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THE RELATION BETWEEN INFLATION AND EXPORT PRICES: AN AGGREGATE STUDY

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I. Introduction

One of the alleged costs of inflation is said to be the loss of competitiveness in international markets if the rate of change of prices is higher in the domestic country than in the rest of the world. It is usually posited that this "external cost" of inflation can be quite severe for countries which rely heavily on foreign markets, thus requiring extra efforts on the part of policy makers to contain inflationary pressures, whether they are cost-push, demand-pull, or a combination of both. It is, of course, possible for a country with above-average inflation to devalue its currency in order to maintain, or even improve, its competitive position, but this does not absolve the country from the requirement of stemming the inflationary pressures in order to make the devaluation successful. But, even if the rate of inflation were the same in all countries, it is by no means clear that there would be no gains or losses of international competitiveness by individual countries. While inflation is measured by changes in the consumer price index, wholesale price index, or the implicit deflator of GNP, competitiveness in this context is determined by changes in the export price index in one country in relation to price changes in other countries.[1]

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1. In addition, equal changes in export prices in all countries may lead to different balance-of-payments effects depending on the price elasticities involved. But, this is the next stage of the analysis and since it is already part of the literature, it will not be further discussed.

While it is possible for domestic and foreign prices to move together under certain assumptions, it is neither theoretically mandatory nor empirically verifiable. It is the purpose of this paper to investigate the relationship between domestic and export prices and to determine the effects of exogenous inflationary forces on these two prices.

II. The Static Microeconomics of Domestic and Export Prices

During the 1920's and 1930's a number of authors investigated the relationship between domestic and export prices for a given commodity. These include Viner [3], Yntema [4], Gilbert [1], and others. The important element in the possible divergence between domestic and export prices was the existence of imperfect competition. A firm with some monopolistic power is able to compartmentalize the two markets in which it sells.[1]

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1. It is possible to segment the foreign and domestic markets because of tariffs and other impediments to the costless movement of goods but arbitrage is generally possible if the two prices diverge by more than the two-way transportation costs plus the foreign tariff. For instance if the domestic price is \$1.00 and the selling price to the foreign country is \$ .50, one-way transportation to the foreign country is \$ .10 (there are no domestic transportation charges) and the tariff is 10% of the landed price, then an arbitrager can purchase the commodity in the foreign country and return it to the domestic country at a cost of .50 + .10 + .1 (.50 + .10) + .10 = \$ .76. This operation would influence the foreign and domestic prices until $p \leq (p^* + s)(1 + t) + s$ where p and p* are the domestic and foreign selling prices, s is the one-way transportation charge and t is the tariff rate. If there is a drawback of a portion of the foreign tariff when the article is re-exported to the home country, the relationship becomes $p \leq (p^* + s)(1 + t\,\{1+ b\}) + s$ where b is the portion of the tariff rate which is returned to the importer in the foreign country upon re-export.

The pricing system is determined by

$$\pi = p\, q + p^{*}\, q^{*} - C(q + q^{*}) \tag{1}$$

where π represents total profits of the firm, p and p^* are the selling prices domestically and abroad, q and q^* are the quantities sold in each of the two markets and $C(q + q^*)$ is the cost function of total output. Profit maximization occurs when

$$\frac{\partial \pi}{\partial q} = \frac{dp}{dq}\, q + p - \frac{dC}{dq} = 0, \tag{2a}$$

$$\frac{\partial \pi}{\partial q^{*}} = \frac{dp^{*}}{dq^{*}}\, q^{*} + p^{*} - \frac{dC}{dq^{*}} = 0. \tag{2b}$$

After some rearrangement we can derive the following relationship:

$$\frac{p}{p^{*}} = \frac{1 + \frac{1}{e^{*}}}{1 + \frac{1}{e}}\ , \tag{3}$$

where e and e^* are the price elasticities of demand at home and abroad, respectively. If the firm is in perfect competition in both markets or if the demand elasticities are equal but less than infinite, then the firm will sell its product at the same price in both markets. If, however, the foreign elasticity is higher than the domestic elasticity, as is often suggested, the price in the foreign market will be lower than in the domestic market leading to the phenomenon commonly referred to as "dumping". This price differential will, of course, be limited by the arbitrage possibilities discussed above.

