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13 An Alternative Approach to International Capital Flows

Michael Melvin

Since the mid-1960s, the standard literature on international capital flows has been characterized by the use of the Tobin-Markowitz type of portfolio choice models to determine the portfolio shares devoted to foreign and domestic assets. In this framework, the stocks of assets held depend on risk and return measures associated with alternative assets. Thus the change in the stocks, the capital flows, will depend on changes in the risk and return measures. This stock-adjustment approach is generally considered an advance beyond the earlier studies that related capital flows to *levels* of return measures. However, the newer models, with their theoretical frameworks including risk terms, have created new problems that have yet to be adequately dealt with. While the risk terms are included in the theoretical models and it is generally recognized that risk reduction through portfolio diversification provides an incentive for capital flows,[1] the empirical treatment of risk has been the low point of the literature to date. One aim of this chapter is to incorporate in a capital-flows equation a measure of risk suggested by a standard finance model.

Besides the introduction of an explicit risk proxy, this chapter will also derive and estimate a theoretically consistent functional form for the capital-flows equation. The existing literature has in many cases not even considered the matter of proper functional form, but instead assumed a simple model where all variables enter in an additive fashion.

The approach taken here will differ from most of the previous studies in two additional ways besides the treatment of risk: (1) net capital flows will be the variable of interest, whereas other studies have estimated the

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1. See Grubel (1968). Even with constant return differentials there would be capital flows to maintain the optimal portfolio shares.

domestic demand for foreign assets separately from the foreign demand for domestic assets (and have usually disaggregated the capital account into components yielding the best empirical fit); (2) the capital-flows equation will be placed in the framework of an eight-country macromodel allowing for simultaneous equation estimation techniques.[2]

13.1 Empirical Predecessors

The leading literature on capital flows generally develops a portfolio model where capital flows are a function of interest rates, wealth, and risk. For example, Miller and Whitman (1970) have a model where long-term portfolio foreign investment is determined in part by the variance of returns on domestic and foreign assets. Since these variances are unobservable, they examine the likely determinants of each, concluding that the variance of domestic returns moves inversely with domestic transitory income. So they use national income and time to proxy for the unobservable transitory income and we have one unobservable proxying for another unobservable with the result that observed income and time are supposed to represent the variance of domestic returns. Likewise foreign return variability should be a function of foreign transitory income, but they also argue for including domestic income and dummy variables for U.S. capital controls and European currency convertibility. Then, by assuming that U.S. and foreign income generally move together, they have the variance of foreign returns represented by U.S. income, time, and the dummy variable. One could easily argue that these variables in a demand for foreign assets function will more likely represent the portfolio scale variable than the determinants of the variances of the domestic and foreign returns. In such a case, the fact that the variables entered significantly should not be surprising, even if they in no way represent variability of returns.

Kouri and Porter (1974), in an oft-cited article, developed a portfolio approach model where capital flows were viewed as equating money demand and money supply. The model included a measure of risk which was supposed to derive from a Markowitz-Tobin formulation, but rather than develop some measure of variability of returns, Kouri and Porter assume that in their model the risk variable should measure changes in exchange-rate expectations. Facing the difficult problem of measuring

2. Most of the existing studies have assumed interest rates and exchange rates exogenous and so used OLS. Since the focus here is on one equation of some larger model, a suitable set of simultaneous equations is provided by the NBER International Transmission of Inflation Model (see part II of this volume). The NBER model contains a capital-flows equation, so the proposed equation may be inserted in place of the existing model equation as no new endogenous variables are introduced and only the exogenous risk terms are added. Note that three of the countries in the NBER Model are not investgated here (France, Japan, and the Netherlands), due to poor quality or unavailability of some data.

exchange-rate expectations in the fixed-rate period, they decide to use dummy variables for "periods when there were definite expectations of parity changes" (Kouri and Porter, p. 452).

In an early application of the portfolio approach to capital flows, Lee (1969) developed a theoretical model based on mean and variance and then in the empirical section estimated a regression where portfolio shares are run on interest differentials letting the estimated coefficients represent the risk terms (which assumes the risk is constant).

In most instances, while risk is mentioned in the theoretical arguments, it is ignored in the empirics. Bryant and Hendershott (1970) dismissed the problem by saying,

> In actual practice, researchers never have adequate information (if they have any at all) about the probability distributions economic units associate with various returns and costs . . . As a result we have not developed proxies for . . . the risk associated with each of the expected costs and returns. (p. 27)

Branson (1968), in what is considered a pioneering effort, developed the application of the portfolio approach to capital flows. His theoretical analysis incorporates risk, but then he ignores the problem in the empirical section. In a follow-up article, Branson and Hill (1971) mention that they are assuming risk to be constant throughout the analysis.

In the more recent literature it is apparent that authors are increasingly concerned over the shortcomings of their empirical work. Hodgson and Holmes (1977) stated

> Recent critics of empirical work have complained that the risk variables are wrongfully ignored when moving from theory to specific estimating equations and applying them to data. While this is true, our market rates of return are unadjusted for risk premia, due to the practical difficulty in obtaining quantified risk data. (p. 267)

While the problems of incorporating a "good" measure of risk in the capital-flows literature are considerable, it appears that even in the most highly regarded articles, the authors have chosen to reach for simple ad hoc formulations that are often hard to relate to the cited portfolio choice theory. As Bryant (1975) has pointed out in an excellent critique of the literature, there appears to be a large gap between the theory and the equations actually estimated.

The failure to develop better risk proxies is rather surprising considering the wide-scale use of ad hoc proxies permeating all the applied econometrics literature. Rather than use time trends and dummy variables to "explain" our ignorance, in the next section we will explicitly enter proxies to attempt to capture the measures of risk discussed in the literature.

13.2 The Traditional Framework

Following the standard framework of studies based on a portfolio selection approach (see Branson and Hill 1971 for instance), we can write the portfolio share devoted to foreign assets as a function of risk and return variables:

$$F/W = f(R_d, R_f, E), \tag{13.1}$$

where F is foreign assets, W is domestic wealth, R_d and R_f are domestic and foreign interest rates, and E is the risk attached to F relative to domestic assets. Multiplying (13.1) through by W, we get the desired stock of foreign assets:

$$F = W \cdot f(R_d, R_f, E). \tag{13.2}$$

The (f) function is then assumed to be linear, and we have our estimating equation:

$$F = b_1 W R_d + b_2 W R_f + b_3 W E + b_4 W, \tag{13.3}$$

where the b_4 term represents a constant added to equation (13.2). The stock of domestic liabilities to foreigners is similarly written so that we may write net foreign asset holdings of country i as

$$\begin{aligned} N_i = {} & b_1 W_i R_i + b_2 W_i R_f + b_3 W_i E_i + b_4 W_i \\ & - b_5 W_f R_i - b_6 W_f R_f - b_7 W_f E_f - b_8 W_f, \end{aligned}$$

or by assuming that it is the return differential that matters, we can write[3]

$$\begin{aligned} N_i = {} & b_1 W_i (R_i - R_f) + b_3 W_i E_i + b_4 W_i \\ & - b_5 W_f (R_i - R_f) - b_7 W_f E_f - b_8 W_f. \end{aligned} \tag{13.4}$$

Differencing (13.4) gives us the net capital-flow equation:

$$\begin{aligned} \Delta N_i = {} & b_1 \Delta(W_i (R_i - R_f)) + b_3 \Delta(W_i E_i) + b_4 \Delta W_i \\ & - b_5 \Delta(W_f (R_i - R_f)) - b_7 \Delta(W_f E_f) - b_8 \Delta W_f, \end{aligned} \tag{13.5}$$

where ΔN_i represents net capital outflows from country i ($\Delta N_i > 0$ is a net capital outflow from i). The foreign return variable has often been an interest rate unadjusted by expected exchange-rate changes. We should, however, consider the return on a foreign security to be the interest rate plus the expected change in the exchange rate. Theoretically, of course, all return and risk variables in the portfolio belong in the equation, but there are practical constraints that would caution against such practice. Besides the obvious problem of few degrees of freedom for the flexible exchange-rate period, there is also the problem of collinearity among the

3. The imposition of such a reasonable restriction seems desirable given the limited degrees of freedom available for the flexible exchange-rate period.

variables. Usually researchers just include one alternative return variable and proceed as if they had a two-country world. While such a solution is theoretically inappropriate and really doesn't "cure" the multicollinearity problem in that theory suggests all assets be represented, it is the "traditional" solution, and is therefore consistent with the spirit of this section (for $i \neq$ U.S., the U.S. interest rate will be the foreign rate, while the Canadian rate will serve as the foreign rate for the U.S.).

The risk variable (E) is the missing link between theory and empirics. Measures of variance are the risk proxies discussed in papers like Miller and Whitman (1970) and Lee (1969), yet such risk measures are hardly consistent with the finance models cited by the authors (we shouldn't care about the variance of a portfolio asset, but rather the contribution of that asset to the overall portfolio variance). In order to preserve the spirit of the capital-flows literature (we will abandon this approach shortly), equation (13.5) will be estimated using the concept of variance of returns as the risk proxy.[4]

The domestic and foreign wealth measures are, respectively, real domestic permanent income and a nominal income weighted average of foreign real income.[5] The interest rates are represented by the ninety-day treasury bill rate for the U.S., and a similar short-term rate elsewhere. The expected change in the exchange rate is taken from the exchange-rate equation of the NBER model, and is defined as the systematic part of a regression of the change in the exchange rate on lagged values of the exchange rate, the change in import prices, the prices of foreign oil, rest-of-world income, imports, rest-of-world prices, and the current change in the exchange rate. An alternative to using observed interest rates and the expected change in the exchange rate is to calculate the "risk premium" in the forward rate. Such an approach will be used below.

Defining the correct risk proxy is not strictly an empirical question, but making the simplifying assumption that the nominal return in each currency is certain so that only the exchange-rate uncertainty is important,

4. There are other kinds of risks besides the market risk considered here, such as default risk, but in keeping with the "traditional" approach, only the variability of return risk will be considered here.

