teranishi (1989).

———. 1988b. Some empirical evidence on hysteresis in aggregate US import prices. NBER Working Paper no. 2483. Cambridge, Mass.: National Bureau of Economic Research.

Branson, William H. 1989. Exchange rate pass-through in the 1980s: The case of U.S. imports of manufacturers: Comments. *Brookings Papers on Economic Activity,* no. 1:330–33.

Bulow, Jeremy I., John D. Geanakoplos, and Paul D. Klemperer. 1985. Multimarket oligopoly: Strategic substitutes and complements. *Journal of Political Economy* 93(3):488–511.

Dixit, Avinash K. 1988. Anti-dumping and countervailing duties under oligopoly. *European Economic Review* 32:55–68.

———. Hysteresis, import penetration, and exchange rate pass-through. *Quarterly Journal of Economics* 104(2):205–28.

Dornbusch, Rudiger. 1987. Exchange rates and prices. *American Economic Review* 77(1): 93–106.

Feenstra, Robert C. 1987. Symmetric pass-through of tariffs and exchange rates under imperfect competition: An empirical test. NBER Working Paper no. 2453. Cambridge, Mass.: National Bureau of Economic Research.

Fisher, Eric. 1989a. Exchange rate pass-through and the relative concentration of German and Japanese manufacturing industries. *Economics Letters* 31(1):81–85.

———. 1989b. A model of exchange rate pass-through. *Journal of International Economics* 26:119–37.

Froot, Kenneth A., and Paul D. Klemperer. 1989. Exchange rate pass-through when market share matters. *American Economic Review* 79(4):637–54.

Hooper, Peter, and Catherine L. Mann. 1989. Exchange rate pass-through in the 1980s: The case of U.S. imports of manufacturers. *Brookings Papers on Economic Activity,* 297–329.

Jabara, Cathy L., and Nancy E. Schwartz. 1987. Flexible exchange rates and commodity price changes: The case of Japan. *American Journal of Agricultural Economics* 69(3):580–90.

Khosla, Anil, and Juro Teranishi. 1989. Exchange rate pass-through in export prices—An international comparison. *Hitotsubashi Journal of Economics* 3(1):31–48.

Kim, Yoonbai. 1990. Varying parameter estimation of exchange rate pass-through. *Journal of Business and Economic Statistics* 8(3):305–15.

Kmenta, Jan. 1971. *Elements of econometrics.* New York: Macmillan.

Knetter, Michael M. 1989. Price discrimination by U.S. and German exporters. *American Economic Review* 79(1):198–210.

Kravis, Irving B., and Robert E. Lipsey. 1978. Price behavior in the light of balance of payments theories. *Journal of International Economics* 8(2):193–246.

Krugman, Paul. 1987. Pricing to market when the exchange rate changes. In *Real-financial linkages among open economies,* ed. Sven W. Arndt and J. David Richardson. Cambridge: MIT Press.

Mann, Catherine L. 1986. Prices, profit margins, and exchange rates. *Federal Reserve Bulletin* 72:366–79.

Marston, Richard C. 1990. Price behavior in Japanese and U.S. manufacturing. *Journal of International Economics* 29: 217–36.

Moffett, Michael H. 1989. The J-curve revisited: An empirical examination for the United States. *Journal of International Money and Finance* 8(3):425–44.

Ohno, Kenichi. 1990. "Exchange rate fluctuations, pass-through, and market share. *International Monetary Fund Staff Papers* 37(2):294–310.

Wonnacott, Thomas H., and Ronald J. Wonnacott. 1990. *Introductory Statistics for Business and Economics.* New York: Wiley.

Comment Won-Am Park

This paper is interesting and stimulating, as the author calls attention to the effect of cost externality on the pass-through relationship. The paper comprises two parts, one modeling, the other empirical. I will comment on them one at a time.

I have no objections to the setup of the model. However, it is very important to note that the derived model is confined to static pass-through. In the literature, models of pass-through can be grouped into three categories. One contains *hysteresis models,* which explain a structural break after a big movement in exchange rate. The other models try to find reasons for partial pass-through and are divided into two groups. One group is of *dynamic models,* which explain partial pass-through as a short-run response to exchange rate change. The other group contains *strategic interaction models,* which view such interaction as the source of partial pass-through in the static framework. The model presented here is of the last type, which emphasizes strategic interactions. To incorporate dynamics into the model, one must specify expectations formation for exchange rates and short-run adjustment costs.

The empirical part finds more questions than answers about Taiwanese pass-through. This problem is related to the specification of the estimation equation. The empirical investigation was carried out in two stages. The first is estimating the degree of exchange rate pass-through. The second is finding the determinants of exchange rate pass-through.

