Exchange-Rate Uncertainty and Foreign Direct Investment in the United States

By

David O. Cushman

Contents: I. Introduction. – II. Some Models of the Multinational Firm. – III. Empirical Tests with U.S. Direct Investment Inflows. – IV. Economic Impacts on FDI from Exchange Rate Factors. – V. Summary and Conclusions. – Appendix.

I. Introduction

While economists have frequently analyzed both the theoretical and empirical effects of exchange rate uncertainty on international trade flows (for a summary, see Cushman [1988]), they have less often investigated its effects on another multinational firm activity, foreign direct investment (FDI). Some initial theoretical work analyzed FDI in a portfolio theory framework. Rugman [1977; 1979] emphasized the role of direct investment in the diversification of real assets by the multinational firm. In such a context, a rise in bilateral exchange risk would presumably raise a foreign subsidiary's "market risk" and lower the desired holdings of foreign real assets, similar to models of international financial assets [Branson and Henderson, 1985]. This result for FDI can be seen more explicitly in Hartman [1979, p. 219, eq. (11)] and Siegel [1983, pp. 31–37].

However, Itagaki [1981] and Cushman [1985] indicated a number of situations in which uncertainty could also theoretically *increase* FDI, for example, as a substitute for reduced exports. In the only empirical analysis conducted thus far, Cushman [1985] found that the increase in real exchange rate variability under floating had indeed apparently stimulated U.S. FDI outflows. Meanwhile, an expected appreciation of, or a high level of foreign currency price reduced U.S. FDI outflows.

In this paper, I attempt to augment the paucity of empirical work in the area by discovering whether or not similar effects can be found for FDI *into* the United States. Compared to Cushman [1985], the current paper uses an additional measure of exchange risk and an improved expectations variable. And the data runs through 1986 rather than 1978. But first, the paper presents a summary of theoretical possibilities. This highlights certain factors overlooked by the Siegel, Itagaki, and Cushman papers.

Remark: I would like to thank Greg Fouch of the Bureau of Economic Analysis, U.S. Department of Commerce, for helpful discussion about BEA's foreign direct investment data. However, I bear full responsibility for all interpretations presented here as well as any errors.

II. Some Models of the Multinational Firm

A firm considering a direct investment may experience considerable uncertainty over the future course of profits from that investment. Given that such uncertainty will be due in part to uncertain future changes in the exchange rate, the firm will respond to its estimates of the expected value and standard deviation of the future change in the exchange rate. The models that follow use a two-period framework in which an investment is made now and uncertain profits are earned in the future. Assuming real profit maximization and uncertain future exchange rates and domestic and foreign inflation rates, the random variable becomes the future change in the real exchange rate.

Production processes are assumed to use two inputs, capital and labor, and can occur at home or abroad. All capital, domestic or foreign, is financed at home, so foreign capital acquisitions constitute FDI under the U.S. Department of Commerce definition. All output is final output. Now we analyze several key structures implied by the above which can have different effects on FDI.

First, consider the simplest: foreign production with output sold abroad. The future real profits (π) of such a firm would be (see Table 1 for variable definitions)

$$\pi_{DI} = [P^*Q^* - W^*L^* + (1-d)Pk^*K^*]\,R\theta - (1+i)\,Pk^*R\,. \qquad (1)$$

The first term gives future revenue, the second gives future labor cost, the third gives the future value of the capital asset, and the fourth gives future capital liability, all in future home currency.[1] The uncertain variable is θ, the future change in the real exchange rate.

Table 1 - *Variable List*

P, P*	= domestic and foreign real price of output
Q, Q*	= domestic and foreign output
K, K*	= domestic and foreign capital stock
L, L*	= domestic and foreign labor input
Pk, Pk*	= domestic and foreign real capital price
W, W*	= domestic and foreign real wage rate
i, i*	= domestic and foreign real interest rate
n, n*	= 1 - (1/output price elasticity of demand)
d	= capital depreciation rate
R	= real price of foreign exchange
θ	= R_{t+1}/R_t
Z	= exports to the foreign country, or imports from the foreign subsidiary if Z is negative

[1] Note that the future liability is not affected by exchange rate changes since it is initially denominated in home currency.

Now for simplicity we assume the firm maximizes its utility:

$$U = E\pi - \Phi\sigma\pi\,, \tag{2}$$

(as used by Hooper and Kohlhagen [1978] and Cushman [1985]) where E = expected value, σ = standard deviation, and $\Phi > 0$ implies risk aversion.