However, this type of analysis, which is microeconomic and static in nature, can give us little insight into the determination of aggregate domestic and export prices in the form of indexes or into the process by which these prices change over time when they are subjected to exogenous shocks.

III. A Model of Aggregate Domestic and Export Prices

In order to evaluate the effects of different types of inflationary pressures on price indexes, rather than individual prices, it is necessary to focus on the aggregative aspects of the problem. Assume that there are two industries in the economy, both of which produce for domestic consumption and exports.[1]

Define

P = price level of aggregate output,

Q = quantity of aggregate output,

P^* = price level of aggregate exports,

X = quantity of aggregate exports,

p_i = price level of output of i^{th} industry,

q_i = quantity of output of i^{th} industry,

x_i = quantity of exports of i^{th} industry,

S_i = supply of output of i^{th} industry,

D_i = domestic demand for output of i^{th} industry, and

a,b,c = shift variables.

Two identities can now be written:

$$P\,Q = p_1q_1 + p_2q_2 \tag{4}$$

and

$$P^*X = p_1x_1 + p_2x_2. \tag{5}$$

The assumption is now made that the output of the i^{th} industry is sold at equal prices in both the domestic and foreign markets.[2]

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1. Later, a third industry which does not export its output will be introduced, but it can conveniently be left out of the following analysis without any loss of generality.

2. Despite differences in elasticities, the threat of anti-dumping duties will force firms to adopt such a policy.

In equilibrium,

$$q_1 = S_1(p_1, a) = D_1(p_1, b) + x_1(p_1, c) \tag{6}$$

and

$$q_2 = S_2(p_2, a) = D_2(p_2, b) + x_2(p_2, c). \tag{7}$$

These two equations contain the assumption that there is no interaction between the two markets, or in other words, that the cross-elasticities are zero. This may be rather difficult to justify in a two-industry model, but with a large number of industries the spill-over effects of a disturbance in one industry would be quite small unless we are dealing with strong substitutes or complements.[1]

Differentiating (6) and (7) totally will allow us to solve for dp_1 and dp_2:

$$dp_i = \frac{(\partial D_i/\partial b)db + (\partial x_i/\partial c)dc - (\partial S_i/\partial a)da}{\partial S_i/\partial p_i - \partial D_i/\partial p_i - \partial x_i/\partial p_i} \qquad (i = 1,2). \tag{8}$$

The derivatives, dp_i/da, indicate shifts in the two supply curves. Since $\partial S_1/\partial a$ is not necessarily equal to $\partial S_2/\partial a$, the exogenous inflationary forces may not be the same for both industries. With some oversimplification, dp_i/da may be called cost-push inflation. Similarily, dp_i/db may be termed domestic demand-pull inflation and dp_i/dc would be foreign demand-pull inflation.

Substituting (6) and (7) into (4) and (5), we obtain

$$p = \frac{p_1 \cdot S_1(p_1, a) + p_2 \cdot S_2(p_2, a)}{S_1(p_1, a) + S_2(p_2, a)} \tag{9}$$

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1. An additional assumption is that foreign prices remain constant and thus they do not enter into the demand functions as arguments.

and

$$p^* = \frac{p_1.x_1(p_1,c) + p_2.x_2(p_2,c)}{x_1(p_1,c) + x_2(p_2,c)} . \tag{10}$$

Differentiating (9) with respect to $\underline{a}$,

$$\frac{\partial P}{\partial a} = \left[Q\left(\frac{\partial p_1}{\partial a} q_1 + p_1 \frac{\partial S_1}{\partial a} + p_1 \frac{\partial S_1}{\partial p_1}\frac{\partial p_1}{\partial a} + \frac{\partial p_2}{\partial a} q_2 + p_2\frac{\partial S_2}{\partial a} + p_2\frac{\partial S_2}{\partial p_2}\frac{\partial p_2}{\partial a}\right)\right.$$

$$\left. - PQ\left(\frac{\partial S_1}{\partial a} + \frac{\partial S_1}{\partial p_1}\frac{\partial p_1}{\partial a} + \frac{\partial S_2}{\partial a} + \frac{\partial S_2}{\partial p_2}\frac{\partial p_2}{\partial a}\right)\right]/Q^2 . \tag{11}$$