5. For a further description of this and other series see the Data Appendix at the end of this volume. The model includes eight countries with the following i subscript assignment: 1. U.S., 2. U.K., 3. Canada, 4. France, 5. Germany, 6. Italy, 7. Japan, 8. Netherlands. We should note that the data for each country are in terms of domestic currency, so that the estimated coefficient magnitudes reported below tend to reflect the differences in currencies as measuring devices. For instance, Italian capital flows, measured in lira, have a larger numerical magnitude than U.S. capital flows measured in dollars. Since the income series in the NBER model (used in the simultaneous estimation) are in logs, the wealth measures used in the present paper will also be logs.

A weighted average of foreign permanent income was also tried, but since the results did not improve, it was decided to use the real income weighted average, as this series appears in the NBER model.

we can estimate equation (13.5) using the variability of the expected exchange-rate change as the relevant risk measure. This proxy is created as the standard deviation of the expected change in the exchange rate, where the standard deviations are computed over the last eight quarters.

Table 13.1A presents the estimates of (13.5) omitting the risk proxies, and table 13.1B gives the results with the risk terms included. The overall explanatory power of the regressions is generally poor in terms of R^2 when compared to the earlier literature. However, the equations estimated here differ from the earlier literature in that net capital flows are the dependent variable, whereas earlier works generally looked at the foreign holdings of domestic liabilities apart from domestic holdings of foreign liabilities. More important, however, is the fact that the present study looks at the entire capital account—current account minus official settlements balance of payments. Previous researchers have found that by eliminating certain components of the capital account they could improve the fit of their equations.

An exception to these generalities is provided by Branson and Hill (1971), who used disaggregated capital account data for the U.S. but net capital-flows data for the U.K., Canada, France, Germany, Italy, and Japan.[6] While their study is conducted over the fixed rate period excluding certain "crisis" quarters and departs from a strict portfolio distribution approach by including trade balance and "monetary indicator" variables such as velocity, their results might serve as a crude standard. Comparing unadjusted R^2 (since this is what they report), we find the following:

	B and *H*	Table 13.1B
U.K.	.78	.50
Canada	.55	.93
Germany	.79	.79
Italy	.74	.41

Given the amount of experimentation carried out by Branson and Hill, we may consider their R^2 measures as an upper bound on the explanatory power of capital-flows equations run over the fixed rate period. With similar ad hoc searching, the flexible period results in table 13.1B, which in some cases compare favorably already, could perhaps run a close race

6. Herring (1973) used the net capital account for the U.S. plus the same countries used by Branson and Hill (1971). In his study, very high R^2 values were achieved by including an additional variable, "unusual capital movements." These "unusual" movements he first identified, and then, by normalizing all of the estimates on the largest estimated movement, he created a dummy series of relative magnitudes of unusual capital movements. While this is most definitely a way to explain much of the variability in capital movements, it represents no theory and essentially states that capital movements are "explained" primarily by random shocks. Since the goal of the current paper is to estimate a systematic component of capital flows, such approaches are not very useful.

Table 13.1A **Equation (13.5) without Risk Variables**

	US	UK	CA	GE	IT
Coefficients					
b_0	63.58	7.22	−44.72	64.90	−2657
	(2.95)	(2.41)	(−13.29)	(2.10)	(−.97)
b_1	17.64	−4.00	−4.83	18.13	618
	(.46)	(−1.73)	(−1.13)	(.96)	(.99)
b_4	−6318	−1284	3516	−5340	124538
	(−2.30)	(−2.74)	(12.58)	(−1.81)	(.50)
b_5	−270	−114.0	−106.79	730.00	32015
	(−.15)	(−1.75)	(−.65)	(.79)	(.65)
b_8	−319	−95.09	4.20	1048	−51271
	(−1.29)	(−3.01)	(.27)	(3.06)	(−1.82)
Error process	AR2 −.00, −.20	AR2 .38, −.54	AR2 .31, −.72	AR1 −.21	AR2 .88, −.15
S.E.E.	11.63	1.70	.96	19.45	993
$\bar{R}^2$	.15	.40	.88	.40	.02
D-W	1.99	2.36	2.36	1.90	2.05

with the Branson and Hill findings. Because of the few degrees of freedom available, equation (13.5) remains a basic portfolio distribution approach, as I have refrained from further ad hoc experimentation.

Given the disclaimers above, the variables of interest are the risk terms. While the traditional approach leads to an estimating equation like (13.5), actual estimation using proxies for E has not been carried out by past authors. The usual procedure is to estimate an equation omitting the risk proxies as reported in table 13.1A. When the risk proxies are included, the results are somewhat mixed as reported in table 13.1B. In four of the five countries the fit (in terms of standard error of estimate) is improved when the risk terms are included, and six of the individual risk coefficients enter significantly at the 10% level of significance. In terms of a joint F test of the hypothesis $b_3 = b_7 = 0$, only for the U.S and Italy are both b_3 and b_7 significant.

Regarding the signs of the various coefficients, we must remember that wealth enters interactively with both risk and return. Thus, to determine the sign of any individual effect, we must evaluate the partial derivative of the function with respect to the particular argument. Interaction terms also have implications for hypothesis testing. The test that a variable has no effect on capital flows would involve an F test of the hypothesis that all regressors involving that variable have coefficients that are jointly zero.

Table 13.1B **Equation (13.5) with Risk Variables**

	US	UK	CA	GE	IT
Coefficients					
b_0	75.13	8.06	−45.93	28.04	−1780
	(4.76)	(2.33)	(−14.43)	(1.15)	(−.70)
b_1	36.63	−5.29	−5.56	24.90	297
	(1.14)	(−1.92)	(−1.27)	(1.29)	(.50)
b_3	6297	55.82	−32.95	−1095	37802
	(3.47)	(.83)	(−.13)	(−2.81)	(1.87)
b_4	−8157	−1456	3622	−1188	21116
	(−4.00)	(−2.61)	(13.63)	(−.49)	(−.09)
b_5	607	−145	−157	917	−3730
	(.38)	(−1.89)	(−.89)	(1.01)	(−.08)
b_7	2.6×10^5	1001	1701	−37798	3862830
	(3.38)	(.59)	(.22)	(−2.20)	(2.18)
b_8	−2248	−126	1.58	2169	−140277
	(−3.77)	(−2.28)	(.03)	(4.49)	(−3.07)
Error process	AR2 .11, −.62	AR2 .45, −.54	AR2 .34, −.85	AR2 −.67, −.13	AR2 .83, −.07
S.E.E.	9.87	1.77	.95	17.87	908
$\bar{R}^2$	.49	.32	.90	.71	.19
D-W	2.60	2.28	2.50	1.74	1.97

b_0 Constant
b_1 Δ(Product of domestic wealth and return differential)
b_3 Δ(Product of domestic wealth and risk)
b_4 Δ(Domestic wealth)
b_5 Δ(Product of foreign wealth and return differential)
b_7 Δ(Product of foreign wealth and risk)
b_8 Δ(Foreign wealth)
AR1 First-order autoregressive process
AR2 Second-order autoregressive process
Estimation period 1971II to 1976IV
t statistics in parentheses

Analyzing the various derivatives in table 13.1B we have

$$\delta\Delta N_i/\delta E = b_3 W_{it} - b_7 W_{ft},$$
$$\delta\Delta N_i/\delta(R_i - R_f) = b_1 W_{it} - b_5 W_{ft},$$
$$\delta\Delta N_i/\delta W_i = b_1(R_{it} - R_{ft}) + b_3 E_{it} + b_4,$$
$$\delta\Delta N_i/\delta W_f = -b_5(R_{it} - R_{ft}) - b_7 E_{ft} - b_8.$$

Considering first the risk variable (E), in each equation this variable appears twice, as the risk proxy enters in both the domestic demand for foreign securities and the foreign demand for domestic securities. Under the theory considered in this section, the net effect of an increase in E is uncertain. As the risk associated with foreign assets increases, the domestic demand for foreign assets falls as does the foreign demand for domestic assets so that the net effect could go either way. Thus, ceteris paribus, the effect of greater exchange-rate variability would be to reduce the overall level of activity with no clear effect on the net capital flows of any country. Analyzing the partial $\delta\Delta N_i/\delta E$, at each point in the sample space we find mixed results. For the U.S., the U.K., and Germany the sign is positive, but for Canada and Italy the effect is negative. While intuition is of little use in determining the expected sign of the risk term, on the basis of the joint F test mentioned above we assert that this variable can be important in explaining capital flows along the lines of the traditional approach.

For the return differentials, we would clearly expect a negative effect as we are measuring the return on a country i security minus the return on a foreign security. As this differential increases, ceteris paribus, capital outflows should fall. Examining the derivative $\delta\Delta N_i/\delta(R_i - R_f)$ at each point in the sample space indicates that only for Canada is the sign overwhelmingly negative while for the U.K. approximately half the signs are negative. However, the individual t statistics on b_1 and b_5 suggest that the estimated coefficients are insignificantly different from zero.

Finally, for the domestic and foreign wealth terms we expect positive and negative signs respectively according to the portfolio theory, as increases in the portfolio scale lead to asset purchases. Thus an increase in domestic wealth would increase capital outflows while an increase in foreign wealth would lead to increased capital inflows. Examining the derivatives with respect to domestic wealth, only for Canada and Italy are the signs positive while the U.S., the U.K., and Germany have surprisingly negative signs. An examination of the derivatives with respect to foreign wealth reveals negative signs for Canada and Germany and positive signs for the U.S., the U.K., and Italy. Thus in each case only two of the five countries have the sign expected by the portfolio theory.