Now assume homogeneous decreasing returns to scale production function $Q^*(K^*, L^*)$ and demand function $P^*(Q^*)$ and substitute (1) into (2). Then maximize with respect to K^* and L^* to obtain the following first-order conditions:

$$U_{K^*}\!: \; P^*n^*Q^*_{K^*} = [(1+i)\,Pk^*/(E\theta - \Phi\sigma\theta)] - (1-d)\,Pk^* \tag{3}$$

$$U_{L^*}\!: \; P^*n^*Q^*_{L^*} = W^*\,. \tag{4}$$

The current level of the exchange rate, R, has no effect on optimal K^* because it affects all revenues and costs proportionately the same. But an expected appreciation of foreign currency (rise in $E\theta$) lowers the "cost of capital", increasing K^*, while an increase in the exchange risk (rise in $\sigma\theta$) increases the cost of capital, lowering K^*. These results illustrate a simple version of an application of "standard" portfolio theory to FDI and would seem to be the "conventional wisdom".[2] But such an application overlooks certain details of FDI in particular which may reverse the conclusions.

So now let us suppose that the firm also supplies the foreign market by exporting. Export profits from home production will be

$$\pi_X = P^*QR\theta - WL - (d+i)\,PkK\,. \tag{5}$$

Adding these profits to (1), substituting into (2), using $Q(K, L)$, and assuming $P^*(T)$ where $T = Q^* + Q$, we obtain the following first-order conditions in addition to (3) and (4):

$$U_K\!: \; P^*n^*Q_K = (d+i)\,PkK/[R(E\theta - \Phi\sigma\theta)] \tag{6}$$

$$U_L\!: \; P^*n^*Q_L = W/[R(E\theta - \Phi\sigma\theta)]\,. \tag{7}$$

A rise in R can now affect direct investment, K^*, indirectly through its effect on exports. The proportional rise in K, L, and Q in (6) and (7) will lower P^*, discouraging the use of K^* (and L^*) in (3) and (4). A rise in $E\theta$ or reduction in $\sigma\theta$ will do the same, if the indirect effects from (6) and (7) offset the direct effects from (3). Thus, as I stressed in my 1985 article, an expected appreciation of foreign currency may reduce direct investment as firms prepare to increase exports. And a rise in risk may stimulate the use of direct investment as a partial substitute for reduced exports.

Now turning to a different situation, suppose that (as in Itagaki) all output

[2] See p. 465 of the popular Caves and Jones [1985] text where it is implied that any effects from exchange risk would be the reduction of both international trade *and* investment.

from the direct investment is exported back to the home country (with no home production). Future real profits will be

$$\pi_{DI} = PQ^* + [-W^*L^* + (1-d)Pk^*K^*]R\theta - (1+i)Pk^*K^*R. \quad (8)$$

Exposure to future exchange rate movements (the bracketed term of (8)) can be negative or positive depending on whether future labor cost is greater or less than the future capital asset value (the future capital liability is not subject to exchange rate uncertainty since its real home currency value is fixed when the investment is made).

Substituting (8) into (2) and assuming domestic demand function P(Q*), the first-order conditions are

$$U_{K^*}: \; PnQ^*_{K^*} = [1 + i - (1-d)(E\theta - x\Phi\sigma\theta)]Pk^*R \quad (9)$$

$$U_{L^*}: \; PnQ^*_{L^*} = W^*R\,(E\theta - x\Phi\sigma\theta), \quad (10)$$

where $x = +1$ (-1) if exchange risk exposure is positive (negative).[3]

A rise in R increases the cost of both K* and L* by the same proportion, so K* (direct investment) is reduced. An expected appreciation (rise in Eθ) lowers capital cost but raises labor cost. Therefore, K* is increased unless an output reducing effect from the increased labor cost dominates.

As noted by Itagaki, the effect of risk depends on whether exchange risk exposure is positive or negative. If positive, an increase in σθ raises capital cost but lowers labor cost. Assuming the capital cost effect dominates, we therefore observe the same signs for Eθ and σθ as in the "standard" case first noted above. But if the labor cost effect dominates, and its output effect is stronger than its substitution effect, the signs are reversed, as in the export-direct investment substitution case.

If exchange risk exposure is negative, an increase in σθ *lowers* capital cost (but raises labor cost). An increase in K* is then desirable because it *diminishes* the value in (8) subject to exchange risk. In such a case, then, we observe a positive effect from both Eθ and σθ. But if the labor cost output effect dominates, the signs are both negative. Note that the longer the relevant time frame of the firm (in this model the time between investment and sale of output) the larger is d likely to be, making it more likely that risk exposure is negative (see (8)) and that the capital cost effects of Eθ and σθ are small.

Now let us consider the most general case. Assume that not only can output be produced in either location, it can also be sold in either location, with excess demand in one location being satisfied with exports from the other. This case is interesting because Siegel highlights a situation under this

[3] This adjusts for the fact that when the standard deviation of (8) is taken, the coefficient of σθ must always be positive, prior to substitution into the utility function (2).

structure where the capital investment is completely unaffected by exchange risk.