Substituting (8) into (11) on the assumption that db = dc = 0 and defining

$$\eta_{S_i} = (\partial S_i/\partial p_i)(p_i/q_i) = \text{supply elasticity},$$

$$\eta_{D_i} = (\partial D_i/\partial p_i)(p_i/D_i) = \text{domestic demand elasticity},$$

$$\eta_{x_i} = (\partial x_i/\partial p_i)(p_i/x_i) = \text{foreign demand elasticity},$$

and $\eta_{D+x_i} = (\partial D_i/\partial p_i + \partial x_i/\partial p_i)(p_i/q_i) = \eta_{D_i}(D_i/q_i) + \eta_{x_i}(x_i/q_i) =$ total demand elasticity, thenequation (11) can be rewritten as

$$\frac{\partial P}{\partial a} = -\frac{1}{Q}\left[p_1 \frac{\partial S_1}{\partial a}\left(\frac{1 + \eta_{D+x_1}}{\eta_{S_1} - \eta_{D+x_1}}\right) + p_2 \frac{\partial S_2}{\partial a}\left(\frac{1 + \eta_{D+x_2}}{\eta_{S_2} - \eta_{D+x_2}}\right) - P\frac{\partial S_1}{\partial a}\left(\frac{\eta_{D+x_1}}{\eta_{S_1} - \eta_{D+x_1}}\right)\right.$$

$$\left. - P\frac{\partial S_2}{\partial a}\left(\frac{\eta_{D+x_2}}{\eta_{S_2} - \eta_{D+x_2}}\right)\right]. \tag{12}$$

By appropriate choice of quantity units it is possible to equate the initial prices of the two products. Thus,

$$p_1 = p_2 = P. \tag{13}$$

This allows us to simplify equation (12) to

$$\frac{\partial P}{\partial a} = -\frac{P}{Q}\left[\frac{\partial S_1}{\partial a}\left(\frac{1}{\eta_{S_1} - \eta_{D+x_1}}\right) + \frac{\partial S_2}{\partial a}\left(\frac{1}{\eta_{S_2} - \eta_{D+x_2}}\right)\right] . \tag{14}$$

Since $\partial S_i/\partial a < 0$ for an upward shift of the supply curve, $\partial P/\partial a > 0$.

Similarily differentiating (10) with respect to a,

$$\frac{\partial P^*}{\partial a} = \left[X \left(\frac{\partial p_1}{\partial a} x_1 + p_1 \frac{\partial x_1}{\partial p_1} \frac{\partial p_1}{\partial a} + \frac{\partial p_2}{\partial a} x_2 + p_2 \frac{\partial x_2}{\partial p_2} \frac{\partial p_2}{\partial a} \right) - P^* X \left(\frac{\partial x_1}{\partial p_1} \frac{\partial p_1}{\partial a} + \frac{\partial x_2}{\partial p_2} \frac{\partial p_2}{\partial a} \right) \right] \Big/ X^2. \tag{15}$$

Substituting (8) into (15) and from

$$p_1 = p_2 = P^*, \tag{16}$$

we derive

$$\frac{\partial P^*}{\partial a} = - \frac{P^*}{X} \left[\frac{\partial S_1}{\partial a} \frac{x_1}{q_1} \left(\frac{1}{\eta_{S_1} - \eta_{D + x_1}} \right) + \frac{\partial S_2}{\partial a} \frac{x_2}{q_2} \left(\frac{1}{\eta_{S_2} - \eta_{D + x_2}} \right) \right]. \tag{17}$$

Again $\partial P^*/\partial a > 0$ unequivocally. Thus with cost-push inflation, both price indexes, P and P*, rise.

Next, let us examine the effects of a shift in domestic demand. That is, da = dc = 0.

$$\frac{\partial P}{\partial b} = \left[Q \left(\frac{\partial p_1}{\partial b} q_1 + p_1 \frac{\partial S_1}{\partial p_1} \frac{\partial p_1}{\partial b} + \frac{\partial p_2}{\partial b} q_2 + p_2 \frac{\partial S_2}{\partial p_2} \frac{\partial p_2}{\partial b} \right) - PQ \left(\frac{\partial S_1}{\partial p_1} \frac{\partial p_1}{\partial b} + \frac{\partial S_2}{\partial p_2} \frac{\partial p_2}{\partial b} \right) \right] \Big/ Q^2. \tag{18}$$