In the first stage, the author estimates equation (17) instead of equation (7), which is derived from the model, assuming that everything except exchange rate and prices is constant over time and that the effects of exchange rate on export price are reflected in the constant term of equation (17). This assumption is seriously misleading and could distort the final outcome of the paper.

Equation (17) takes the polynomially distributed lag form of exchange rates, in which the length of the lag ranges from 12 to 36 months. This specification can be applied when one wants to obtain rough estimates of pass-through elasticity without specifying the pass-through equation. If a reduced-form equation pass-through, such as equation (7), has been derived, however, it is not sensible to rely on equation (17).

The estimation results for pass-through elasticity by industry are reported in table 10.2. They vary significantly across industries and countries to which goods are exported. Furthermore, the estimated elasticity exceeds one frequently. These results could be avoided if equation (7) were directly estimated with domestic and foreign cost variables in the right-hand side. Then, the lagged coefficients might be less significant and pass-through elasticity might be less than one.

We now turn to the second stage—testing the significance of the determi-

Won-Am Park is a fellow at the Korea Development Institute.

nants of pass-through elasticity. The sample was divided into four groups: first into positive and negative pass-through groups, then each group was subdivided according to economies or diseconomies of scope.

The criteria for the division of the sample play an important role in detecting the impact of cost externality on exchange rate pass-through. If equation (7) is used to obtain the pass-through elasticity, the positive and negative pass-through groups so determined will be different from those in the paper. The criteria for determining economies or diseconomies of scope is crucial. In the paper, economies of scope were represented by negative correlation between marginal cost of good i exported to destination j and export share of good i to markets other than j. It would be better to explain how marginal costs are calculated.

For both the first-stage estimation of equation (17) and the detection of economies of scope on the basis of cost factors, time-series industry-specific cost data are required. If those data are not directly available, one could utilize wage and import price data to construct a cost series. Economies of scope might be better represented by negative correlation between unit cost of a certain industry, which is assumed to be the same across markets, and export share of good i to markets other than j.

Upon reflection, the estimation results are counterintuitive and not always convincing. In table 10.2, the pass-through elasticities of products which have economies of scope are not much larger than those of products which have diseconomies of scope. Also, Taiwan's exports to the United States show low pass-through. If economies or diseconomies of scope play an important role in determining the pass-through rate, there might exist diseconomies of scope for products which are exported to the United States because the United States is the largest export market for Taiwan. In table 10.5, the role of market structure which is represented by the concentration ratio turns out to be insignificant. These results could change if the pass-through is respecified.

I would like to recommend that a pricing-to-market model be used instead of a pass-through model if cost data are not easily available. Changes in costs are likely to be less important in pricing-to-market behavior between domestic and export markets. Furthermore, if the correlation between exchange rates and inflation is strong, the use of relative prices should be seriously considered in work concentrating on estimating pass-through elasticities.

Comment

Serguey Braguinsky

The theoretical model of incomplete pass-through in this paper is rather interesting. The main theme can be briefly restated as follows. Ceteris paribus, a

Serguey Braguinsky is associate professor of international economics at Yokohama City University.

firm, enjoying some degree of power in a foreign market, would respond to an appreciation of home currency by raising its export prices less and reducing its volume of exports less than would usually be expected, if in this case it faces cost-saving externality in the production of the export good. Thus, the exchange-rate appreciation would be passed through incompletely (see fig. 10C.1).

Let (P_{x0},X^0) and (P_{y0},Y^0) be profit-maximizing prices and quantities in the absence of external effects. In contrast, in the case of favorable external cost effects, the simplest profit-maximizing condition can be written as $P = C_x - P'X + \partial C_y (X,Y)/\partial X$, where $\partial C_y (X,Y)/\partial X < 0$; a similar condition can be specified for P_y. It immediately follows that the price is set lower and the quantity higher than in the absence of externalities. We express it in figure 10C.1 as a shift from point B on the marginal revenue curve to point E to the right of it for both X and Y. Starting from points B on each of the diagrams, increasing production lowers marginal costs in the production of both X and Y, producing a favorable cumulative effect.

Figure 10C.1 can also be used to illustrate incomplete pass-through. An appreciation of home currency relative to the currency of the country where X is marketed can be treated as an upward shift (from FE to BC) in the marginal cost curve of X denominated in foreign currency. If price is raised to $P_x{}^o$ and sales reduced to X^0, this will have an adverse effect on the marginal cost of producing Y. Cutting the production of Y will then feed back to the cost of producing X, etc. An unfavorable chain of events would be set in motion, so it pays to pass through less than what is dictated by the task of maximizing profit in the absence of externalities.