The real profit function becomes

$$\pi = P(Q - Z) + [P^*(Q^* + Z) - W^*L^* + (1 - d)Pk^*K^*]R\theta$$
$$- WL - (d + i)PkK - (1 + i)Pk^*K^*R. \quad (11)$$

The two total revenue components now indicate that, because of export and import flows, a location's sales need not equal its production. The first-order conditions are now, in addition to (3) (with x inserted before Φ) and (4),

$$U_K:\ PnQ_K = (d + i)\ Pk \quad (12)$$

$$U_L:\ PnQ_L = W \quad (13)$$

$$U_Z:\ Pn = P^*n^*R(E\theta - x\Phi\sigma\theta). \quad (14)$$

Equations (3), (4), (12), and (13) equate marginal revenue products and factor costs while (14) specifies that the firm equates marginal revenues in the two markets via the export flow. A rise in R or Eθ will cause the following adjustments. An increase in foreign sales and reduction in domestic sales restores condition (14) through a fall in P* and rise in P. These price changes then indicate that foreign production be reduced as indicated by (3) and (4) and domestic production be increased as indicated by (12) and (13). Meanwhile, a rise in Eθ additionally lowers the cost of K* in (3). Thus, FDI is reduced because foreign output falls, unless, in the case of Eθ, the capital cost effect is strong. Meanwhile, more is exported to the foreign market.

A rise in risk has an effect opposite to that for Eθ and, therefore, encourages FDI unless the capital cost effect is strong ($\sigma\theta$ signs are again reversed if risk exposure in (3) and (11) is negative). This result differs from Siegel's primarily because he assumes output prices are set competitively, thus output adjustments cause no change in P or P*. Since he also uses variance rather than standard deviation, changes in exchange risk can be completely offset by changes in trade flows: rather than $x\Phi\sigma\theta$, the risk term in (3) and (14) becomes $2[P^*(Q^* + Z) - W^*L^* + (1 - d)Pk^*K^*]\Phi\sigma^2\theta$.[4] Thus, there are neither price nor capital cost effects.

While all the above models show a negative R effect, unfortunately, anything can happen in response to changes in Eθ and $\sigma\theta$.[5] The standard

[4] Changes in Eθ are similarly offset, but changes in R would have effects as the Z adjustment altered (3). It may also be noted that the use of standard deviation rather than variance in conjunction with competitive prices would not permit interior solutions for sales so all output would be sold exclusively in one market.

[5] For R, Cushman [1985] showed a positive effect if an intermediate good is shipped to the foreign subsidiary for final processing. But the signs for Eθ and $\sigma\theta$ were still (+,–). Effects from changes in exchange rate *levels* (R, here) were first discussed in some detail in Stevens [1977], Logue and Willett [1977], and Kohlhagen [1977].

effect is (+,–). Cushman [1985] demonstrated that with exports as an alternative to supplying the foreign market the signs could be (–,+) if there were a strong price effect from changes in the export market. Itagaki did not include this latter effect, but pointed out that supplying the home market from abroad could lead to negative risk exposure, giving the signs (+,+) rather than the (+,–) observed under positive exposure. These results occur in the present paper when the capital cost effect dominates. While my 1985 paper did not recognize that the signs would be the same under negative risk exposure, that paper did note that the labor cost effect could reverse the capital cost effect, giving (–,+) under positive exposure.[6] By focusing on production rather than input levels, Itagaki did not include the indirect effects of labor costs on K*. But, as shown in the present paper, a dominant labor cost effect produces the signs (–,–) under negative risk exposure.

The general model modifying the Siegel structure duplicates these combinations. Under positive exposure, we observe (–,+) if the foreign output price effect dominates, and (+,–) if the capital cost effect dominates. Under negative exposure we observe either (–,–) or (+,+) under similar circumstances. There is no labor cost effect.

III. Empirical Tests with U.S. Direct Investment Inflows

To test for the possible exchange rate effects analyzed above, this paper examines annual bilateral FDI flows into the United States from the United Kingdom, France, Germany, Canada, and Japan over the years 1963–1986.

Due to various lags, multinational firms may not be able to instantaneously adjust capital levels in accordance with profit maximization. Thus, for empirical implementation, I use a partial adjustment model (as in Cushman [1985]):

$$FDI_t = \alpha\,(K^*_{Dt} - K^*_{t-1})\,, \tag{15}$$

where FDI_t gives this year's investment flow, K^*_{Dt} is this year's desired stock of FDI, K^*_{t-1} is last year's actual FDI stock, and α is the adjustment proportion.

From the theoretical section, the exchange rate factors determining K^*_{Dt} are R, the current level of the real exchange rate, $E\theta$, the expected future change in R, and $\sigma\theta$, the standard deviation of the future change in R.