This reduces to

$$\frac{\partial P}{\partial b} = \frac{P}{Q} \left[\frac{\partial D_1}{\partial b} \left(\frac{1}{\eta_{S_1} - \eta_{D+x_1}} \right) + \frac{\partial D_2}{\partial b} \left(\frac{1}{\eta_{S_2} - \eta_{D+x_2}} \right) \right]. \tag{19}$$

Since $\partial D_i/\partial b > 0$, then $\partial P/\partial b > 0$. Also,

$$\frac{\partial P^*}{\partial b} = \left[X\left(\frac{\partial p_1}{\partial b} x_1 + p_1\frac{\partial x_1}{\partial p_1}\frac{\partial p_1}{\partial b} + \frac{\partial p_2}{\partial b} x_2 + p_2\frac{\partial x_2}{\partial p_2}\frac{\partial p_2}{\partial b}\right) - P^*X\left(\frac{\partial x_1}{\partial p_1}\frac{\partial p_1}{\partial b} + \frac{\partial x_2}{\partial p_2}\frac{\partial p_2}{\partial b}\right)\right] \Big/ X^2; \quad (20)$$

or

$$\frac{\partial P^*}{\partial b} = \frac{P^*}{X}\left[\frac{\partial D_1}{\partial b}\frac{x_1}{q_1}\left(\frac{1}{\eta_{S_1} - \eta_{D+x_1}}\right) + \frac{\partial D_2}{\partial b}\frac{x_2}{q_2}\left(\frac{1}{\eta_{S_2} - \eta_{D+x_2}}\right)\right]. \quad (21)$$

Again $\partial P^*/\partial b > 0$.

Finally the effect of a shift in foreign demand (that is, $da = db = 0$) can be indicated by

$$\frac{\partial P}{\partial c} = \left[Q\left(\frac{\partial p_1}{\partial c} q_1 + p_1\frac{\partial S_1}{\partial p_1}\frac{\partial p_1}{\partial c} + \frac{\partial p_2}{\partial c} q_2 + p_2\frac{\partial S_2}{\partial p_2}\frac{\partial p_2}{\partial c}\right) - PQ\left(\frac{\partial S_1}{\partial p_1}\frac{\partial p_1}{\partial c} + \frac{\partial S_2}{\partial p_2}\frac{\partial p_2}{\partial c}\right)\right] \Big/ Q^2, \quad (22)$$

or

$$\frac{\partial P}{\partial c} = \frac{P}{Q}\left[\frac{\partial x_1}{\partial c}\left(\frac{1}{\eta_{S_1} - \eta_{D+x_1}}\right) + \frac{\partial x_2}{\partial c}\left(\frac{1}{\eta_{S_2} - \eta_{D+x_2}}\right)\right]. \quad (23)$$

Since $\partial x_i/\partial c > 0$, therefore $\partial P/dc > 0$.

$$\frac{\partial P^*}{\partial c} = \left[X\left(\frac{\partial p_1}{\partial c} x_1 + p_1\frac{\partial x_1}{\partial c} + p_1\frac{\partial x_1}{\partial p_1}\frac{\partial p_1}{\partial c} + \frac{\partial p_2}{\partial c} x_2 + p_2\frac{\partial x_2}{\partial c} + p_2\frac{\partial x_2}{\partial p_2}\frac{\partial p_2}{\partial c}\right) - P^*X\left(\frac{\partial x_1}{\partial c} + \frac{\partial x_1}{\partial p_1}\frac{\partial p_1}{\partial c} + \frac{\partial x_2}{\partial c} + \frac{\partial x_2}{\partial p_2}\frac{\partial p_2}{\partial c}\right)\right] \Big/ X^2, \quad (24)$$

which reduces to

$$\frac{\partial P^*}{\partial c} = \frac{P^*}{X}\left[\frac{\partial x_1}{\partial c}\frac{x_1}{q_1}\left(\frac{1}{\eta_{S_1} - \eta_{D+x_1}}\right) + \frac{\partial x_2}{\partial c}\frac{x_2}{q_2}\left(\frac{1}{\eta_{S_2} - \eta_{D+x_2}}\right)\right]. \quad (25)$$

Similarily $\partial P^*/\partial c > 0$.