It is likely (and the paper shows this rigorously under its assumptions) that the production of Y will even be increased beyond Y' to offset some of the adverse effects on the marginal cost of X of an appreciating home currency. The extent of the increase (not shown in fig. 10C.1) will be determined by the strength of externalities present, the slope of the respective marginal revenue curves, and the relative sizes of the markets.

Several theoretical problems present themselves, however, at this stage. The most important of them is that, in the case of monopolistic behavior, not all of the increase in cost will be passed through to price in any case. The necessary and sufficient condition under which complete pass-through can be expected in the case of a monopolistic firm is that the demand and marginal revenue curves have the same slope at each X. This is so if the demand function can, for example, be written in the form $P = A - B\log(X)$. Since this cannot be generally expected, a difficult task for the empirical specification of the model in question is to determine, from the market demand function, the degree of pass-through incompleteness which would be observed even in the case where there are no external cost effects.

Since there is no reason to expect that the extent of cost externalities will be correlated in any way to particular forms of demand functions, it is difficult to

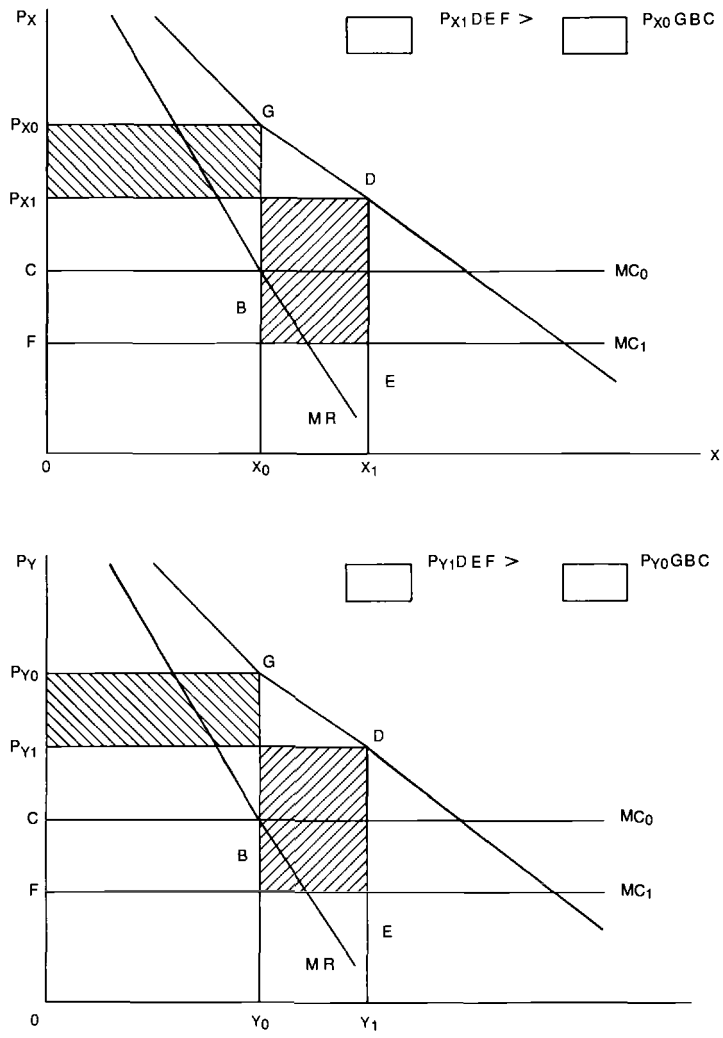

Fig. 10C.1 Cost externalities and the rate of pass-through

see how lower or higher degrees of pass-through among different products can be explained empirically by cost-externalities, as is attempted in the final part of the paper (I will have more to say about this later). In other words, differences between the products' demand functions may more than offset cost externalities in their effects on the degree of pass-through, and this is not taken into account adequately.

To tackle this problem, the author has either to assume linear demand functions for all products (and thus a pass-through ratio of 0.5 in the absence of externalities) or to postulate collusive behavior such that the absence of exter-

nalities will imply degree of pass-through equal to one. Neither attempt is made in the paper, indeed, the reaction functions (the ρ's) are left totally unspecified in section 10.2.

This problem can also be brought home by using the very mathematical model presented. Slopes of demand functions enter all the equations describing the reaction to exchange-rate appreciation (see particularly eqq. [8], [9] and [10]). For example, by differentiating equation (10) with respect to P' and P'_y, we see that when $C_x + \alpha$ is negative (strong cost-saving externality) $d\varepsilon/dP'$ and $d\varepsilon/dP'_y$ are less than zero, that is, smaller absolute values of P' and P'_y (more elasticity of demand for X and/or Y) imply smaller ε (less pass-through). In particular, it is clear that, under the same cost externality, Taiwanese firms facing more competitive and larger markets (say, the U.S. market) will pass through less exchange-rate appreciation than those facing smaller markets where demand curves for their products are less elastic.