The empirical measurement of these variables proceeded as follows. Each year's U.S. bilateral FDI inflow (difference between successive years' direct investment position) in dollars was deflated by the U.S. nonresidential capital price index. Based on this, a real capital stock series was created. For estimation, this series was converted to logs; first differences of the logs give

[6] Cushman [1985] overlooked the requirement of x in the risk term.

the FDI flows.[7] FDI_t thus gives the proportional change in actual real FDI assets from the previous year.

Each bilateral real exchange rate (R) was calculated using wholesale price indexes and converted to logs. The proxy for $E\theta$ is $R_{TREND,t}/R_t$ where $R_{TREND,t}$ is the fitted value from the regression $R_t = a + bt$.[8] Thus, if R is currently above its long-run trend value, it is expected to fall, eventually.[9] The greater the deviation, the larger are the long-run profit implications.

I believe this measurement of $E\theta$ is superior to that used in Cushman [1985]. That measurement calculated the inverse of the mean of quarterly changes in the real exchange rate within the year. If the exchange rate had quite recently appreciated, for example, it was now expected to depreciate. Such a measure has a very short time frame of reference both from the point of view of exchange rate prediction and a firm's planning horizon for capital investments. It is also negatively correlated (though insignificantly so) with the actual changes in the real exchange rate over the subsequent three-year period for each of the five countries. The five bilateral $E\theta$ proxies were each regressed on the net actual change in R over the subsequent three-year period (the actual three-year θ value).[10] For the old proxy, the mean coefficient is -1.12 with a mean t-ratio of -0.65 and adjusted R^2 of -0.016. For the proxy in the current paper, all countries show positive correlation with a mean coefficient of 0.893, a mean t-ratio of 3.84, and mean adjusted R^2 of 0.389. Thus, the current measure would appear to be the more rational of the two.[11]

Finally, two proxies for $\sigma\theta$ were tried. Both assume volatility is an appropriate measure of exchange risk (see Kenen and Rodrik [1986] and Akhtar and Hilton [1984] for discussion). The first is a short-run measure and is given by the mean of the four quarterly values within the year of a moving four-quarter standard deviation of θ; this was used in Cushman [1985].[12] A

---

[7] Year-end FDI positions for 1974 and again for 1980 were subsequently subject to large revisions associated with benchmark studies by the U.S. Department of Commerce. The changes represented accumulated errors and omissions since the previous benchmark. I distributed them to each year since the previous benchmark as the mean of a straight line allocation and one proportional to the annual FDI flows with the same sign as the net change due to the revision. Several other methods of allocation yielded empirical results virtually unchanged from those reported below. Meanwhile, negative values in early Japanese FDI positions meant that a linear approximation to the log function (starting at 10 percent of mean assets) had to be used for small values.

[8] In order to estimate a strictly linear function, R is not in logs for this purpose.

[9] Direct investors are assumed to take primarily a long view. They may reasonably expect R to return to a purchasing-power-parity value for which R_{TREND} could be an estimate.

[10] The estimation period is 1963–1984 to allow measurement of the three subsequent years observable at the time of this writing.

[11] Over 1963–1978, the estimation period in Cushman [1985], the old proxy for three of the five countries is at least positively correlated with the future change. But none of the five are significant.

[12] The quarterly values of this measure also appear in Cushman [1983; 1988] and IMF [1984] for trade flow analysis. Kenen and Rodrik's measure uses monthly instead of quarterly changes.

short-run measure may be appropriate if direct investment is primarily influenced via substitution for exports, themselves reduced by short-run risk. However, capital decisions may be insensitive to short-run variations but responsive to long-run variations. Therefore, the second measure is a moving three-year standard deviation of recent annual changes in the real exchange rate (annual θ values).

Several other variables are also included as determinants of the desired capital stock in (15). Host country real GNP (Y_{US}), in logs, captures the "size of market" variable traditional to FDI studies. The source country real interest rate, i, measures the cost of funds used to finance FDI. And the host country real interest rate, i_{US}, measures the cost of borrowing in the host country. If i_{US} rises, more financing occurs in the source country, raising measured direct investment (see Cushman [1985] for further details).[13] Finally, W_{US} measures the cost of labor input for foreign production and is expressed in logs.[14]

Estimation of (15) proceeded as follows. First, (15) can be thought of as a reduced form equation. I assume that simultaneous interaction between FDI and the right-hand-side variables of (15) is negligible since it appears that FDI would have played a small role in determining the other variables.[15] Second, an initial analysis of covariance suggested that the hypothesis of equal slopes across countries for a given variable could be accepted, except for W_{US}, allowing the greater efficiency of pooling. Pooling was achieved by estimating the five flows as a set of equations with parameters for each variable constrained equal (except W_{US}). The seemingly unrelated regressions approach was used to take advantage of any contemporaneous error correlation.