In order to measure the relative effects of any of these three exogenous changes on domestic and export prices we want to compare $\partial P/\partial a$ and $\partial P^*/\partial a$, $\partial P/\partial b$ and $\partial P^*/\partial b$, and finally $\partial P/\partial c$ and $\partial P^*/\partial c$. For instance, if $\frac{\partial P}{\partial a} - \frac{\partial P^*}{\partial a} > 0$, then an upward shift in the supply curves will result in a larger increase in the domestic price index then in the export price index.

From equations (13) and (16) we have $P = P^*$. Therefore,

$$\frac{\partial P}{\partial a} - \frac{\partial P^*}{\partial a} = P\left[\frac{\partial S_1}{\partial a} A_1\left(\frac{1}{X}\ \frac{x_1}{q_1} - \frac{1}{Q}\right) + \frac{\partial S_2}{\partial a} A_2\left(\frac{1}{X}\ \frac{x_2}{q_2} - \frac{1}{Q}\right)\right], \tag{26}$$

where $A_i = 1/(\eta_{S_i} - \eta_{D+x_i})$.

Whether equation (26) is positive or negative depends on a number of factors. Let us concentrate on the terms in the round brackets. For simplicity define

$$X = \alpha Q$$

and

$$x_i = \beta_i q_i \quad (i = 1,2).$$

Thus

$$\alpha = \beta_1 k + \beta_2 (1-k), \tag{27}$$

where $k = q_1/Q$. This implies that the total export-total output ratio is a weighted average of the export-output ratios of the two industries. Substituting into equation (26)

$$\frac{\partial P}{\partial a} - \frac{\partial P^*}{\partial a} = \frac{P}{Q}\left[\frac{\partial S_1}{\partial a}\ A_1\left(\frac{\beta_1}{\alpha} - 1\right) + \frac{\partial S_2}{\partial a}\ A_2\left(\frac{\beta_2}{\alpha} - 1\right)\right]. \tag{28}$$

Obviously if both industries export the same proportion of total output (i.e., $\beta_1 = \beta_2 = \alpha$) then $\partial P/\partial a = \partial P^*/\partial a$. Also if the second industry, for example, exports none of its output then

$$\frac{\partial P}{\partial a} - \frac{\partial P^*}{\partial a} = - \frac{P}{Q} \frac{\partial S_2}{\partial a} A_2 > 0.$$

If instead, there is a third industry which produces only for domestic consumption then equation (28) becomes

$$\frac{\partial P}{\partial a} - \frac{\partial P^*}{\partial a} = \frac{P}{Q} \left[\frac{\partial S_1}{\partial a} A_1 \left(\frac{\beta_1}{\alpha} - 1\right) + \frac{\partial S_2}{\partial a} A_2 \left(\frac{\beta_2}{\alpha} - 1\right) - \frac{\partial S_3}{\partial a} A_3 \right]. \quad (29)$$

If $\beta_1/\alpha > 1$, then $\beta_2/\alpha < 1$ and if the first two elements of equation (29) are roughly equal, but of opposite sign, then there is a tendency for $\partial P/\partial \alpha > \partial P^*/\partial a$. In general, the larger the number of industries which do not export, the more likely is it that domestic price increases will exceed export price increases. This tendency is reinforced if the shifts in the supply curves are smaller for "major" export industries (i.e., $\beta_i > \alpha$) than for "minor" export industries (i.e., $\beta_i < \alpha$). This may not be an unlikely event since firms which rely heavily on export markets may be less susceptible to cost-push inflation. In addition, following Kravis [2], it is likely that "major" export industries have higher supply elasticities than "minor" export industries. Then, if the demand elasticities are roughly equal, A_i will be smaller for "major" export industries than for "minor" export industries. All these factors put together indicate the possibility that $\partial P/\partial a > \partial P^*/\partial a$.

