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INTERNATIONAL FINANCE DISCUSSION PAPERS

COMMENT ON "THE EFFECTS OF EXCHANGE RATE ADJUSTMENT ON
INTERNATIONAL INVESTMENT" BY DENNIS E. LOGUE
AND THOMAS D. WILLETT[1]

· by

Guy V.G. Stevens[2]

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This comment will concentrate exclusively on the direct investment aspects of the Logue & Willett-paper. Throughout the paper the authors make a number of theoretical and empirical statements applicable to the analysis of foreign investment. Their general conclusion, albeit tentative, is that both theory and fact imply that a devaluation of the dollar will discourage U.S. direct investment outflows and encourage direct investment into the United States. Thus, on page 1 they point to the trade-off between production abroad by U.S. subsidiaries and exports, stating: "During the period of overvaluation of the dollar, U.S. direct investment abroad was artificially stimulated in relation to exports whereas foreign investment in the U.S. was discouraged relative to exporting to the U.S." Later in section III.C they come to the same conclusion for apparently different theoretical reasons, emphasizing the lower foreign currency price of existing American assets after the U.S. devaluation. Finally in section III.C they adduce empirical evidence to support the same overall result.

I do not want to deny the authors conclusion. However, my position is that such a conclusion is much less obvious than the above arguments suggest; in fact, depending on the alternative ways a devaluation of the dollar can affect the costs and revenues of direct investors, one can make a plausible theoretical case for any outcome: the devaluation may discourage U.S. direct investment abroad, encourage it or leave it unchanged. We can arrive at such differing conclusions because there are a number of different ways that

devaluations can affect the revenues and costs of foreign subsidiaries.

_Perhaps it will help to clarify the issues to explore the effects of exchange-rate changes in the context of a simple model of the profit-maximizing international firm.[3] The main point will be to trace the effect of exchange-rate changes on the output of a U.S. foreign subsidiary; although I will not trace the subsequent effects in this comment, changes in output will have effects in the same direction on the capital stock of the subsidiary and, presumably, the financing of investment by capital outflows from the U.S.: U.S. direct investment. The analysis will be partial equilibrium, which can of course lead to errors; but, unfortunately, none of our research has gone beyond this point.

We need consider only the simplest kind of model. The profits (P) of a given foreign affiliate at any time t are equal to its revenues (R) minus it costs (C). Revenues are assumed equal to price time output (pQ), and costs are some increasing function of output [C(Q)]. An important question is in what currencies these revenues and costs are denominated.

The first case, leading to a conclusion that a devaluation has no effect at all, is that of a subsidiary which sells all its output in a given foreign market and incurs all its costs in foreign currencies: i.e. it employs only foreign labor and buys its capital inputs abroad (a very common phenomenon). Letting the subscript f stand for foreign currency units and $ for magnitudes expressed in

dollars, for this case the profits of the subsidiary are initially wholly in foreign currency:

$$P_f = p_f Q - C_f(Q) \tag{1}$$

The U.S. owners, we assume, ultimately want only dollars; so the value of these profits to a U.S. owner is the foreign currency value times the exchange rate (dollars per unit of foreign currency):

$$P_\$ = x P_f = x(p_f Q - C_f(Q)) \tag{2}$$

Assuming that the U.S.-owned firm maximizes dollar profits, the output of the foreign subsidiary will be set so that marginal revenues in dollars will equal marginal costs in dollars. But in this case, since the exchange rate simply multiplies both revenues and costs in foreign currencies, the optimal point is reached when marginal revenue equals marginal cost denominated in foreign currency:

$$\frac{dP_\$}{dQ} = x(MR_f - MC_f) = 0, \text{ or } MR_f - MC_f = 0 \tag{3}$$

Equation (3) shows that the exchange rate does not enter into the marginal equation determining optimal output; hence exchange rate changes in any direction will not affect the level of output, capital stock, or direct investment of such a subsidairy. This is true even though the _value_ of such a firm or asset to its U.S. owners is definitely increased by a devaluation (an increase in x). Letting r be the discount rate, the value of this firm V in a perfect market will be the present value of its future profits:

$$- V_\$(0) = x \int_{t=o}^{\infty} P_f(t)e^{-rt}dt \qquad\qquad (4)$$

Clearly a given percentage change in the exchange rate leads to the same percentage change in the dollar value of the asset. However, this need not, and does not in this case lead to a change in direct investment. Such results may seem paradoxical, but they aren't if we remember that the exchange rate has changed nothing at the margin, increasing, rather, the rate of profit on all intra-marginal units. Further, the rate of return on the firm will not change, since the dollar value of both profits and the value of the firm have changed by the same percentage; the only real change is that the owner of the firm at the time of the devaluation has reaped a once-and-for-all windfall gain. In fact, Logue and Willett implicately recognize this case when they analyze portfolio investment (section III.A); however, they did not consider its application to direct investment.