Previous authors have told stories about wealth entering with signs opposite to what would be expected from a portfolio theory. Prachowny (1969) has suggested that capital flows should be a function of the growth rates of domestic and foreign income in that the demand for foreign assets is related to the general level of economic activity. In his analysis, higher domestic income and lower foreign income are associated with capital inflows. Branson's (1968) analysis allows for wealth effects to go either direction as the portfolio effect of increasing the demand for foreign securities could be offset by an increase in the domestic supply of securities via a wealth effect on the desired stock of liabilities. Kreicher (1981), in a study using the Branson approach, found that in his sample the sign of the wealth effect did indeed vary across countries.

Taken together, the results presented in table 13.1B are interpreted as offering promise with regard to specifying empirical proxies for risk as defined in the traditional capital-flows literature. Had we just examined the results for the U.S., Germany, and Italy, we would have made a much more impressive case. But considering a wider application of the approach allows us to draw more useful conclusions. First, we know that specifying a proxy variable for risk involves a great deal of arbitrariness. No doubt what works well in some countries won't work in others so that a persistent searcher could probably find more significant risk proxies. A second point regards the theoretical consideration of portfolio risk. As mentioned above, the capital-flows literature has generally spoken of risk in terms of the variance of returns on individual assets. This is certainly not the risk discussed in the modern finance models where the risk of an individual asset is a function of not only its own variance, but also the covariances with other assets. So we see that the inclusion of proxies like the standard deviations included here may not provide a useful test other than to illustrate the naive notion of risk portrayed by the earlier literature. The next section attempts to develop an alternative proxy consistent with a well-known finance model.

Before proceeding to the next section, we should reconsider the return differential used above, as this same variable will be of interest throughout the analysis. In specifying appropriate interest rates to be used in international comparisons, we always run into the problem of finding comparable rates. The author has no a priori confidence in comparing U.S. and U.K. treasury bill rates, for instance, but uses such rates on the basis of their availability. Rather than be forced into specifying domestic interest rates for each country in order to create a return differential, we could instead construct a series for the "risk premium" contained in the forward rate. In order to proceed along these lines we need the preliminary assumption that interest parity holds.

In equation (13.5), the return differential was written as $(R_i - R_f)$, where R_i was the domestic interest rate, and R_f the foreign rate. Now let's explicitly write $R_f = R_j + \mu_{ji}$, where R_j is the interest rate in foreign country j and μ_{ji} is the expected change in the exchange rate, or

$$\mu_{ji} = \frac{E(S_{ji,t+1}) - S_{ji,t}}{S_{ji,t}},$$

where S_{ji} is units of i's currency per unit of j's. The investor in country i can then earn $(1 + R_i)$ at home by investing 1 unit of currency i or $[(1 + R_j)F_{ji}/S_{ji}]$ by investing the unit of i currency in country j securities (F_{ji} is the relevant forward rate at which the j currency earnings are sold).

Arbitrage results in the following:

$$1 + R_i = \frac{(1 + R_j)F_{ji}}{S_{ji}},$$

or

$$\frac{1 + R_i}{1 + R_j} = \frac{F_{ji}}{S_{ji}},$$

subtracting one from both sides, we get

$$\frac{R_i - R_j}{1 + R_j} = \frac{F_{ji} - S_{ji}}{S_{ji}},$$

which is usually approximated as

$$R_i - R_j = \frac{F_{ji} - S_{ji}}{S_{ji}}.$$

Since the relevant return differential is $(R_i - R_j - \mu_{ji})$, by subtracting μ_{ji} from each side of the above equation we get

$$R_i - R_j - \mu_{ji} = \frac{F_{ji} - E(S_{ji,t+1})}{S_{ji}}.$$

Thus, if interest-rate parity holds (and careful studies seem to indicate that it does), we can write the return differential strictly in terms of the risk premium in the foreign exchange market.

Note that there exists some controversy over the very existence of this risk premium. The controversy stems from a debate centering on whether the forward rate is an unbiased predictor of the future spot rate. The question is considered in detail elsewhere (Melvin 1981), but this author feels that the evidence is not yet overwhelming on either side, as there exists empirical support both for the existence of a risk premium and for no premium.

The risk premium series was created from spot and forward rate data provided by Richard Levich to the NBER international model effort (the data are originally from Harris Bank). Assuming efficient markets, the realized future spot rate should only differ from the expected future rate by an additive error term, so the realized rate was used as a proxy for the expected rate. Then the risk premium series was used in place of the return differential in reestimating tables 13.1A and 13.1B as shown in tables 13.1C and 13.1D respectively.

7. No doubt there is measurement error involved here. If the risk premiums alone were measured incorrectly, then their coefficients would be biased downward. However, if some other variables involved measurement error, then the effect on the risk premium coefficients would not necessarily be downward.

There is a striking similarity between table 13.1A and table 13.1C. Just as the return differentials were insignificant in explaining capital flows in 13.1A, so are the risk premiums insignificant in 13.1C.[7] The other coefficients remain just about the same in 13.1C as they were in 13.1A. Comparing table 13.1B to 13.1D, we find that the results are generally alike here also. The similarity of the results seems to bode well both for the domestic rates chosen for the original return differential and for the assumption of interest parity holding for these particular rates. Since the results are so similar (there certainly is no reason to prefer the risk premiums over the return differentials), the analysis will proceed in terms of the return differential rather than the risk premium, as the NBER model to be used for simultaneous equation estimation contains the interest rates. The novel approach to capital-flows estimation to be developed in the next section will also be phrased in terms of the return differential.

So far the period of analysis has conformed to the data base used in the NBER model. Alternative results estimated through 1978 using IMF *International Financial Statistics* data are presented in section 13.4.

13.3 An Alternative Framework

This section will develop an estimating equation consistent with the utility-maximizing behavior of individuals. Previous studies have started with a general notation as in equation (13.1), asserting that theory suggests that capital flows are some function of returns and risks. With such a beginning, the author declares the hunting season open for the "proper" fuctional form. Usually the assumption of linearity is made. As Branson and Hill (1971) say after writing down their general form, "Since we have, at this point, no particular *a priori* information on the form of the portfolio distribution function $f(\cdot)$, we may assume it is linear" (p. 7). It is my contention that the estimating equation derived from the portfolio theory will in general have variables not entering in a strictly additive fashion. Rather than merely assert that portfolio theory suggests capital flows are *some* function of risks and returns, it would be preferable to derive the functional form suggested by the theory. Then, if the researcher proceeds to move away from this form, it is clear that the estimating equation is not exactly consistent with the underlying theory. After developing what I believe to be a theoretically consistent estimating equation, I will investigate its empirical possibilities.

A measure of risk more consistent with theory than that of the previous section may be found in Solnik's international asset pricing model. Solnik (1973) developed an "international asset pricing model" (IAPM) by extending Merton (1973) to encompass international portfolio diversification. Included in the model are demand functions for foreign assets.

Table 13.1C **Equation (13.5) without Risk Variables, with Risk Premium**

	US	UK	CA	GE	IT
Coefficients					
b_0	63.71	6.74	−44.97	72.29	−2757
	(1.86)	(2.22)	(−12.56)	(3.01)	(−.96)
b_1	8.62	11.28	1.54	−29.69	−1666
	(.12)	(1.20)	(.24)	(−.44)	(−1.23)
b_4	−6403	−1223	3534	−5887	1.4×10^5
	(−1.49)	(−2.59)	(11.90)	(−2.56)	(.54)
b_5	879	279	18.48	−428	1.0×10^5
	(.34)	(1.29)	(.10)	(−.14)	(−1.14)
b_8	−423	−103	2.42	1299	−45037
	(−1.48)	(−3.23)	(.15)	(4.63)	(−1.74)
Error	MA2	AR2	AR2	AR2	AR2
process	−.24, −.26	.36, −.57	.37, −.79	−.19, −.29	.88, −.16
S.E.E.	11.85	1.75	1.01	18.12	1000
$\bar{R}^2$	−.004	.39	.87	.61	−.004
D-W	2.01	2.34	2.03	1.93	2.05

Rather than reproduce the entire derivation (which is lengthy and published elsewhere), I will begin from one of the optimality conditions (Solnik, p. 22) keeping all of Solnik's assumptions except for his initial assumption that the expected change in exchange rates is zero. In my version I will assume that the expected return from holding foreign assets is equal to the foreign rate of interest plus the expected change in the exchange rate. The optimality condition is then

$$(R_i + \mu_{ik} - R_k) = -\frac{W^k J^k_{ww}}{J^k_w}[\Sigma_{j\neq k} Y^k_j \phi^k_{ij}], \tag{13.6}$$

where R_i = the risk-free interest rate in country i;
μ_{ik} = the expected change in the exchange rate, in units of k's currency per unit of i's: $(S^*_{ik,t+1} - S_{ik,t})/S_{ik,t}$;
W^k = the wealth of k;
J^k = the utility of wealth function, where J^k_{ww} and J^k_w are second and first derivatives respectively so that $-J^k_{ww}/J^k_w$ represents absolute risk aversion for k investors;
Y^k_j = the proportion of k's wealth invested in j's liabilities;
ϕ^k_{ij} = the elements of the covariance matrix of exchange rates for country k; for instance, $||\phi^k_{ij}||_{n-1\times n-1}$,

Table 13.1D **Equation (13.5) with Risk Variables and Risk Premium**

	US	UK	CA	GE	IT
Coefficients					
b_0	72.08	4.73	−45.55	37.17	−2669
	(3.34)	(1.44)	(−13.21)	(1.61)	(−.97)
b_1	5.12	19.66	3.69	39.49	−650
	(.09)	(1.85)	(.60)	(.46)	(−.41)
b_3	6025	−30.03	−107	−1038	35515
	(3.12)	(−.55)	(−.47)	(−2.33)	(1.60)
b_4	7822	−940	3591	−2144	1.2×10^5
	(2.83)	(−1.83)	(12.50)	(−.94)	(.46)
b_5	352	511	102	2552	−27716
	(.16)	(1.99)	(.56)	(.65)	(−.26)
b_7	2.4×10^5	−1926	−649	−39307	3.4×10^6
	(3.00)	(−1.24)	(−.09)	(−1.89)	(1.72)
b_8	−2193	−76.05	14.88	2264	-1.1×10^5
	(−3.29)	(−1.67)	(.29)	(4.38)	(−2.52)
Error	AR2	AR2	AR2	AR2	AR1
Process	.30, −.48	.34, −.58	.41, −.92	−.65, −.40	.75
S.E.E.	11.09	1.72	1.00	17.62	986
$\bar{R}^2$	.29	.42	.89	.77	.07
D-W	2.45	2.28	2.07	1.88	1.93

b_0 Constant
b_1 Δ(Product of domestic wealth and risk premium)
b_3 Δ(Product of domestic wealth and risk)
b_4 Δ(Domestic wealth)
b_5 Δ(Product of foreign wealth and risk premium)
b_7 Δ(Product of foreign wealth and risk)
b_8 Δ(Foreign wealth)
MA2 Second-order moving average process
AR1 First-order autoregressive process
AR2 Second-order autoregressive process
Estimation period 1971II to 1976IV
t statistics in parentheses

where ϕ_{ij}^k is the covariance of the change of i's and j's exchange rate where both are stated relative to k.