Now, turning to the effect of a shift in domestic demand, we can write

$$\frac{\partial P}{\partial b} - \frac{\partial P^*}{\partial b} = \frac{P}{Q} \left[\frac{\partial D_1}{\partial b} A_1 \left(1 - \frac{\beta_1}{\alpha}\right) + \frac{\partial D_2}{\partial b} A_2 \left(1 - \frac{\beta_2}{\alpha}\right)\right] . \quad (30)$$

Again, since both terms in the round brackets cannot be positive (or both negative) it is impossible to obtain a definite sign for equation (30). By adding the non-exporting industry, we obtain

$$\frac{\partial P}{\partial b} - \frac{\partial P^*}{\partial b} = \frac{P}{Q}\left[\frac{\partial D_1}{\partial b} A_1\left(1 - \frac{\beta_1}{\alpha}\right) + \frac{\partial D_2}{\partial b} A_2\left(1 - \frac{\beta_2}{\alpha}\right) + \frac{\partial D_3}{\partial b} A_3\right]. \quad (31)$$

Once more, the larger the number of non-exporting industries, the more likely is it that $\partial P/\partial b > \partial P^*/\partial b$. Finally, the effect of a shift in foreign demand, with one non-exporting industry, will be

$$\frac{\partial P}{\partial c} - \frac{\partial P^*}{\partial c} = \frac{P}{Q}\left[\frac{\partial x_1}{\partial c} A_1\left(1 - \frac{\beta_1}{\alpha}\right) + \frac{\partial x_2}{\partial c} A_2\left(1 - \frac{\beta_2}{\alpha}\right) + \frac{\partial x_3}{\partial c} A_3\right]. \quad (32)$$

But if we assume that the third industry does not export before or after the exogenous shift in foreign demand then $\partial x_3/\partial c = 0$ and equation (32) reduces to

$$\frac{\partial P}{\partial c} - \frac{\partial P^*}{\partial c} = \frac{P}{Q}\left[\frac{\partial x_1}{\partial c} A_1\left(1 - \frac{\beta_1}{\alpha}\right) + \frac{\partial x_2}{\partial c} A_2\left(1 - \frac{\beta_2}{\alpha}\right)\right]. \quad (33)$$

In this case it is likely that $\partial x_i/\partial c$ will be larger for the "major" export industry than for the "minor" export industry and thus $\partial P/\partial c < \partial P^*/\partial c$. But this may be offset by the fact that A_i is smaller for the "major" export industry.

In summary, cost-push or domestic demand-pull inflation, as they have been defined in this paper, will probably result in a larger increase in domestic prices than in export prices. On the other hand foreign demand-pull inflation will have a tendency to increase export prices more than domestic prices. Nevertheless, one can think of a constellation of parameters in equations (29), (31) and (33) which could reverse these propositions and a final answer depends on more *a priori* knowledge than can be gleaned from the model.

IV. Some Empirical Evidence on the Model

It is not the intention to subject the complete model of the previous section to empirical verification, since data on many of the variables are not available. But it is possible to reduce the model to a simpler version which can then be tested. Essentially,

$$dP/P - dP^*/P^* = f\ (da/a,\ db/b,\ dc/c). \qquad (34)$$

This equation uses rates of change rather than levels or differentials since price changes are usually measured in this way. Because the shift variables a, b, c are theoretical constructs, empirical counterparts are required to test the model. There are a number of factors which can cause supply or demand curves to shift. For our purposes, we will use an increase in unit labour cost as the variable which causes the supply curve to shift upward. Thus an increase in unit labour cost results in the same quantity being sold at a higher price. A shift in domestic demand will be denoted by increases in domestic GNP and a shift in the foreign demand curve will be represented by increases in foreign income. Thus a linear version of equation (34) with the appropriate proxy variables would be:

$$\Delta P/P - \Delta P^*/P^* = \gamma_0 + \gamma_1\ (\Delta L/L) + \gamma_2\ (\Delta Y/Y) + \gamma_3\ (\Delta Y^*/Y^*), \qquad (35)$$

where $\Delta P/P$ = rate of change of GNP price index,

$\Delta P^*/P^*$ = rate of change of price index of exports of goods and services,

$\Delta L/L$ = rate of change of unit labour cost,

$\Delta Y/Y$ = rate of change of domestic GNP,

$\Delta Y^*/Y^*$ = rate of change of foreign GNP.

If the hypothesis enunciated in the previous section is correct, one would expect that $\gamma_1 > 0$, $\gamma_2 > 0$ and $\gamma_3 < 0$.

