An Empirical Evaluation of International Capital Flows

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Abstract: A critical assessment and evaluation of international capital flows and its major components, namely bank lending, foreign direct investment, and portfolio investment in the form of equity and debt, are essential concerns for developed and developing countries alike. The drastic change in the composition of capital flows to developing countries in the last decade was due to a structural change in international capital markets. This paper analyses the literature relating to empirical international capital flows models according to established statistical and econometric criteria used in estimation, evaluation and forecasting. Such an evaluation permits a critical assessment of the relevance and practicality of the international capital flows literature.

Keywords: International capital flows; Empirical models; Statistical and econometric criteria

1. INTRODUCTION

Capital flows from rich to poor countries are worth examining for several reasons. Foreign capital can finance investment and stimulate economic growth, thereby smoothing out consumption and increasing the standard of living in the developing world. Capital flows can help developed countries achieve a better international diversification of their portfolios, and provide support for pension funds and retirement accounts into the future. However, large capital inflows tend to cause rapid monetary expansion, inflationary pressure, real exchange rate appreciation, and widening current account deficits in the recipient countries [Calvo et al., 1996]. These undesirable macroeconomic effects render the economy more vulnerable to foreign shocks. When the inflow of foreign capital is interrupted, the economy experiences reverse adjustments in the current account and real exchange rate. The process of adjustment to adverse shocks in capital movements can be painful, as dramatized by episodes of debt crises [Kim, 2000].

The factors that affect international capital flows can be characterized as internal to the economies receiving the flows (pull factors), external to those economies (push factors), or both. Internal factors include increases in creditworthiness as a result of macroeconomic stabilization, widespread liberalization of financial markets, and successful resolution of the debt problem. This 'pull' story leads to the optimistic view that the sustainability of these flows is, to a large extent, a function of domestic policies which are under the control of developing countries. On the other hand, external factors include an increased availability of financial capital with a sustained decline in the world interest rate and recession in industrial economies. This 'push' story leads to the concern that these flows are highly volatile because they are subject to factors beyond the control of policy-makers [Fernandez-Arias, 1996].

The plan of the paper is as follows. Section 2 provides a quantitative classification of empirical international capital flows models, which forms the database for this paper. The data are classified and described in Section 3. Various theoretical and empirical model specifications used in the literature are reviewed analytically in Section 4. Some concluding remarks are given in Section 5.

2. CLASSIFICATION OF INTERNATIONAL CAPITAL FLOWS MODELS

For purposes of evaluating the significance of empirical models of international capital flows, it is necessary to analyse such models according to established statistical and econometric criteria. The primary purpose of each of these empirical papers is to evaluate the practicality and relevance of the economic theory pertaining to international capital flows. An examination of the empirical impact and statistical significance of the results of the international capital flows models will be based on an evaluation of the descriptive statistics relating

to the models as well as the econometric procedures used in estimation, testing and forecasting.

The paper reviews 20 published empirical studies on international capital flows [these papers are listed in Hoti, 2001]. A classification of the papers is given according to the data and sample sizes used, the pooled and time series nature of the data by both the number of countries and the number of time series observations used, the model specifications examined, the choice of dependent and explanatory variables considered, the number of explanatory variables used, econometric issues concerning the recognition, type and number of omitted explanatory variables, the number and type of proxy variables used when variables are omitted, the method of estimation, and the use of diagnostic tests of the auxiliary assumptions of the models.

3. CLASSIFICATION OF THE DATA

Scrutiny of the ECONLIT software package and the Social Science Citation Index for the most widely cited articles in the International Capital Flows literature yields at least 20 published empirical papers over the last decade in refereed journals (the first paper was published in 1991). The leading journals in the literature on international capital flows are World Bank Economic Review and Policy Research Working Papers (5 papers), Journal of Development Economics (4 papers), World Development (4 papers), IMF Staff Papers and Working Papers (2 papers), and 4 other journals each publishing one paper on the topic. For further details, see Hoti [2001].