Since Y_j^k is equal to the proportion of k's wealth invested in j's liabilities, or $Y_j^k = e_j^k/W^k$, where e_j^k is the demand for j's liabilities by k, we can use (13.6) to solve for the asset demand. Rewriting (13.6) in matrix form,

$$||R_i + \mu_{ik} - R_k|| = \phi^k Y^k A^k,$$

where

$$A^k = -\frac{W^k J^k_{ww}}{J^k_w}.$$

We can solve for Y^k by matrix inversion:

$$Y^k = (\phi^k)^{-1} ||R_i + \mu_{ik} - R_k|| (A^k)^{-1}, \tag{13.7}$$

or, for illustrative purposes (assuming k is the nth country),

$$\begin{bmatrix} Y^n_1 \\ Y^n_2 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ Y^n_{n-1} \end{bmatrix} = \begin{bmatrix} \phi^n_{11} & \phi^n_{12} \ldots\ldots \phi^n_{1,n-1} \\ \phi^n_{21} & \phi^n_{22} \ldots\ldots \\ \cdot & \ldots\ldots \\ \cdot & \ldots\ldots \\ \cdot & \ldots\ldots \\ \cdot & \ldots\ldots \\ \phi^n_{n-1,1} & \ldots\ldots \phi^n_{n-1,n-1} \end{bmatrix}^{-1} \begin{bmatrix} R_1 + \mu_{1n} - R_n \\ R_2 + \mu_{2n} - R_n \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ R_{n-1} + \mu_{n-1,n} - R_n \end{bmatrix} (A^k)^{-1}$$

Writing (13.7) in summation notation and multiplying through by W^k, we get the demand for i's liabilities by k:

$$e^k_i = B^k W^i \Sigma_{j \neq k}\, \eta^k_{ij}(R_j + \mu_{jk} - R_k) + B_0 W^k, \tag{13.8}$$

where the η^k_{ij} are elements of the $(\phi^k)^{-1}$ matrix, $B^k = -[J^k_w/W^k J^k_{ww}]$, and B_0 represents a constant term inserted in (13.7).[8]

The total demand for foreign assets by K is found by summing (13.8) over i. The total foreign demand for i's liabilities is found by summing over k. Thus net holdings of foreign assets by i can be found as total foreign assets minus total liabilities to foreigners:

$$N_i = \Sigma_{k \neq i}\, e^i_k - \Sigma_{k \neq i}\, e^k_i \tag{13.9}$$

or by substituting

$$\begin{aligned} N_i = {} & B_i W^i \sum_k \Sigma_{j \neq i}\, \eta^i_{kj}(R_j + \mu_{ji} - R_i) \\ & + B^i_0 W^i - \Sigma_{k \neq i}\, B_k W^i\, \Sigma^k_{j \neq k}\, \eta^k_{ij} \\ & (R_j + \mu_{jk} - R_k) - B^k_0 W^k. \end{aligned} \tag{13.10}$$

8. The constant is inserted in recognition of the fact that we are dealing with the entire capital account of a nation. The portfolio theory presented here determines the portfolio shares for individual investors. But the capital account data include flows besides portfolio assets (for instance, foreign direct investment and errors and omissions) so that we would expect to observe flows not explained by the theory. It should be noted, however, that in correspondence with the author, John Makin indicated that his recent work has led him to believe that "errors and omissions" are in fact capital flows.

N_i gives the total net demand for foreign assets by i. The change in N_i would represent i's capital flows. If $dN_i > 0$, we have a net capital outflow from i; if $dN_i < 0$, then there is a net capital inflow to i. Differencing (13.10) would give us net capital outflows as a function of changes in the covariances of exchange-rate changes and return differentials (treating the risk aversion terms as parameters) as well as changes in wealth.

There are some obvious differences between equation (13.10) and the "traditional" approach outlined earlier. Besides the different measure of risk, we also note that in contrast to the previous section, the theory suggests that the covariances and return differentials enter in a multiplicative form so that we are creating indexes of return differentials (the price of risk) weighted by covariances of exchange-rate changes (the measure of risk).

Since asset pricing models produce static equilibrium relations, wealth or portfolio scale is assumed constant. Then, holding wealth constant, the demand for any particular asset is given by its return and risk characteristics. While the equilibrium relation given by equation (13.10) is assumed to hold at each period, to use the model in a time series framework we must place the equation in a model that can explain changes in variables which the static framework takes as given. The NBER Mark III International Transmission Model discussed earlier will serve this purpose.

Differencing (13.10) gives a capital-flows equation of the form

$$\begin{aligned}(13.11)\qquad \Delta N_i = {} & \beta_i \Delta[W^i \sum_k \Sigma_{j \neq i}\, \eta^i_{kj}(R_j + \mu_{ji} - R_i)] \\ & + \beta^i_0 \Delta W^i - \Sigma_{k \neq i}\, \beta_k \Delta[W^k\, \Sigma_{j \neq k}\, \eta^k_{ij} \\ & (R_j + \mu_{jk} - R_k)] - \beta^k_0 \Delta W^k .\end{aligned}$$

The η variable is the explicit risk proxy. As discussed above, the η^k_{ij} are elements of the inverted matrix of covariances of exchange-rate changes. The proxies for the η^k_{ij} will be formed, using monthly exchange-rate data, by taking the pairwise covariances over the past eighteen months. Thus the covariance matrix at period t is created by computing the covariance over monthly data corresponding to the previous six quarters, $t-1$ to $t-6$. The resulting matrix is a standard symmetric matrix with the variances of the exchange-rate changes along the main diagonal and the various pairwise covariances in the off-diagonal elements as illustrated by the matrix above. In the eight-country world under consideration, for each country k, the other seven currencies are stated in terms of currency k and then a 7×7 covariance matrix is formed using these other seven currencies. A 7×7 matrix of covariances for each period is then inverted to give the η^k_{ij} for that period (for country k). The process is then repeated for each country and period.

As before, we have the problem of collinearity, only this time it involves the various covariance weighted return differentials. Since the theory suggests that all the covariance weighted return differentials belong in the equation, we cannot "cure" the multicollinearity problem unless we have strong prior convictions that a subset of the variables will capture the relevant phenomena. Suppose we begin our estimation procedure by taking the familiar approach of choosing one foreign country as proxying for the foreign sector. Following the approach of the previous section, we will let the U.S. represent the foreign sector for each country (Canada represents the foreign sector for the U.S.), so we can estimate (13.11) as an equation with five parameters if we include a constant.

At first glance it may seem improper to use the observed nominal interest rates in the return differential $(R_j + \mu_{ji} - R_i)$ as the IAPM is phrased in terms of certain real returns in each country. However, it must be remembered that the variable of interest is the return differential, and when the investor deflates both domestic and foreign returns by his domestic price, the price effects cancel out so that writing $(R_j + \mu_{ji} - R_i)$ in terms of observed rates is consistent with the underlying theory.

The estimation results are presented in table 13.2. Comparing this table with table 13.1B, we see that the standard error of the regression was lowered in only one of the five countries so that equation (13.11) cannot be said to do a "better" job in explaining net capital flows over this period. Only four of the risk-return coefficients enter significantly at the 10% level in table 13.2.[9] In evaluating the effect of the wealth terms, we must look at the partial derivatives in equation (13.11):

$$\delta \Delta N_i / \delta W^i = \beta_i \sum_k \sum_{j \neq i} \eta^i_{kj}(R_j + \mu_{ji} - R_i) + \beta^i_0,$$

$$\delta \Delta N_i / \delta W^k = -\beta_k \sum_{j \neq k} \eta^k_{ij}(R_j + \mu_{jk} - R_k) - \beta^k_0.$$

Evaluating these derivatives at each point in the sample space, we find results similar to those of table 13.1B. Domestic wealth has a positive effect on net capital outflows in Canada and Italy while foreign wealth has a negative effect only for Canada and Germany. Thus, as before, only for Canada do the wealth effects seem consistent with the portfolio approach while for the other countries the results seem to fall in line with the Prachowny (1969) or Branson (1968) arguments.

One might question whether (13.11) is properly specified when applied to the aggregate net capital account. In particular, there may be an important omitted variable since many researchers over the fixed rate period found the balance of trade to be a significant proxy for the "trade

9. While relative risk aversion is theoretically a positive value, I don't really care to test either the sign or magnitude of β, just that it differs significantly from zero. I'm interested in testing for the effect of the risk and return variables on capital flows. β is a convenient parameter that arises from the theory.

financing" motive for capital flows.[10] However, when country i's balance of trade was added to equation (13.11), only in the U.K. equation did it seem important, and even then the sign was wrong.