Analysis of the Durbin h-statistics in the initial runs suggested significant serial correlation in several of the equations. Therefore, the equations were reestimated in generalized difference form using rho values calculated from the residuals of the uncorrected versions.[16]

---

[13] Real interest rates are derived from the long-term government bond rate, deflated by the GNP price deflator as in Cushman [1985]. They are in decimal form.

[14] W_{US} is the manufacturing wage deflated by the wholesale price index and adjusted for productivity using real GDP per person employed.

[15] Consider first potential impact on exchange rate variables. FDI from the five countries averaged approximately 4 percent of each country's total demand for dollars in 1979, assuming a flow theory framework is appropriate (defining dollar demand as imports of goods and services on current account plus net purchases of all U.S. assets). Alternatively, with the asset market approach to exchange rate determination in mind, I calculate that FDI assets of these five countries averaged about 19 percent of their total assets in the U.S. in 1979. Moreover, this would probably overstate the contribution of FDI to total asset demand since, unlike many other assets, only a fraction of desired FDI stock changes are usually implemented in a given year. Relevant to the non-exchange rate variables, in 1979 foreign FDI from the five countries totaled about 3 percent of U.S. net capital formation, while each country's own FDI contribution constituted an average of only 2 percent of its own net capital formation.

[16] First observations are retained by use of the Prais-Winsten technique.

Table 2 - *FDI Flows into the United States*

Variable		Short-run risk measure (1)		Long-run risk measure (2)	
R		-0.752	(-4.13)	-0.708	(-4.13)
Eθ		-0.448	(-1.86)	-0.437	(-2.06)
σθ		1.016	(2.34)	0.490	(1.76)
Y_{US}		1.359	(3.93)	1.292	(4.26)
i		-2.067	(-2.49)	-1.775	(-1.98)
i_{US}		3.361	(3.46)	3.017	(2.64)
W_{US}	U.K.	0.696	(1.70)	0.395	(1.01)
	Fra.	-1.118	(-2.63)	-1.215	(-3.51)
	Ger.	-0.256	(-0.56)	-0.434	(-1.03)
	Can.	-0.399	(-0.78)	-0.425	(-0.80)
	Jap.	-9.628	(-2.01)	-9.899	(-2.08)
	wt. mean	-1.043	(-1.56)	-1.244	(-1.94)
K^*_{t-1}		-0.330	(-4.33)	-0.324	(-4.35)
rho	U.K.	0.59		0.57	
	Fra.	0.07		0.10	
	Ger.	0.07		0.05	
	Can.	0.73		0.70	
	Jap.	-0.12		-0.12	

Note: t-ratios are given in parentheses beside each parameter estimate. Standard errors were calculated using White's [1982] formulas to correct for heteroscedasticity. The constants, a different one for each country, are not reported to save space. For W_{US}, the weighted means use the average asset values as weights.

Table 2 presents the results. Column 1 utilizes the short-run risk measure while Col. 2 utilizes the long-run risk measure. In both columns, the variables Y_{US}, i, i_{us}, and K^*_{t-1} show the expected signs and are generally highly significant. W_{US} is negative for four of the countries (significantly so for two) and negative on average.

Now turning to the exchange rate variables, we observe, as suggested by the theoretical models above, a negative impact from R which is also highly significant. The coefficient for Eθ is significantly negative at the 0.10 level in Col. 1 and at the 0.05 level in Col. 2. The coefficient for σθ is significant at almost the 0.02 level in Col. 1 and at the 0.10 level in Col. 2.

The sign combination for Eθ and σθ (–,+) is consistent with three stories told earlier about the possible effects of these variables. First, it could be that direct investment and exports have behaved as substitutes in supplying the foreign market (the U.S.) *and* the price effect from the export market has been strong. Or second, it suggests the case where foreign production is exported back to the home country *and* foreign risk exposure is positive *and* the labor cost output effect from Eθ and σθ dominates. Or third, it is consistent with the structure of production and sales in both locations with concurrent export or import flows, when the foreign price effect dominates under positive risk exposure.

The short-run measure of $\sigma\theta$ fits the data slightly better than the long-run measure, hinting that risk may have affected FDI primarily through substitution with exports, which many other studies have found reduced by short-run risk. However, the significance of both measures makes the general conclusion of a positive impact on FDI more robust.