In Table 1, the 20 studies are classified according to the type of data used, namely time series, cross-section or pooled, which combines time series and cross-section samples. Common sources of data are the International Monetary Fund, various sources of the World Bank, Bank for International Settlements, and various country-specific statistical bureaux. Of the 22 types of data used in the 20 studies, more than one-half are pooled data, with monthly, quarterly, cross-section and annual data being used far less frequently.

Table 1: Classification by Type of Data Used*

Type of Data	Frequency
Monthly	4
Quarterly	3
Annual	1
Pooled	12
Cross-section	2
TOTAL	22

*Two types of data were used in two studies.

Table 2 classifies the 12 studies using pooled data according to the number of countries, which varies from 9 to 62 countries, with mean 28.1, median 22, and mode 9, with the frequency of occurrence of each number apart from the mode being 1.

Table 2: Classification of Pooled Data by Number of Countries*

Number of Countries	Frequency
9	4
13, 20, 21, 22, 25, 29, 37, 47, 49, 60, 62	1
TOTAL	15

*Three studies used two data sets.

The same 12 studies using pooled data are classified according to the number of annual and quarterly/monthly observations in Tables 3 and 4, respectively. For the annual observations, the range of the 10 data sets is 5 to 26 years, with the mean and median of the number of observations being 12.9 and 8, respectively, with the frequency of occurrence of each number varying between 1 and 2. The 3 data sets using quarterly and monthly observations have 14 and 57 observations, respectively.

Table 3: Classification of Pooled Data by Annual Observations*

Number of Annual Observations	Frequency
5, 7, 8	2
18, 21, 24, 26	1
TOTAL	10

*One study used two time series data sets.

Table 4: Classification of Pooled Data by Quarterly and Monthly Observations

Number of Time Series Observations	Frequency
14*	1
57**	2
TOTAL	3

*Refers to quarterly observations. **Refers to monthly observations.

Tables 5 and 6 classify the studies using quarterly data according to the number of countries and the number of time series observations, respectively. In Table 5, the range of the 4 data sets is 2 to 9 countries, with mean 6, median 6.5, and mode 9. The 3 data sets using quarterly data in Table 6 have a range of 40 to 150 observations, with mean 112.7, median 148, and no mode.

Table 5: Classification of Quarterly Data by Number of Countries*

Number of Countries	Frequency
2, 4	1
9	2
TOTAL	4

*One study used two data sets.

Table 6: Classification of Quarterly Data by Number of Time Series Observations

Number of Observations	Frequency
40, 148, 150	1
TOTAL	3

Tables 7 and 8 classify the studies using monthly data according to the number of countries and the number of time series observations, respectively. In Table 7, the range of the 5 data sets is 3 to 22 countries, with mean 10.6, median 9, and mode 9. The 4 data sets using monthly data in Table 8 have a range of 48 to 167 observations, with mean 101.8, median 96, and no mode.

Table 7: Classification of Monthly Data by Number of Countries*

Number of Countries	Frequency
3	1
9	2
10, 22	1
TOTAL	5

*One study used two data sets.

Table 8: Classification of Monthly Data by Number of Time Series Observations

Number of Observations	Frequency
48, 72, 120, 167	1
TOTAL	4

4. THEORETICAL AND EMPIRICAL MODEL SPECIFICATIONS

The general international capital flows model typically estimated (and occasionally also tested and evaluated) is given as:

$$f(Y_t, X_t, u_t; \beta) = 0 \qquad (1)$$

in which $f(.)$ is an unspecified functional form, Y is the designated (vector of) endogenous variables, X is the (vector of) exogenous variables, u is the (vector of) errors, β is the vector of unknown parameters, and $t = 1,...,n$ observations. As will be discussed below, equation (1) is typically given as a linear or log-linear regression model, or as a VAR model. The elements of Y and X will also be discussed below. Defining the information set at time $t-1$ as $I_{t-1} = [Y_{t-1}, Y_{t-2},...; X_t, X_{t-1}, X_{t-2},...]$, the assumptions of the classical model are typically given as follows:

(A1) $E(u_t) = 0$ for all t;
(A2) Constant variance of u_t;
(A3) Serial independence (namely, no covariation between u_t and u_s for $t \neq s$);
(A4) X is weakly exogenous (that is, there is no covariation between X_t and u_s for all t and s);
(A5) u is normally distributed with mean 0 and constant variance;
(A6) Parameters are constant;
(A7) Y and X are both stationary processes, or are cointegrated if both are non-stationary.