So far we have been assuming that actual capital flows equal desired capital flows as the market attains equilibrium each period. Yet it is well known that many countries place restrictions on international capital flows. Thus, besides the usual macroeconomic assumption of adjustment costs due to some nonspecified causes, in the international monetary literature we also have government regulation providing a specific barrier to complete adjustment. Bryant (1975) has argued that the existing capital-flows literature (with the exception of Bryant and Hendershott 1970) has failed to incorporate the effects of governmental restrictions on capital flows (Bryant, p. 339). Yet without specific knowledge of the effects of controls we are constrained to use such approaches as dummy variables or partial adjustments. If we assume that $\Delta N_i = \alpha_i(N_i^* - N_{i,t-1})$, where N_i^* is the desired level, then as Bryant points out we should model α as changing with changes in capital controls. Lacking degrees of freedom and knowledge of how controls affected market participants in different countries, I am willing to assume a constant effect across the recent flexible rate period and specify α as a constant.

Writing the desired net asset holdings in the form of (13.10), we have

$$\Delta N_i = N_i - N_{i,t-1} = \alpha_i(N_i^* - N_{i,t-1}) \text{ or}$$

$$\begin{aligned} N_i = {} & \alpha_i[\beta_i W^i \sum_k \Sigma_{j \neq i}\, \eta^i_{kj}(R_j + \mu_{ji} - R_i) \\ & + \beta^i_0 W^i - \Sigma_{k \neq i}\, \beta_k W^k \\ & \quad \Sigma_{j \neq k}\, \eta^k_{ij}(R_j + \mu_{jk} - R_k) - \beta^k_0 W^k] \\ & + (1 - \alpha_i) N_{i,t-1}. \end{aligned} \tag{13.12}$$

Differencing (13.12) gives us the partial adjustment capital-flows model:

$$\begin{aligned} \Delta N_i = {} & \alpha_i \beta_i \Delta[W^i \sum_k \Sigma_{j \neq i}\, \eta^i_{kj}(R_j + \mu_{ji} - R_i)] + \alpha_i \beta^i_0 \Delta W^i \\ & - \alpha_i \Sigma_{k \neq i}\, \beta_k \Delta[W^k\, \Sigma_{j \neq k}\, \eta^k_{ij}(R_j + \mu_{jk} - R_k) \\ & - \alpha_i \beta^k_0 \Delta W^k] + (1 - \alpha_i)\Delta N_{i,t-1}. \end{aligned} \tag{13.13}$$

10. Leamer and Stern (1970) argue that "the primary variable for explaining trade financing should be expressed in terms of *changes* in sales rather than levels. The reason for this is that rapid growth in sales that reflects favorable profit opportunities will engender increases in trade credit. When sales and profit opportunities level off, there will be a tendency for firms to rely more on internal financing and domestic credit sources. The result will be a leveling off and perhaps even a decline in the use of foreign credits" (p. 96). It is interesting to note that Branson and Hill (1971) found the change in the trade balance to be an important explanatory variable over the fixed rate period for the net capital account of the U.K. and Canada.

Table 13.2 **Equation (13.11)**

	US	UK	CA	GE	IT
Coefficients					
b_0	57.18 (2.79)	6.84 (2.39)	−44.28 (−12.38)	73.12 (2.94)	−3216 (−1.13)
b_1	−.0001 (−2.44)	8.6×10^{-7} (.23)	1.5×10^{-6} (.71)	-3×10^{-6} (−.13)	-5×10^{-4} (−.75)
b_2	.003 (2.41)	7.7×10^{-4} (3.50)	-1.9×10^{-4} (−.83)	.011 (1.93)	.31 (1.49)
b_3	−5434 (−2.09)	−1237 (−2.75)	3477 (11.67)	−6151 (−2.56)	203248 (.79)
b_4	−256 (−1.24)	−96.04 (−2.97)	5.44 (.31)	1043 (3.37)	−8273 (−.33)
Error process	—	AR2 .69, −.72	AR2 .51, −.86	AR2 −.17, −.38	AR2 1.09, −.36
S.E.E.	9.88	1.51	1.00	19.00	1000
$\bar{R}^2$	.36	.51	.86	.61	.01
D-W	1.91	2.34	2.21	1.95	2.19

Table 13.3 **Equation (13.13)**

	US	UK	CA	GE	IT
Coefficients					
αb_0	30.88 (2.96)	6.81 (2.44)	−29.31 (−4.55)	1.22 (.06)	−2524 (−1.17)

αb_1	-2.2×10^{-4} (−3.86)	3.2×10^{-6} (.69)	-9.7×10^{-7} (−.54)	-1.7×10^{-5} (−1.23)	-3.7×10^{-4} (−.53)
αb_2	.001 (1.12)	8.8×10^{-4} (3.10)	-2.9×10^{-4} (−.92)	.010 (2.02)	.684 (2.01)
αb_3	−2888 (−2.33)	−1209 (−2.73)	2295 (4.46)	247.58 (.12)	2.1×10^{-5} (1.03)
αb_4	−48.20 (−.41)	−79.18 (−2.11)	−14.00 (−.88)	357.95 (1.43)	−7183 (−.29)
$(1-\alpha)$	.439 (3.91)	.201 (.99)	.374 (2.63)	.715 (4.28)	.793 (3.33)
Error process	AR2 −.79, −.64	AR2 .56, −.67	AR2 .03, −.59	AR2 −.97, −.56	AR2 .25,.25
S.E.E.	8.89	1.53	.95	16.88	927
$\bar{R}^2$	.77	.51	.90	.85	.40
h [D-W]	−.10	−3.99	−1.31	.24	[1.92]

b_0 Constant
b_1 Δ(Product of domestic wealth, inverse of covariance matrix, and return differential)
b_2 Δ(Product of foreign wealth, inverse of covariance matrix, and return differential)
b_3 Δ(Domestic wealth)
b_4 Δ(Foreign wealth)
α Partial adjustment coefficient
AR2 Second-order autoregressive process
h Durbin's "h" statistic; when h can't be computed (this occurs when the product of the sample size and the estimated variance of $(1-\alpha)$ exceeds one), the D-W statistic is reported
Estimation period 1971II to 1976IV
t statistics in parentheses

Table 13.3 presents estimates of (13.13). Only for the U.K. could we not reject the hypothesis that α equals one. Implied values of α range from .80 for the U.K. to .21 for Italy. Compared to table 13.2, the standard error of the regression falls for all but the U.K. Those familiar with the work on net capital flows will recognize that these results would not compare unfavorably with the previous work, especially if we were to compare unadjusted R^2, the statistic reported by many previous authors.

It is interesting to note the sensitivity of the results to the error process estimated. The TROLL system allows the estimation of first- and second-order autoregressive and moving average processes. The process that minimized the sum of squared errors (and therefore the standard error of the regression) was chosen. If the empirical race was to be run on the basis of $\bar{R}^2$, then in certain instances different processes would have been chosen as the quasi-differencing induced by an assumed error process results in a different dependent variable series with sometimes less variation to be explained by the regression (the TROLL package computes $\bar{R}^2$ using the quasi-differenced equations). For instance, the standard error and $\bar{R}^2$ for Italy in table 13.3 are 927 and .40 respectively, based on fitting a second-order autoregressive process. In contrast, the OLS estimate for Italy produces a standard error and $\bar{R}^2$ of 949 and .44. Since much of the older literature does not include fitted error processes (even though there is often evidence of at least first-order autocorrelation from the Durbin-Watson statistic), the informativeness of the reported diagnostic statistics is somewhat suspect and not exactly comparable to the current results.

As discussed earlier, there is no a priori expected sign on b_1 or b_2. Also, we now see in table 13.3 that the estimated scale coefficients have the positive sign consistent with the portfolio theory only for Germany. The remaining negative coefficients again seem counter to the notion that the income terms represent portfolio scale variables and seem more consistent with Prachowny's or Branson's approach.

13.4 A Simultaneous Equation Approach

A recurring problem in the capital-flows literature is the failure to acknowledge the presence of simultaneity problems. As shown in the previous chapter, interest rates and wealth terms are included on the right-hand side of these equations, and it is unreasonable to expect these terms to be exogenous variables.

The NBER International Transmission of Inflation Model provides a ready-made general equilibrium setting into which the present capital-flows equations may be inserted. The choice of variables and time span for estimation has been made consistent with the model. As the new capital-flows equations add no new endogenous variables, they can simply replace the similar equations existing in the model (the model includes a capital-flows equation for each country).

As discussed in part II of this volume, the problem in using two-stage least-squares (2SLS) estimation with the model is that the number of predetermined variables exceeds the number of observations. Thus the standard econometric solution of taking the leading principal components of the predetermined variables is used. The first-stage regression is then done using the principal components rather than the actual predetermined variables. Given the short sample for the floating exchange-rate period, the number of components taken was constrained to be equal to half the number of observations (if the number of predetermined variables in the first-stage regression equals the number of observations, then the actual values of the endogenous variables are perfectly reproduced and no simultaneous equation bias is removed). By taking the first eleven principal components, however, it was possible in each case to explain at least 95% of the variance of the instrument list.

The 2SLS estimates of equation (13.5) without and with the risk proxies are given in tables 13.4A and 13.4B respectively. When compared to the single-equation estimates, the results, in particular the standard errors of the regressions (SEE), have deteriorated with the simultaneous estimation. Note that the R^2 values are reported, but of course they have a different meaning in a simultaneous setting and can range from minus infinity to one.[11]

Why do the results of the simultaneous estimations look poorer? The problem lies in the first-stage regressions. If the R^2 in the first stage is close to one, then the results in the second stage will be very close to OLS estimates, as the fitted values of the endogenous variables are very close to their actual values. If the first-stage R^2 values are close to zero, then the fitted values of the endogenous variables will in no way resemble the actual endogenous variables and the second-stage regression is nonsense. Unfortunately, the first-stage R^2 values for all but the wealth terms are quite low, and the results presented in tables 13.4A and 13.4B are therefore not very useful.