In sum, the present paper supports my earlier (1985) results for R, $E\theta$, and $\sigma\theta$ but with different FDI flows, much more recent data, and a presumably superior measure of $E\theta$.[17]

IV. Economic Impacts on FDI from Exchange Rate Factors

In Table 2, the negative of K^*_{t-1} 's slope gives the adjustment proportion (α) while the other slopes give α times the elasticities with respect to FDI *asset* levels (percentage change in K^*_t relative to percentage change in X when X $= Y_{US}$, W_{US}, R, and $E\theta$ and relative to a unit change in X when X $=$ i, i_{US}, and $\sigma\theta$). To further evaluate the impact of exchange rate factors, these values are converted in Table 3 to elasticities (e's) for the annual FDI *flows*, with all e's now completely in terms of percentage changes. Similarly, beta coefficients (β's) for FDI flows are presented (these give the standard deviation change in FDI relative to a standard deviation change in X).[18] These show that changes in R and $E\theta$ elicit strong responses in the FDI flow. The e's for $\sigma\theta$ are much smaller, but the percentage changes have been large over the estimation period so the β's may be more indicative of impact (see data for $\sigma\theta$ in Table 4; also note that there is considerably less disparity between the β's of the three

Table 3 - *Elasticity (e) and Beta (ß) Coefficients for U.S. FDI Inflows*[a]

	R		Eθ		σθ	
	e	β	e	β	e	β
Short-run risk measure	-7.18	-1.11	-5.02	-0.62	0.28	0.24
Long-run risk measure	-6.76	-1.06	-4.90	-0.61	0.25	0.26

[a] For the β coefficients, two extreme values of Japanese FDI were omitted prior to computing the standard deviation of FDI.

[17] If my old measure of $E\theta$ is used here, its coefficient and t-ratio are virtually zero. R remains significantly negative, and $\sigma\theta$ positive but not quite significant.

[18] These values are weighted means of the five countries' e's and β's which differ since FDI, R, $E\theta$, and $\sigma\theta$ means and standard deviations differ for each country. The weights are the average real asset values over 1963–1986.

variables than between the e's).

The total FDI flow into the U.S. from the other five countries averaged \$481 million per year over 1963-1966 but \$10,496 million per year over 1983-1986 (all figures in 1986 dollars). The stock of FDI assets in the U.S. owned by firms in these other countries rose from \$12,214 million at year-end 1962 to \$117,913 million by year-end 1986. Table 4 presents estimates of the contributions of the exchange rate variables to this spectacular growth.

Using the parameter estimates in Col. 1 of Table 2, I first calculated the fitted values for the stock of FDI assets from 1963 to 1986. Then dynamic simulations were performed to estimate the path that FDI asset growth would have followed if each of the three exchange rate variables had remained equal

Table 4 - *Simulated Impacts of Exchange Rate Variables on U.S. FDI Inflows*

Variable and Period		U.K.	Fra.	Ger.	Can.	Jap.	Total
I. Actual							
average	63-66	193	40	74	200	-26	481
FDI flows[a]	83-86	4,563	307	1,466	1,033	3,127	10,496
Actual							
FDI assets	62	6,400	658	532	4,294	331	12,214
(year-end)[a]	86	51,397	7,415	17,356	18,312	24,433	117,913
II. $\sigma\theta$ levels							Mean[b]
and effects							
$\sigma\theta$	63-66	0.0062	0.0091	0.0055	0.0049	0.0068	0.0061
$\sigma\theta$	83-86	0.0438	0.0421	0.0359	0.0100	0.0379	0.0340
FDI_w/FDI_{w0}	83-86	0.992	1.043	0.944	0.970	0.927	0.965
K^*_w/K^*_{w0}	86	1.126	1.092	1.096	1.019	1.095	1.091
III. $E\theta$ levels							
and effects							
$E\theta$	63-66	1.049	0.943	0.957	0.970	0.991	1.003
$E\theta$	83-86	0.933	0.876	0.863	0.959	0.936	0.925
FDI_w/FDI_{w0}	83-86	1.429	11.120	1.802	1.180	1.505	1.763
K^*_w/K^*_{w0}	86	1.081	1.000	1.042	1.013	1.014	1.046
IV. R levels							
and effects							
R	63-66	1.000	1.000	1.000	1.000	1.000	1.000
R	83-86	0.971	1.352	1.011	0.958	0.881	0.991
FDI_w/FDI_{w0}	83-86	0.732	0.308	0.606	0.855	0.985	0.789
K^*_w/K^*_{w0}	86	1.183	1.373	1.121	1.096	1.364	1.116

[a] These figures are millions of 1986 dollars. – [b] Except for FDI flow effects, all means are weighted by average asset value over 1963-1986. Mean FDI flow effects for 1983-1986 are weighted by average FDI flow value over 1983-1986.

to its 1963–1966 average value over the entire 1963–1986 period.[19] From these simulations, two ratios were calculated for each exchange rate variable and each country: first, that of estimated assets with to estimated assets without the actual subsequent changes in the exchange rate variables (i.e., the differences between the log values, plus 1.0); second, the ratio of estimated FDI flows with to FDI flows without these changes for the years 1983–1986.