One can get different results by having the exchange rate affect the profits of the foreign affiliate in more complicated ways. The key is whether the exchange rate affects directly the profits of the foreign affiliate (P_f) before they are changed into dollars to be remitted to the U.S. owners. A simple case, showing that a dollar devaluation can have a positive effect on output and direct investment is that where the foreign subsidiary uses an input imported from the United States. We can represent this by splitting the subsidiary's cost function into two parts: costs initially denominated in foreign currency $[C_f(Q)]$ and U.S. currency $[C_\$(Q)]$. As the dollar depreciates,

the foreign currency cost of this latter input decreases as can be seen by the modified expression for subsidiary profits (in foreign currency units):

$$P_f = P_f Q - C_f(Q) - \frac{C_\$(Q)}{x} \qquad (5)$$

Contrary to the previous model, the optimal level of output is affected by the exchange rate:

$$\frac{\partial P_\$}{\partial Q} = 0 = \frac{\partial}{\partial Q} \{x \, P_f Q - x C_f(Q) - \frac{x C_\$(Q)}{x} \} \quad \text{which implies}$$

$$x MR_f = x MC_f + MC_\$ \qquad (6)$$

Intuitively we can see that as x increases (the dollar is devalued), the dollar marginal revenue is now greater than the total marginal cost in dollars ($x MC_f + MC_\$$). Hence, we would expect output to expand until the equality is re-established. This can be established rigorously by differentiating the marginal condition (6) with respect to the exchange rate (x), and solving for dQ/dx.

$$MR_f + x \frac{dMR_f}{dQ} \frac{dQ}{dx} = MC_f + \frac{x dMC_f}{dQ} \frac{dQ}{dx} + \frac{dM_\$}{dQ} \frac{dQ}{dx}$$

$$\text{Hence} \quad \frac{dQ}{dx} = \frac{MR_f - MC_f}{x \dfrac{dMC_f}{dQ} + \dfrac{dMC_\$}{dQ} - x \dfrac{dMR}{dQ}} \qquad (7)$$

The second order condition for a profit maximum implies that the denominator of (7) must be positive (marginal revenue is decreasing faster than total marginal cost). And equation (6) shows that $MR_f - MC_f$ is greater than zero, hence $\frac{dQ}{dx}$ must also be positive -- as

we deduced intuitively. But this is a conclusion opposite to that of Logue and Willett, since direct investment will increase as Q increases.

Finally, the Logue-Willett conclusion can be supported in the following two ways, both of which cause the revenues of the foreign-produced good to be reduced. First, what if the international firm supplies the same market by both exporting from the United States and producing the same commodity abroad? Second, what if U.S. firms export products that are imperfect substitutes for the production of foreign affiliates?

To keep the analysis simple and comparable to the previous example, assume first that an identical good is produced in both locations.[4] The total amount sold in the foreign market is, as before, Q; but this amount is made up of a part, Q_1, produced in the United States and a part, Q_2, produced abroad. Of course $Q_1 + Q_2 = Q$. If we assume that the marginal costs of producing are increasing, then we get a interior maximum. The firm maximizes profits as before, but now there are two interrelated problems: how much to produce (Q) and where to produce it (the division of Q between Q_1 and Q_2). Substituting $Q_1 + Q_2$ for Q, the firm maximizes profits with respect to Q_1 and Q_2, where P now equals:

$$P_\$ = x \, p_f(Q) \cdot [Q_1 + Q_2] - x \, C_f(Q_2) - C_\$(Q_1) \tag{8}$$

Maximizing with respect to Q_1 and Q_2, we get two marginal equations (note that $\frac{\partial Q}{\partial Q_i} = 1$):

$$\frac{\partial P_\$}{\partial Q_1} = 0 = x(\frac{\partial P_f}{\partial Q} [Q_1 + Q_2] + P_f) - \frac{\partial C_\$}{\partial Q_1} \qquad (9)$$

$$\frac{\partial P_\$}{\partial Q_2} = 0 = x(\frac{\partial P_f}{\partial Q} [Q_1 + Q_2] + P_f) - \frac{x \partial C_f}{\partial Q_2} \qquad (10)$$

Since the first term in parentheses is equal to marginal revenue, we have the familiar condition that marginal cost in each location is set equal to the common marginal revenue (MR). Note also that the exchange rate does not cancel from equation (9).

To find the effect of a dollar devaluation on direct investment, we again calculate the effect of a change in x on foreign output, Q_2. A standard comparative static analysis shows that dQ_2/dx equals the following:

$$\frac{dQ_2}{dx} = \frac{MR \ (\partial MR/\partial Q)}{[x \ dMR/dQ - dMC_\$/dQ_1][dMR/dQ - dMC_f/dQ_2] - x(dMR/dQ)^2} \qquad (11)$$

Since MR > 0, and since $\partial MR/\partial Q$ can be of any sign, we see that the effect of the exchange rate on foreign subsidiary output is _ambiguous_; but for the usual case where marginal revenue is decreasing ($\partial MR/\partial Q < 0$), a devaluation will decrease foreign output and direct investment.