The 2SLS estimates of equations (13.11) and (13.13) are presented in tables 13.5 and 13.6 respectively; once again the problem of low first-stage R^2 values is present so that the estimated regressions are not

11. If the structural equation to be estimated is $Y_1 = Y_2\beta + X\delta + u$ and Y_1 and Y_2 are endogenous while X is exogenous, then we regress Y_2 on instruments in the first stage and use the fitted values $\hat{Y}_2$ in the second-state regression: $Y_1 = \hat{Y}_2\beta + X\delta + e$. One can then construct a measure of R^2 as $R^2_{2SLS} = 1 - [\hat{v}'\hat{v}/\dot{Y}_1{}'\dot{Y}_1]$, where $\dot{Y}_1$ has the mean removed and $\hat{v}$ is given as $\hat{v} = Y_1 - Y_2\hat{\beta} - X\hat{\delta}$, where the true Y_2, not the fitted value, is used. Thus R^2_{2SLS} cannot exceed one, but could be negative, and is not the measure of the percentage of variance explained that appears in an OLS regression.

Table 13.4A **2SLS Estimate of Equation (13.5) without Risk Variables**

	US	UK	CA	GE	IT
Coefficients					
b_0	60.02	2.31	−39.68	49.88	−3717
	(2.19)	(.62)	(−8.73)	(1.01)	(−1.44)
b_1	−8.81	−1.61	.319	94.16	−156
	(−.12)	(−.36)	(.04)	(1.11)	(−.15)
b_4	−5773	−463	3094	−3623	2.4×10^5
	(−1.63)	(−.78)	(8.20)	(−.76)	(.98)
b_5	−1464	−49.58	170	3825	−24231
	(−.48)	(−.49)	(.65)	(1.11)	(−.30)
b_8	−268	−22.66	−14.16	1353	−48472
	(−.73)	(−.37)	(−.70)	(2.27)	(−1.37)
Error process	MA1	MA1	MA1	AR1	AR1
	.01	−.77	.10	−.15	.82
S.E.E.	11.92	1.93	1.13	28.95	1040
$\bar{R}^2$	.07	−.04	.76	−.38	−.04
D-W	1.70	2.28	1.40	2.45	2.07

particularly informative. While some of the parameters estimated in tables 13.5 and 13.6 are close to their OLS counterparts, we also observe some rather strange results such as an implied adjustment coefficient in the partial adjustment equation for Germany that is greater than one in table 13.6.

As stated in Intriligator (1978, p. 392), "the method of two-stage least squares works poorly if the R^2 values in the first stage are 'too small,' i.e., close to zero" and "it is only in the case of 'intermediate' values of R^2 in the first stage that the 2SLS estimators make sense." While statements like "too small" and "too close to zero" are open to subjective evaluation, I believe that the results displayed in tables 13.4A through 13.6 are indeed the product of such phenomena. It is small comfort to know that others have also experienced difficulty in applying 2SLS to a net capital-flows equation. Herring (1973) attempted to estimate a Canadian capital-flows equation using 2SLS but given the bizarre behavior of his second-stage estimates is "forced to rely on the results of the ordinary least squares estimation" (p. 73).

Thus it is not clear at all that 2SLS is a useful approach in terms of the current data set under consideration. While OLS is generally biased in a simultaneous setting, we are venturing into somewhat unknown territory with small sample applications of 2SLS, as 2SLS is unbiased and *asymptotically* efficient. It may well be the case that in a small sample the biased

Table 13.4B 2SLS Estimate of Equation (13.5) with Risk Variables

	US	UK	CA	GE	IT
Coefficients					
b_0	40.96	3.45	−38.47	12.23	−3124
	(2.29)	(.65)	(−6.04)	(.35)	(−1.22)
b_1	21.76	−10.88	−3.67	83.13	−453
	(.37)	(−1.49)	(−.39)	(1.10)	(−.40)
b_3	6522	222	965	−1250	76489
	(2.79)	(1.05)	(1.40)	(−1.50)	(1.72)
b_4	−3785	−840	2962	485	98852
	(−1.60)	(−.98)	(5.48)	(.14)	(.39)
b_5	−345	−290	15.56	3432	−66818
	(−.13)	(−1.51)	(.05)	(1.11)	(−.68)
b_7	2.6×10^5	4621	28715	−44109	6.2×10^6
	(2.64)	(.92)	(1.46)	(−1.23)	(1.79)
b_8	−2098	−170	−229	2428	-2.0×10^5
	(2.69)	(−1.00)	(−1.52)	(2.70)	(−2.51)
Error process	AR2 .30, −.55	AR1 .70	MA1 .04	AR1 −.43	AR2 .43,.39
S.E.E.	11.59	2.25	1.32	23.60	1060
$\bar{R}^2$	.25	−.24	.64	.28	.15
D-W	2.19	1.82	2.21	2.13	1.71

b_0 Constant
b_1 Δ(Product of domestic wealth and return differential)
b_3 Δ(Product of domestic wealth and risk)
b_4 Δ(Domestic wealth)
b_5 Δ(Product of foreign wealth and return differential)
b_7 Δ(Product of foreign wealth and risk)
b_8 Δ(Foreign wealth)
MA1 First-order moving average process
AR1 First-order autoregressive process
AR2 Second-order autoregressive process
Estimation period 1971II to 1976IV
t statistics in parentheses

OLS estimate may "make up" for the bias in terms of smaller variance so that the mean square error of the OLS estimates is less than that of an unbiased, asymptotically efficient 2SLS estimate. At any rate, as Intriligator suggests (p. 420), "OLS may be appropriate if the first-state R^2 values are either 'too small' or 'too large,'" and so I conclude that the OLS regressions are more informative than the 2SLS.

Table 13.5 2SLS Estimate of Equation (13.11)

	US	UK	CA	GE	IT
Coefficients					
b_0	58.69	5.39	−35.89	33.85	−4194
	(2.04)	(1.26)	(−5.77)	(.69)	(−1.51)
b_1	−.0003	7.6×10^{-6}	-2.1×10^{-6}	2.7×10^{-5}	−.0007
	(−2.08)	(.82)	(−.57)	(.26)	(−.59)
b_2	.0042	.0008	.0004	.0125	.0469
	(1.89)	(.82)	(.65)	(1.54)	(.09)
b_3	−5714	−984	2782	−2661	2.9×10^5
	(−1.54)	(−1.46)	(5.38)	(−.57)	(1.10)
b_4	−353	−31.86	−14.99	984	−54933
	(−.91)	(−.58)	(−.53)	(1.27)	(−1.32)
Error process	MA1	AR1	AR1	MA1	AR1
	−.13	.43	.10	−.37	.81
S.E.E.	11.79	1.93	1.27	21.20	1100
$\bar{R}^2$	.05	.04	.58	.23	−.16
D-W	2.06	1.39	1.53	2.29	1.87

Table 13.6 2SLS Estimate of Equation (13.13)

	US	UK	CA	GE	IT
Coefficients					
αb_0	12.89	4.09	−23.14	53.49	−1700
	(.99)	(.96)	(−2.62)	(1.43)	(−.77)

αb_1	$-.0001$	1.2×10^{-5}	7.0×10^{-7}	4.0×10^{-5}	-1.1×10^{-5}
	(-1.00)	(1.24)	$(.24)$	$(.47)$	$(-.01)$
αb_2	.0029	.0008	.0004	.0126	.6430
	(1.54)	(1.04)	(.66)	(1.13)	(1.01)
αb_3	-757	-773	1793	-4239	95114
	$(-.48)$	(-1.13)	(2.53)	(-1.22)	(.48)
αb_4	48.57	-20.75	-15.74	1371	-25853
	(.23)	$(-.36)$	$(-.79)$	(1.89)	$(-.56)$
$(1-\alpha)$	.5679	.1688	.4405	$-.1168$	.4716
	(3.68)	(.67)	(2.35)	$(-.45)$	(1.65)
Error	AR1	MA1	MA1	AR2	AR1
process	$-.59$	$-.57$	.10	$.25, -.43$	.37
S.E.E.	9.93	1.90	1.03	21.47	1010
$\bar{R}^2$	.59	.03	.80	.44	.29
h [D-W]	$-.82$	(1.84)	-1.37	(1.97)	(1.87)

b_0 Constant
b_1 Δ(Product of domestic wealth, inverse of covariance matrix, and return differential)
b_2 Δ(Product of foreign wealth, inverse of covariance matrix, and return differential)
b_3 Δ(Domestic wealth)
b_4 Δ(Foreign wealth)
α Partial adjustment coefficient
MA1 First-order moving average process
AR1 First-order autoregressive process
AR2 Second-order autoregressive process
Estimation period 1971II to 1976IV
t statistics in parentheses
h Durbin's "h" statistic; when h can't be computed (this occurs when the product of the sample size and the estimated variance of $(1-\alpha)$ exceeds one), the D-W statistic is reported

13.5 Estimation with an Alternative Data Set

The empirical work described above used the data set created for the NBER International Transmission of Inflation Model. Unfortunately this data set only runs through 1976, so to provide more recent data it was necessary to use the IMF *International Financial Statistics* data base. After identifying and collecting the appropriate IFS counterparts to the NBER data set, it was possible to estimate equations (13.5) and (13.11) through 1978IV (see the data appendix to this chapter for a list of IFS variables chosen and a discussion of the data set construction).[12]

The results for equation (13.5) without risk variables are presented in table 13.1A′ while table 13.1B′ presents the estimates with the risk variables included. In two of the four countries the fit (in terms of standard error of estimate) is improved when the risk terms are included, and two of the individual risk coefficients enter significantly at the 10% level of significance. In terms of a joint F test, only for Germany are both b_3 and b_7 significant. The evidence of promise with regard to specifying risk proxies as defined in the traditional capital-flows literature is weaker for this time period. By just including the results for Germany we could have made a stronger case. Unfortunately any single specification of the period over which the standard deviations are calculated will not work well for all countries. Experimentation did reveal that one could tailor the choice for individual countries and find risk proxies that entered more significantly for certain countries than the evidence presented here. Those researchers predisposed to ad hoc searching may take comfort in knowing that choosing the period over which the standard deviation is to be taken is like most other empirical specifications: if you beat the data long enough, it will confess.