From these ratios, we see that the estimated impact of $\sigma\theta$ on FDI assets ranges from the low of a 1.9 percent contribution in the case of Canada to 12.6 percent in the case of the U.K. Total assets of the five countries are estimated to have been 9.1 percent higher by 1986 than they would have been with constant risk since 1963–1966. Meanwhile, 1983–1986 FDI flows are actually somewhat lower than they would have been with no change in risk (with the exception of France). This reflects the fact that the primary adjustment to higher risk occurred prior to 1983.

The opposite is true for the impact of $E\theta$. The FDI flow is estimated to have been 76.3 percent higher on average over the last four years but the 1986 total asset value is only 4.6 percent higher. This reflects the fact that the dollar was presumably expected to fall over most of the last four years. But fluctuations in $E\theta$ mostly cancel out over the entire period of 24 years. A similar pattern holds for the impact of R, though in reverse since expected appreciation of the dollar accompanies low R values.[20]

The combined effect from exchange rate factors on FDI assets is estimated by adding the individual effects. This suggests that actual FDI assets from the five countries by year-end 1986 were 25.3 percent higher than they would have been with no response to the three exchange rate variables over the 24 year period. FDI flows of the last four years are 51.7 percent higher than they would have been in the absence of exchange rate factors over the estimation period. Over the last four years, the positive impact from expected dollar depreciation has dominated the negative impact from recent high dollar levels and slightly lower exchange risk.

V. Summary and Conclusions

This paper has first attempted to clarify the variety of ways in which exchange rate uncertainty could affect FDI. Such uncertainty gives rise to both expectational and risk effects. These depend on both the specific structure of the multinational firm and on the relative importance of capital versus labor

---

[19] The prediction errors from the initial fitting process mentioned in the previous sentence are factored out of the dynamic simulation since the presence of the lagged dependent variable would otherwise cause their presence to be compounded.

[20] One might argue that a simulation that holds R constant while allowing continual changes in $E\theta$ is illogical since expectations would continually be disappointed. However, one may alternatively interpret this (and the previous simulations) as the result of a zero value for the parameter in question.

cost effects and output price effects. In general, the effects of expected appreciation of real foreign currency and of real exchange rate risk are ambiguous.

The paper then finds that, empirically, expected appreciation (and also high levels) of the dollar are associated at significant levels with reductions in U.S. FDI inflows from the five other countries. Increases in risk are significantly associated with increases in these inflows. These results are consistent with three production-sales structures for a multinational firm, all involving export or import flows in addition to production decisions. They are also consistent with my previous findings for U.S. FDI outflows in Cushman [1985]. The results of the present paper suggest that FDI assets in the U.S. were about ten percent higher by 1986 than they would have been in the absence of exchange risk. They were twenty-five percent higher than they would have been in the absence of all exchange rate factors. Recent FDI flows have been over fifty percent higher than they otherwise would have been.

Appendix

Data Sources

FDI position, total foreign assets, imports of goods and services: U.S. Department of Commerce, *Survey of Current Business.*
Exchange rates, real GNP, GNP price deflators, wholesale price indexes, government bond rates, wage rates: IMF, *International Financial Statistics.*
Real GDP per person employed: OECD, *Historical Statistics.*
Capital prices, net capital formation: OECD, *National Accounts Bulletin.*

References

Akhtar, Mohammad A., R. Spence Hilton, *Exchange Rate Uncertainty and International Trade: Some Conceptual Issues and New Estimates for Germany and the United States.* Federal Reserve Bank of New York, Research Papers, 8403, New York 1984.

Branson, William H., Dale W. Henderson, "The Specification and Influence of Asset Markets". In: Ronald W. Jones, Peter B. Kenen (Eds.), *Handbook of International Economics,* Vol. 2. Amsterdam 1985, pp. 749-805.

Caves, Richard E., Ronald W. Jones, *World Trade and Payments.* 4th ed. Boston 1985.

Cushman, David O., "The Effects of Real Exchange Rate Risk on International Trade". *Journal of International Economics,* Vol. 15, 1983, pp. 45-63.

–, "Real Exchange Rate Risk, Expectations, and the Level of Direct Investment". *The Review of Economics and Statistics,* Vol. 67, 1985, pp. 297-308.

–, "U.S. Bilateral Trade Flows and Exchange Risk During the Floating Period". *Journal of International Economics,* 1988, forthcoming.

Hartman, David G., "Foreign Investment and Finance with Risk". *Quarterly Journal of Economics,* Vol. 93, 1979, pp. 213- 232.