This equation will be tested for two countries, Canada and Japan. As can be seen from Table 1, both of these countries are at extremes opposites. Canada had the highest rate of increase of export prices of the six countries enumerated but was very close to the best performance in terms of GNP prices. On the other hand, Japan had the second lowest rate of increase in export prices (in fact Italy's export prices showed a decline from 1956 to 1967) but had the highest rate of increase in GNP prices. Thus, if the model described in the previous section is to have any general applicability it should be able to explain the difference between rates of increase in GNP prices and export prices for two countries with such disparate experiences.

TABLE 1

Average Annual Rate of Change of Implicit Price Deflators for GNP and Exports of Goods and Services

Country	Years Covered	Average Annual Increase in GNP Deflator (percentages)	Average Annual Increase in Export Deflator (percentages)
Canada	1956-69	2.59%	1.55%
Germany	1956-67	2.95%	.93%
Italy	1956-67	3.47%	- .63%
Japan	1956-69	4.01%	.40%
United Kingdom	1956-67	2.55%	1.45%
United States	1956-69	2.49%	1.31%

The equation for Canada is tested with annual data for the period 1951-69. Foreign GNP in this case is U.S. GNP. Both growth rates of GNP are in money terms and unit labour costs are defined as total labour income divided by Gross Domestic Product. The resulting equation is

$$\frac{\Delta P}{P} - \frac{\Delta P^*}{P^*} = \underset{(.76)}{.640} + \underset{(3.19)}{.672}\frac{\Delta L}{L} + \underset{(2.34)}{.315}\frac{\Delta Y}{Y} - \underset{(2.39)}{.400}\frac{\Delta Y^*}{Y^*}$$

$\bar{R}^2 = .41$

d.w. = 1.88

The figures in brackets beneath the coefficients are t-test statistics.

For Japan, the equation used annual data from 1953 to 1968. Foreign GNP was defined as GNP for all OECD countries except Japan. Unit labour costs are defined as for Canada. The equation is

$$\frac{\Delta P}{P} - \frac{\Delta P^*}{P^*} = \underset{(1.08)}{2.916} + \underset{(1.49)}{.412}\frac{\Delta L}{L} + \underset{(1.43)}{.236}\frac{\Delta Y}{Y} - \underset{(1.65)}{.423}\frac{\Delta Y^*}{Y^*}$$

$\bar{R}^2 = .08$

d.w. = 2.27

Both equations give results which generally support the hypothesis of the previous section. The coefficients in the two equations conform to a priori expectations. Nevertheless, the equation for Japan has very low explanatory power and the coefficients are not significant at the .05% level. This can be explained in part by the fact that Japanese industry typically intensifies its export promotion during periods of recession or slow growth. This includes lowering of export prices to the point of covering only variable costs. Since this influences $\Delta P^*/P^*$ for those periods when export promotion is particularly strong, it makes the influence of $\Delta Y/Y$ ambiguous. Whereas the model hypothesized an increased spread between $\Delta P/P$ and $\Delta P^*/P^*$ when $\Delta Y/Y$ increases, the export promotion effect indicates that a lower $\Delta Y/Y$ has a downward effect on $\Delta P^*/P^*$.

V. Some Policy Implications of the Model

If equation (35) adequately represents the relationship between domestic and export prices, then it can be shown that the trade-off between improving the balance of payments and reducing unemployment may not be as large as is often considered. The following model will be used to investigate this hypothesis.

$$P = \lambda(Y - Y_f), \tag{36}$$

$$P - P^* = \phi(Y, Y^*, L), \tag{37}$$

$$B = X(P^*, Y^*) - M(P, Y), \tag{38}$$

where previously undefined variables are

Y_f = full-employment income,

B = balance of trade,

X = total exports,

M = total imports.

Equation (36) shows that prices increase as the gap between actual income and full-employment income closes, equation (37) is similar to equation (35) except that the relationship is expressed in levels rather than rates of change and equation (38) shows that exports are a function of export prices and foreign income while imports are a function of domestic prices and income.

In this model Y, domestic income, is the policy variable which can be influenced by monetary or fiscal policy.