To determine the sign of the effects of the various coefficients, we must again evaluate the various derivatives. A priori, the reasoning presented in section 13.2 applies here. The net effect of an increase in the risk variable is a priori uncertain. Evaluating the partial derivative, $\delta \Delta N_i / \delta E$, at each point in the sample space we generally find a positive sign for the U.S., Germany, and Italy and a negative sign for Canada. For the return differentials, we expect a negative effect as net capital outflows fall with increases in the differential. Examining the derivative $\delta \Delta N_i / \delta (R_i - R_f)$, we find negative signs for the U.S. and Italy and positive signs for Canada and Germany. Looking at the t statistics on the individual coefficients, it is difficult to believe that the return differentials contain much explanatory power for capital flows.

Finally, for the wealth terms, we expect a positive sign for domestic wealth and a negative sign for foreign wealth according to the portfolio

12. Note that the U.K. results are excluded from the extended data set. The IFS tape obtained did not contain a complete data series for the U.K.

theory. However, only for Canada is the derivative with respect to domestic wealth positive while the derivative with respect to foreign wealth is negative for Canada, Germany, and Italy.

Comparing these results to those reported for the earlier period in section 13.2, we see that once again there is some evidence supporting the usefulness of empirical risk proxies, once again the return differentials do not seem to be very useful in explaining capital flows, the wealth terms perform somewhat better than before for foreign wealth (in terms of consistency with the portfolio theory), while domestic wealth again gives support to a Branson (1968) or Prachowny (1969) approach.

With the availability of the extended data set it became possible to consider the question of the appropriate starting period. Although there was quite clearly a break from fixed exchange rates in 1971, generalized floating did not begin until early 1973. Therefore one might rightly question how sensitive the results would be if begun in 1973. Equation (13.5) was reestimated over the 1973–78 period. The results without risk variables are presented in table 13.1A″, while the results with risk variables are shown in table 13.1B″. Over this time period we see that two of the four countries have an improved fit (in terms of standard error of estimate) when the risk proxies are included. The sign of the effect of the risk proxy changes for the U.S. and Germany (although the risk proxies don't seem to carry much explanatory power in any case over this sample period). The sign of the return differential changes for the U.S. so that only Italy is left with the expected negative sign (overall the return differentials still don't explain much). The wealth effects have maintained the same signs as before. As for supporting an argument in favor of the "traditional" risk proxies, the 1973–78 estimation results do poorly.

Turning now to the IAPM formulation of the capital-flows equation, we find quite interesting results. Table 13.2′ presents the estimates of equation (13.11) over the 1971–78 period. Compared to table 13.1B′ we find that the SEE (standard error of estimate) fell in only two of the cases. Table 13.2″ gives the estimation results over the period 1973–78. Compared to table 13.1B″, we find that the SEE falls in two of the cases. Note that 13.2′ only moderately improves the explanatory power of a few countries (compared to 13.1B′) while 13.2″ improves the explanatory power for the U.S. and Canadian equations considerably. While individual risk return coefficients don't enter significantly in table 13.2′, in 13.2″ we find four significant coefficients. Evaluating the derivatives of the wealth terms, we find for both periods that domestic wealth has a positive effect on net capital outflows for Canada only, while foreign wealth has a negative effect for Germany and Italy. Thus the wealth effects are similar whichever functional form is chosen (equation (13.5) or (13.11)).

Finally, if we estimate the partial adjustment equation (13.13) over the

Table 13.1A′ Equation (13.5) without Risk Variables

	US	CA	GE	IT
Coefficients				
b_0	51.98	−22.11	63.11	19635
	(1.49)	(−1.94)	(1.67)	(2.60)
b_1	−.63	2.40	4.00	−210
	(−.24)	(1.74)	(1.78)	(−.84)
b_4	−7157	1827	−8079	-2.8×10^6
	(−1.51)	(1.74)	(−1.30)	(−2.72)
b_5	119	150	124	−32785
	(.58)	(1.38)	(.34)	(−.43)
b_8	−84.19	23.29	1499	37652
	(−.41)	(.52)	(4.54)	(.61)
Error process	AR2 .85, −.14	AR2 −.14, .66	MA2 .18, .08	AR2 .08, .35
S.E.E.	7.13	2.25	19.76	2920
$\bar{R}^2$	−.05	.06	.43	.13
D-W	1.93	1.79	1.94	1.95

two periods, we find results as presented in tables 13.3′ and 13.3″. The differences here are striking. Over the 1971–78 period, the adjustment coefficient is significantly different from unity in all cases and implies values of α ranging from .19 for Italy to .45 for Germany. For the 1973–78 period, the adjustment coefficient differs significantly from unity only for Italy. In the context of the discussion underlying the development of equation (13.13) in section 13.3, we would infer that the differences between tables 13.3′ and 13.3″ are due to lower costs of adjusting capital flows to desired levels over more recent periods. The dismantling of exchange and capital controls and the refinement and expansion of the international money market through the 1970s would lead to actual and desired capital flows converging.

While the "traditional approach" equations do not fare too well over the more recent estimation periods, the "alternative approach" equations do quite well. Comparing the estimation results for the 1971–78 and 1973–78 periods, we see that the starting period does make a difference and allows us to infer that actual capital flows are closer to desired levels for more recent periods.

13.6 Conclusions

The "portfolio approach" to capital flows that has been popular since the mid-1960s has advanced the state of the art. Unfortunately the

Table 13.1B′ Equation (13.5) with Risk Variables

	US	CA	GE	IT
Coefficients				
b_0	60.66	−22.85	75.53	23601
	(1.65)	(−2.06)	(1.39)	(2.91)
b_1	−.81	2.32	3.50	−36.11
	(−.30)	(1.61)	(2.07)	(−.15)
b_3	14.62	−21.66	81.38	21597
	(.19)	(−.49)	(.78)	(1.94)
b_4	−8383	1905	−10056	-3.4×10^6
	(−1.67)	(1.86)	(−1.09)	(−3.03)
b_5	151	181	187	3382
	(.70)	(1.58)	(.64)	(.05)
b_7	8141	−3255	−17619	1.1×10^6
	(.96)	(−1.24)	(−2.02)	(.95)
b_8	212	65.23	2005	146
	(−.87)	(1.12)	(2.92)	(.00)
Error process	AR2 .87,−.15	AR2 −.17,.60	AR2 −.12,.22	AR2 .22,.35
S.E.E.	7.28	2.27	17.15	2780
$\bar{R}^2$	−.10	.07	.44	.18
D-W	1.92	1.87	1.96	1.90

b_0 Constant
b_1 Δ(Product of domestic wealth and return differential)
b_3 Δ(Product of domestic wealth and risk)
b_4 Δ(Domestic wealth)
b_5 Δ(Product of foreign wealth and return differential)
b_7 Δ(Product of foreign wealth and risk)
b_8 Δ(Foreign wealth)
MA2 Second-order moving average process
AR2 Second-order autoregressive process
Estimation period 1971II to 1976IV
t statistics in parentheses

empirical work done in this area has not been particularly faithful to the theory cited. In the second section an ad hoc formulation of the portfolio approach is represented as being characteristic of the approach taken by past authors. This ad hoc approach contained one glaring omission in practice in that while the specification included risk variables, the empirical approach of past authors was to throw risk out. We know that such equations are misspecified by leaving out the risk terms, but a priori we

Table 13.1A″ **Equation (13.5) without Risk Variables**

	US	CA	GE	IT
Coefficients				
b_0	54.10	−31.64	60.58	19175
	(1.29)	(−3.75)	(1.88)	(2.22)
b_1	3.12	3.25	6.58	−166
	(.73)	(1.46)	(2.85)	(−.52)
b_4	−7393	2668	−7142	-2.8×10^6
	(−1.31)	(3.48)	(−1.35)	(−2.40)
b_5	475	515	417	−15071
	(1.14)	(3.24)	(1.01)	(−.15)
b_8	−166	49.67	1514	51449
	(−.70)	(.99)	(4.96)	(.72)
Error process	AR2 .95, −.22	AR2 −.04, −.11	AR2 .01, −.68	MA2 .06, −.42
S.E.E.	7.86	2.31	19.30	3200
$\bar{R}^2$	−.04	.50	.59	.09
D-W	1.98	1.91	1.96	1.84

don't know how important the omitted variables are. It is shown that it is possible to specify proxies for risk that can add significant explanatory power to the ad hoc formulations.