It is instructive to look at this effect as the exchange rate affecting the _marginal revenue_ curve of the foreign subsidiary. Thus, in the case where perfect competition prevails, increased exports from the United States will not affect the price at which foreign subsidiary output will be sold ($\partial MR/\partial Q = 0$); hence $\frac{dQ_2}{dx} = 0$.

It might be noted that commodities need not be perfect substitutes for effects such as those in equation (11) to be observed. U.S. exports may be imperfect substitutes for U.S. foreign subsidiary production (e.g. big American cars and little European cars produced by U.S. affiliates); nevertheless, as long as there is some cross-elasticity of demand, changes in U.S. exports brought on by devaluation will affect foreign subsidiary output and direct investment.[5]

In summary, the theoretical story of the effect of a devaluation on direct investment is, in my opinion, ambiguous. It should be emphasized, further, that all the analysis, so far, has been partial equilibrium in nature; much more can happen as we move to the overall general equilibrium solution.

In view of this theoretical ambiguity, the ball would seem to be in the court of the empiricists. Unfortunately, as I am sure Messrs. Logue and Willett would agree, we have as yet virtually nothing on the empirical side to aid in the choice of the right theoretical model. The authors tentatively point to data on foreign investment into and out of the United States as support for their thesis that a devaluation decreases outflows of direct investment and increase inflows. I know nothing about the upsurge in inflows reported by the authors. On the outflow evidence, however, there are alternative conjectures at least as plausible as that of Logue and Willett. Other qualified observers attribute the pattern of 1973 to a high speculative outflow in the beginning of the year in anticipation of the subsequent devaluation; following the devaluation there were lower-

than normal outflows, not because foreign subsidiary output had been cut, but because the higher anticipatory outflows had reduced financial needs for the remainder of 1973. Thus if investors antici- pated the devaluation, the flows observed in 1973 could have occurred under any of the hypotheses set out above.

FOOTNOTES

1. The paper by Logue and Willett and the following comment were delivered at the Conference on the Effects of Exchange Rate Adjustments, sponsored by the Treasury Department and the Federal Reserve Board, and held April 4 and 5, 1974. Both pieces will be published in Peter Clark, D. Logue and R. Sweeney, eds., The Effects of Exchange Rate Adjustments, (U.S. Government Printing Office, 1974).

2. Chief, Quantitative Studies, International Division, Federal Reserve Board. Many of the ideas presented below were developed over the years in conversation or colloboration with others. I would like to recognize, in particular, Michael Adler, with whom I wrote the article cited in footnote 4 and my colleagues, Dale Henderson and Ray Lubitz.

3. The models discussed below (for what they are worth) were developed over a long period of time. I was not aware of any published literature in this area, but I assumed there must be some. After delivering this comment at the Treasury Conference, I had the good fortune to read an excellent paper by Susan Alexander of Southern Methodist University (dated Dec. 10, 1973). In her review of the literature Ms. Alexander confirms that economists have generally neglected the effects of devaluation on direct investment, but she does point to a few treatments by Meade, Sidney Alexander, H.P. Gray and Houthakker. According to Ms. Alexander all but Houthakker reach the conclusion of the first case discussed below: that devaluation does not affect direct investment. Houthakker, alone, "hints" at a negative effect, but presents no real analysis in support of the conclusion.

Ms. Alexander, by the way, hits the nail on the head by maintaining that one must do a careful analysis of the currencies in which revenues and costs are denominated.

The full references for the works cited above are:

James Meade, The Balance of Payments, (Oxford Univ. Press,1951) Chapters V and VIII.
Sidney Alexander, "Effects of a Devaluation on the Trade Balance," IMF Staff Papers,April,1952,pp.263-278.
H.P. Gray, "U.S. Foreign Investment and the Dollar Exchange Rate," Economia Internazionale, August, 1966, pp. 10-12.
H.S. Houthakker, "Should we Devalue the Dollar?" Challenge, October, 1962, pp. 10-12.

4. It is easy to show that there will be production in both locations only if one or both marginal cost curves are increasing. With constant returns to scale in both locations we would never see production of an identical good in both places; exchange rate changes might, however, have an effect by causing a total shift in production from one location to another. For a full development of this point in the analytically similar case of tariffs, see Thomas Horst, "The Theory of the Multinational Firm: Optimal Behavior Under Different Tariff and Tax Rates," Journal of Political Economy, September/October 1971, pp. 1059-1072.

5. See Michael Adler and Guy Stevens, "Direct Investment and Trade: An Analysis of the Export Displacement Effect," Discussion Paper #41, Division of International Finance, Federal Reserve Board (forthcoming, May 1974, in the Journal of Finance).