Substituting equation (36) into (37) and holding Y_f, Y* and L constant, we obtain upon differentiation

$$dP = (\partial\lambda/\partial Y)\ dY, \tag{39}$$

$$dP^* = (\partial\lambda/\partial Y - \partial\phi/\partial Y)\ dY, \tag{40}$$

$$dB = (\partial X/\partial P^*)\ dP^* - (\partial M/\partial P)\ dP - (\partial M/\partial Y)dY. \tag{41}$$

Substituting (39) and (40) into (41) results in

$$dB/dY = (\overset{(+)}{\partial\lambda/\partial Y} - \overset{(+)}{\partial\phi/\partial Y})\ \overset{(-)}{\partial X/\partial P^*} - (\overset{(+)}{\partial M/\partial P})(\overset{(+)}{\partial\lambda/\partial Y}) - \overset{(+)}{\partial M/\partial Y}. \tag{42}$$

The signs above each element in equation (42) indicate that $dB/dY < 0$ if $\partial\lambda/\partial Y > \partial\phi/\partial Y$.

If, however, we replace equation (37) with a more naive hypothesis that

$$P = P^*, \tag{37'}$$

then

$$dB/\ dY = (\partial\lambda/\partial Y)(\partial X/\partial P) - (\partial M/\partial P)(\partial\lambda/\partial Y) - \partial M/\partial Y. \tag{43}$$

The only term in equation (42) which does not appear in (43) is $\partial\phi/\partial Y$; thus dB/dY from equation (43) has a larger negative value than dB/dY in equation (42).

In Figure 1, let tt' be the trade-off line from equation (43) and TT' from equation (42). Their crossing point is arbitrarily set at the point where B = 0.

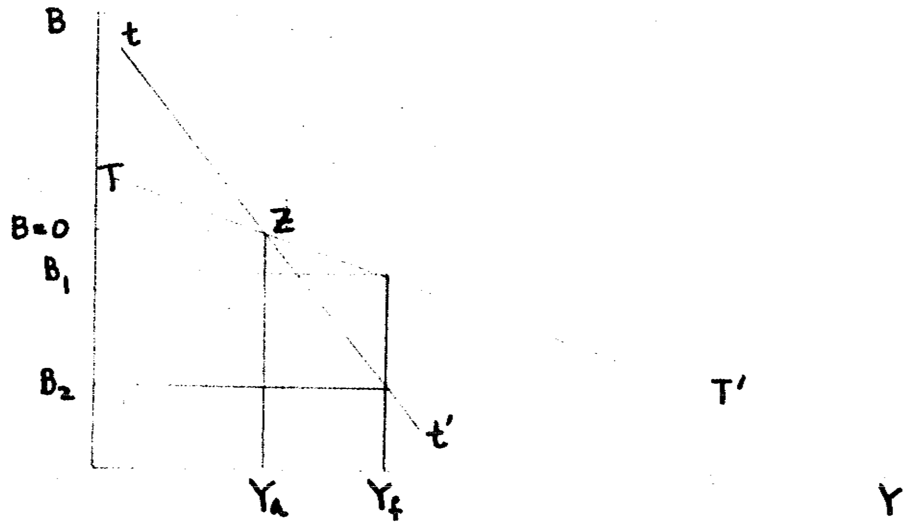

Figure 1: Two Trade-off Lines Between External and Internal Equilibrium

Assume that the economy is at Z where B = 0 and $Y = Y_a$. To get to full-employment income, Y_f, policy makers must use expansionary policy. This will lead to a balance-of-trade deficit. If the policy makers are working on the assumption of P = P* as shown in equation (37') then this expansionary policy would lead to a deficit of B_2. However if equation (37) is the more relevant relationship between P and P*, then the deficit will only be B_1. Thus if policy makers are operating with the naive hypothesis as shown by the trade-off line tt' they will be less likely to undertake the expansionary policy because their calculation of this "external cost" of pursuing such a policy will be larger than it actually is.

VI. Conclusion

Lest there be any confusion on the point, no attempt is made in this paper to <u>explain</u> inflation. Throughout the model, the inflationary forces were abstract, exogenous and arbitrarily catalogued into three categories. The focus of the paper has been on the relationship between aggregate domestic and export prices once inflation starts. The analysis has been in terms of comparative statics rather than dynamic, a characteristic which would have to be incorporated if the inflation process were endogenous to the model. Both the theoretical conclusions and the empirical evidence point to the possibility that aggregate export prices rise more slowly than GNP prices if the inflation is cost-push or domestic demand-pull, with opposite results for foreign demand-pull inflation. These observations are not irrefutable and more detailed analysis of specific countries and periods is certainly in order.

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