In the third section, the functional form of the estimating equation is derived from the underlying portfolio theory. In contrast to the ad hoc approach, risk and return now enter interactively and the concept of risk involves covariances with all the exchange rates in the model rather than just the variance of one exchange rate. Of course as in all empirical work, one's evaluation of the estimation results depends on the questions one has in mind. The "traditional" approach in most cases performs better in terms of standard error than the theoretically consistent estimating equation, but they are generally close. Thus, in terms of an ability to "explain" capital flows, the theoretically consistent equation cannot be said to outperform the ad hoc approach. This is not a very surprising result. If economists believed that developing their estimating equations rigorously from theory would allow an improvement in their ability to "explain" the world, we would not see the volume of ad hoc applied work that we observe. Still, when a partial adjustment approach is added to the theoretically consistent estimating equation, the results generally improve relative to the ad hoc approach. Those familiar with the work on net capital flows will recognize that these improved results would not

Table 13.1B″ Equation (13.5) with Risk Variables

	US	CA	GE	IT
Coefficients				
b_0	60.51	−30.71	61.36	27026
	(1.26)	(−3.34)	(.79)	(2.65)
b_1	3.06	3.22	4.38	−50.34
	(.66)	(1.41)	(2.31)	(−.17)
b_3	−12.55	−3.13	−14.87	20195
	(−.08)	(−.03)	(−.09)	(1.41)
b_4	−8294	2585	−6644	-3.8×10^6
	(−1.28)	(3.08)	(−.49)	(−2.77)
b_5	565	503	30.30	−4033
	(1.23)	(3.03)	(.10)	(−.04)
b_7	8374	−2109	−23776	8.0×10^5
	(.44)	(−.44)	(−1.61)	(.53)
b_8	−251	72.64	2773	33590
	(−.76)	(.95)	(2.63)	(.38)
Error process	AR2 .95, −.21	AR2 −.06, −.08	AR2 .28, −.27	AR2 .24,.42
S.E.E.	8.20	2.39	17.15	3160
$\bar{R}^2$	−.13	.44	.59	.15
D-W	1.97	1.93	1.90	1.85

b_0 Constant
b_1 Δ(Product of domestic wealth and return differential)
b_3 Δ(Product of domestic wealth and risk)
b_4 Δ(Domestic wealth)
b_5 Δ(Product of foreign wealth and return differential)
b_7 Δ(Product of foreign wealth and risk)
b_8 Δ(Foreign wealth)
MA2 Second-order moving average process
AR2 Second-order autoregressive process
Estimation period 1973II to 1978IV
t statistics in parentheses

compare unfavorably with previous work, especially if we were to compare unadjusted R^2, the statistic reported by many previous authors.

In section 13.4, the capital-flows equations are estimated in a simultaneous equation framework but with little success. Due to small first-stage R^2 values for many of the proxies used, it was concluded that the OLS estimates are more informative than the 2SLS estimates.

Finally, in section 13.5 an alternative data set is used which goes

Table 13.2′ **Equation (13.11)**

	US	CA	GE	IT
Coefficients				
b_0	50.51	−14.97	56.96	20404
	(1.44)	(−1.18)	(1.45)	(2.74)
b_1	-3.1×10^{-4}	-6.9×10^{-5}	-2.8×10^{-4}	.10
	(−.14)	(−.42)	(−.26)	(1.48)
b_2	−.10	.19	−.22	−213
	(−.53)	(1.14)	(−.23)	(−1.21)
b_3	−6977	1143	−7296	-3.0×10^{6}
	(−1.46)	(.98)	(−1.13)	(−2.86)
b_4	−115	−11.55	1362	39999
	(−.60)	(−.28)	(4.00)	(.73)
Error process	AR2 .86, −.15	AR2 −.09,.71	AR2 −.28, −.02	MA2 .01, −.54
S.E.E.	7.15	2.34	20.72	2770
$\bar{R}^2$	−.06	−.03	.35	.16
D-W	1.89	1.94	1.93	1.83

through 1978. The ad hoc approach generally deteriorates over the most recent estimation period while the theoretically consistent approach works quite well. Regressions over the 1973–78 period allow us to infer that lags in adjusting actual capital flows to desired levels have decreased over the recent floating exchange-rate period.

Regarding the effects of individual variables, it was found that the portfolio scale variables and risk proxies often had considerable explanatory power while return differentials did not. This latter finding should not be surprising to some. Black (1979), for instance, has argued that we should observe no particular correlation between asset flows and rates of return, as the flows will probably occur before the rates change in anticipation of their change. With perfect markets we would expect the flows to be instantaneous in response to return differentials so that no (risk adjusted) differentials are ever observed. Considering the real world, the financial news often explains capital flows in terms of interest-rate changes. So while capital flows appear to be related in some plausible fashion to interest rates, the response is likely to be fast so that in the absence of barriers to capital movements we should not expect to see any long-term average relation between capital flows and return differentials. The old capital-flows literature assumed that we would observe a correlation between interest rates and capital flows, and usually a significant

Table 13.3′ **Equation (13.13)**

	US	CA	GE	IT
Coefficients				
αb_0	26.08	−12.60	−1.42	15137
	(1.11)	(−2.40)	(−.05)	(4.77)
αb_1	.003	4.0×10^{-5}	-6.3×10^{-4}	.04
	(.79)	(.26)	(−.73)	(.61)
αb_2	−.02	.13	.07	−414
	(−.99)	(.65)	(.07)	(−1.77)
αb_3	−3417	1141	1535	-2.0×10^{6}
	(−1.05)	(2.27)	(.34)	(−4.61)
αb_4	95.94	−37.69	846	1.1×10^{5}
	(.55)	(−1.57)	(2.84)	(3.21)
$(1-\alpha)$	.56	.71	.55	.81
	(3.42)	(5.56)	(3.29)	(7.35)
Error process	AR2 .14,.37	AR2 −.97,−.09	AR2 −.87,−.36	AR2 −.89,−.20
S.E.E.	7.09	2.12	19.98	2500
$\bar{R}^2$	.32	.73	.70	.81
h [D-W]	.34	−.02	.32	.29

b_0 Constant
b_1 Δ(Product of domestic wealth, inverse of covariance matrix, and return differential)
b_2 Δ(Product of foreign wealth, inverse of covariance matrix, and return differential)
b_3 Δ(Domestic wealth)
b_4 Δ(Foreign wealth)
α Partial adjustment coefficient
MA2 Second-order moving average process
AR2 Second-order autoregressive process
h Durbin's "h" statistic; when h can't be computed (this occurs when the product of the sample size and the estimated variance of $(1-\alpha)$ exceeds one), the D-W statistic is reported
Estimation period 1971II to 1978IV
t statistics in parentheses

relation was in fact found. While there is nothing wrong with assuming capital flows respond to yield differentials (after all, the flows are the mechanism that keeps the differentials constant), the empirical findings of the early researchers are called into question by the present study. It is shown in the present paper that capital flows do not appear to be systematically and significantly related to return differentials when the estimating equation is faithful to the underlying theory. The fact that early researchers included various extraneous variables in order to "improve

Table 13.2″ **Equation (13.11)**

	US	CA	GE	IT
Coefficients				
b_0	75.69	−41.11	63.18	18819
	(2.31)	(−3.61)	(1.45)	(2.04)
b_1	.01	4.1×10^{-4}	−.03	.13
	(3.06)	(.36)	(−4.23)	(.13)
b_2	2.23	2.38	−1.46	−310
	(5.10)	(5.73)	(−.88)	(−.84)
b_3	−10169	3481	−8122	-2.8×10^6
	(−2.30)	(3.34)	(−1.13)	(−2.2)
b_4	−27.45	−58.52	1254	45467
	(−.19)	(−1.15)	(3.73)	(.68)
Error	AR2	AR2	AR2	MA2
process	1.29, −.51	.45, −.12	.50, −.68	.01, −.49
S.E.E.	5.58	2.07	18.10	3160
$\bar{R}^2$	.53	.63	.64	.07
D-W	2.15	1.98	1.98	1.83

the fit" casts doubt on any hypothesis testing done for interest-rate coefficients in the context of such "portfolio approach" models. Those who claim that the capital-flows literature casts doubt on Black's assertions may not have very strong evidence.

The findings of the current study suggest that while wealth and risk proxies do have some explanatory power in capital-flows regressions, the overall explanatory power of these regressions is not in general high (in terms of $\bar{R}^2$). The failure to find a strong systematic component of capital flows indicates that much of observed capital flows reflects the behavior of profit maximizers responding to new events and opportunities.

The contribution of this paper has been to (1) incorporate a risk proxy in an equation based on the existing capital-flows literature, and (2) rigorously derive and estimate an alternative functional form for capital flows using the underlying portfolio theory. The goal is to bring the empirical work closer to the underlying theory.

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Table 13.3″ **Equation (13.13)**

	US	CA	GE	IT
Coefficients				
αb_0	75.88	−47.63	114	15399
	(2.21)	(−3.45)	(1.59)	(4.28)
αb_1	.01	4.1×10^{-4}	−.01	.31
	(2.91)	(.42)	(−.71)	(.27)
αb_2	2.25	1.96	−1.53	−576
	(4.17)	(3.31)	(−1.15)	(−1.47)
αb_3	−10190	4007	−16697	-2.1×10^6
	(−2.21)	(3.19)	(−1.43)	(−4.13)
αb_4	−25.68	−56.63	1011	1.3×10^5
	(−.17)	(−1.08)	(2.65)	(3.36)
$(1-\alpha)$	.01	−.34	−.35	.82
	(.05)	(−1.38)	(−1.15)	(6.48)
Error process	AR2 1.28, −.50	AR2 .70, −.28	AR2 .79, −.49	AR2 −.97, −.23
S.E.E.	5.73	2.07	18.30	2710
$\bar{R}^2$	.51	.71	.63	.79
h [D-W]	−1.74	[1.99]	[2.17]	−.64

b_0 Constant
b_1 Δ(Product of domestic wealth, inverse of covariance matrix, and return differential)
b_2 Δ(Product of foreign wealth, inverse of covariance matrix, and return differential)
b_3 Δ(Domestic wealth)
b_4 Δ(Foreign wealth)
α Partial adjustment coefficient
MA2 Second-order moving average process
AR2 Second-order autoregressive process
h Durbin's "h" statistic; when h can't be computed (this occurs when the product of the sample size and the estimated variance of $(1-\alpha)$ exceeds one), the D-W statistic is reported
Estimation period 1973II to 1978IV
t statistics in parentheses

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Data Appendix
(IFS data for extending sample)

Dependent Variable: ΔN_i, measured as current account minus change in reserves. Referring to IFS line number, capital flows are found as

$$77aad + 77acd + 77abd + 77add + 77aed + 77agd - 79kd.$$

Variables were converted to billions of domestic currency units, and seasonally adjusted before summing.

Exchange Rates: Average of noon buying rates in New York for cable transfers as reported in the *Federal Reserve Bulletin*.

Interest Rates: IFS line 60c.

Wealth and Foreign Wealth: Created as in the NBER model using real income from line 99ar.

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