Hooper, Peter, Steven W. Kohlhagen, "The Effect of Exchange Rate Uncertainty on the Prices and Volume of International Trade". *Journal of International Economics,* Vol. 8, 1978, pp. 483-511.

International Monetary Fund (IMF), *Exchange Rate Volatility and World Trade.* Occasional Papers, 28, Washington 1984.

Itagaki, Takao, "The Theory of the Multinational Firm under Exchange Rate Uncertainty". *The Canadian Journal of Economics,* Vol. 14, 1981, pp. 276-297.

Kenen, Peter B., Dani Rodrik, "Measuring and Analyzing the Effects of Short-Term Volatility in Real Exchange Rates". *The Review of Economics and Statistics,* Vol. 68, 1986, pp. 311-315.

Kohlhagen, Steven W., "The Effects of Exchange Rate Adjustment on International Investment: Comment". In: Peter B. Clark, Dennis E. Logue, Richard James Sweeney (Eds.), *The Effects of Exchange Rate Adjustments.* Washington 1977, pp. 194-197.

Logue, Dennis E., Thomas D. Willett, "The Effects of Exchange Rate Adjustment on International Investment". In: Peter B. Clark, Dennis E. Logue, Richard James Sweeney (Eds.), *The Effects of Exchange Rate Adjustments.* Washington 1977, pp. 137-150.

Rugman, Alan M., "Risk, Direct Investment and International Diversification". *Weltwirtschaftliches Archiv,* Vol. 113, 1977, pp. 485-500.

-, *International Diversification and the Multinational Enterprise.* Lexington, Mass., 1979.

Siegel, Michael H., *Foreign Exchange Risk and Direct Foreign Investment.* Ann Arbor, Michigan, 1983.

Stevens, Guy V.G., "Comment on 'The Effects of Exchange Rate Adjustment on International Investment' ". In: Peter B. Clark, Dennis E. Logue, Richard James Sweeney (Eds.), *The Effects of Exchange Rate Adjustments.* Washington 1977, pp. 183-188.

White, Halbert, "Instrumental Variables Regression with Independent Observations". *Econometrica,* Vol. 50, 1982, pp. 483-500.

* * *

Zusammenfassung: Ungewißheit über Wechselkurse und Zustrom ausländischer Direktinvestitionen in die Vereinigten Staaten. - In diesem Aufsatz wird zunächst versucht zu klären, auf welche Weise die Ungewißheit über die Entwicklung der Wechselkurse die ausländischen Direktinvestitionen beeinflußt, und danach werden solche Wirkungen auf den Zufluß ausländischer Direktinvestitionen in die Vereinigten Staaten getestet. Die theoretischen Wirkungen erwarteter Aufwertungen und von Risiken sind im allgemeinen nicht eindeutig und hängen von der Produktions- und Absatzstruktur des multinationalen Unternehmens ab. Im empirischen Teil zeigt sich, daß die Zuflüsse von Direktinvestitionen in die Vereinigten Staaten aus fünf anderen Ländern in signifikantem Maße negativ mit einer erwarteten Dollar-Aufwertung und positiv mit einer Erhöhung der Wechselkursvariabilität verbunden sind. Dieses Ergebnis ist konsistent mit den drei Typen von multinationalen Unternehmen, die sich in ihrer Produktions- und Absatzstruktur unterscheiden und in dieser Arbeit betrachtet werden.

*

Résumé: Incertitude de taux de change et investissement direct étranger dans les Etats Unis. - Cet article essaie de classifier les possibilités différentes de l'influence de l'incertitude de taux de change sur l'investissement direct étranger (IDE) et puis teste les effets des influx américains IDE. Les effets théoriques d'une révalorisation attendue aussi bien que du risque sont ambigus et dépendent de la structure de la production et des ventes de l'entreprise multinationale. Empiriquement, les influx américains IDE d'origine de cinq autres pays sont négativement associés avec la révalorisation attendue du dollar et positivement avec la variabilité accrue du taux de change. Cela est consistent avec trois structures spécifiques d'entreprise multinationale analysées dans l'article.

*

Resumen: La incertidumbre de la tasa de cambio e inversiones extranjeras en los EE UU. – En este trabajo se intentan clarificar las formas en las cuales la incertidumbre de la tasa de cambio puede afectar a la inversión extranjera y someter estas hipótesis a un test empírico en el caso de las inversiones extranjeras en los EE UU. Teóricamente los efectos de una revaluación esperada y del riesgo son ambiguos, dependiendo de la estructura de la producción y de las ventas de la empresa multinacional. Empíricamente las inversiones extranjeras en los EE UU con origen en cinco países resultan estar asociadas negativamente con la revaluación esperada del dólar y positivamente con una más alta variabilidad de la tasa de cambio. Esto es consistente con tres structuras específicas de empresas multinacionales tratadas en este trabajo.