Also, by differentiating equation (9), we find that, in the case of cost-saving externality and economies of scope, an increase of Y output in response to exchange rate appreciation will be greater, the greater the elasticity of demand for X and Y (that is, $d(dY/d\gamma)/dP' > 0$ when $C'_x + \alpha > 0$ and $d\beta/dQ > 0$, and similarly for $d(dY/d\gamma)/dP'_y$). In words, the more elastic the demand for X and Y, the more it pays to offset an increase in the marginal cost of producing X by expanding production of Y and relying on its favorable external effect. Those demand factors are too important for the empirical part to have real meaning without taking them into account.

Another remark is of a technical nature. In section 10.2, the marginal costs C'_x and C'_y are assumed constant. Taken literally, this means that the cost functions $C_x(x,y)$ and $C_y(x,y)$ are quasi-linear. It is also explicitly assumed that the cost functions are well defined, so that second partial cross-derivatives are equal. Then, $\partial\alpha/\partial y = \partial^2 C_y(x,y)/\partial x\partial y = \partial^2 C_y(x,y)/\partial y\partial x = \partial C'_y/\partial x = 0$, $\partial\beta/\partial x = \partial^2 C_x(x,y)/\partial y\partial x = \partial^2 C_x(x,y)/\partial x\partial y = \partial C'_x/\partial y = 0$, and, by definition, both economies and diseconomies of scope are ruled out. Obviously, the assumption must be changed from constant marginal costs to marginal costs of x and y independent of x and y, respectively.

Finally, it is not clear how market structure in the home country (Taiwan) can directly affect behavior in export markets. The monopolistic producer at home need not be monopolistic when he goes abroad. Thus, apart from its effect on cost share, it is difficult to see how pass-through can depend on internal market structure (thus the rejection of the relevant correlation as statistically insignificant in the empirical discussion appears to be perfectly true from a theoretical point of view as well).

Turning now to the empirical part, the idea of examining the existence of cost externalities indirectly, through the effects of exchange rate appreciation on export volume to other markets, is very neat. There seems to be no intrinsic need, however, to limit attention to export-oriented production alone. If the

differentiated product of the same type is produced for the domestic market as well, the existence of externalities would manifest itself in a similar way. Since, it is possible that more information can be obtained about domestic demand functions than about foreign ones, studying the former may help to distinguish externality effects from demand factors, the problem mentioned above.

Generally speaking, though, the empirical section can hardly be regarded as satisfactory. Too many problems remain, notably the already mentioned ambiguity surrounding the key question of what is to be regarded as "proper" pass-through (i.e., disregarding external effects) for each country and each product. The results seem to show that there is some correlation between cost-saving externalities and lower degrees of pass-through. But in view of the overwhelming importance of other factors, this could just be a coincidence, especially if we take into account the very low levels of R^2.

This suspicion is reinforced by differences in the degrees and even the signs of pass-through between products with similar technologies, which one expects to have similar cost externalities—the most striking example being cotton textiles (product 2201). This product is divided into two parts to reflect only different units of measurement, but one part exhibits negative and other rather high positive pass-through. It would have been more helpful, perhaps, if not only product and country averages were presented, but the whole 21×9 matrix of data.

In section 10.3, export shares of good i to markets other than j replace the theoretically correct export levels, obviously for technical reasons. But Liu should be well aware that these are not the same. Namely, if absolute volumes of export and production are falling for other markets, the external cost effects would be adverse even if the share of those other markets was increasing. Thus, the use of shares instead of volumes in determining the type of cost externality cannot be justified.

When dealing with different countries, Liu could also benefit from taking into account the general economic environment, such as price dynamics for competitive products produced in recipient countries relative to exchange rate dynamics. For instance, if the inflation rate in Great Britain was, indeed, higher than the degree of appreciation of the NT dollar against the British pound, this alone could explain a degree of pass-through greater than one. The problem can be addressed, as a first approximation, by using real and not nominal exchange rate appreciation.

It might also be helpful to distinguish between the cases of appreciation and of depreciation of the home currency. For example, in 1986 (the year in question) the NT dollar depreciated, rather than appreciated, against the German mark and the Japanese yen, and it is those countries that exhibit degrees of pass-through almost equal to one.

With the empirical results subject to many unanswered questions, time-series analysis can perhaps be attempted with better results than the cross-

sectional approach. In any case, it seems to be absolutely necessary to repeat the calculations for several years and see if the results obtained are really similar for most products and countries (which should be the case unless there were abrupt changes in technology). Only after such evidence relating to at least several points in time is produced, can the study claim any true empirical significance.