Diagnostic tests play an important role in modern empirical econometrics, and are used to check the adequacy of a model through testing the underlying assumptions. The standard diagnostic checks which are used to test assumptions (A1) through (A7) are various tests of functional form misspecification, heteroscedasticity, serial correlation, exogeneity, third and higher-order moments of the distribution for non-normality, constancy of parameters and structural change, unit root tests, and tests of cointegration.

There is, in general, little or no theoretical basis in the literature for selecting a particular model. In empirical analysis, however, computational convenience and the ease of interpretation of models are primary considerations for purposes of model selection. Of the 27 models given in the 20 studies and reported in Table 9, all but eight are univariate models. The most popular model in the literature is the linear single equation model, which is used 9 times, followed by the log-linear single equation model and the VAR model, each of which is used 4 times. Both the probit and simultaneous equation system models are used twice, and six other models, namely Tobit, logit, log-linear two-equation system, state space form equations, cointegrating single equation, and seemingly unrelated error correction equations, are used once each. Thus, most of the models used in the literature are linear or log-linear single-equation models.

Table 9: Classification by Type of Model*

Model	Frequency
Linear single equations	9
Log-linear single equations, VAR model	4
Probit, Simultaneous equation system	2
Other**	6
TOTAL	27

*More than one model was used in some studies. **Includes entry for each of Tobit, logit, log-linear two-equation system, state space form equations, cointegrating single equation, and seemingly unrelated error correction equations.

The dependent variable for purposes of analysing international capital flows is broadly classified as the amount of capital flowing from one country to another. Of the different types of dependent variables used, with more than one dependent

variable being used in some studies, the most frequently used variable is capital flows, which is used 45 times. This dependent variable is defined as net or gross portfolio capital (bond and equity) flows; total, official and private flows; foreign direct investment flows; short-, medium- and long-term debt flows; and lending commitments. Eight types of dependent variable are used more than once, with global factors (including the first and second principal components of US variables as proxies for foreign factors, US real and nominal GDP, US Treasury Bill rate, and US nominal interest rates) being used 6 times, and net purchases of stocks, price of developing country commercial bank debt, real exchange rate, domestic output, real money supply, capital account balance, and probability of attracting international private capital, being used 2 times each. The remaining 10 types of dependent variable, which were used once each, include actual excess stock return, official reserves (as a proxy for capital inflows), credit premium of foreign flows, spreads on primary market bond issues, probability of a bond issue, contagion, terms of trade, domestic price level, current account balance, and debt rescheduling.

There are two types of explanatory variables used in the various empirical studies, namely economic and financial variables on the one hand, and socio-political variables on the other. Treating country credit risk indicators as economic and/or financial variables, and regional differences as socio-political variables, Tables 10 and 11 present the numbers of each type of variable and their frequency. In Table 10, the number of economic and financial variables ranges from 3 to 30, with mean 9.8, median 9 and two modes of 5 and 12. Four of the 10 sets of economic and financial variables have a frequency of two, with the remaining four of the 10 sets of economic and financial variables having a frequency of one. In Table 11, the number of socio-political variables ranges from 0 to 5, with mean 0.75, median 0 and mode 0. The absence of any socio-political variable occurs 13 times in the 20 studies. Of the remaining 4 sets of socio-political variables, 1 has a frequency of 4, and 3 have a frequency of 1. Hundreds of different economic, financial and socio-political explanatory variables have been used in the 20 separate studies. The set of economic and financial variables include indicators for domestic and international economic performance, domestic and international financial performance, country credit risk ratings, monetary reserves, debt service, and structural differences. The set of socio-political variables include indicators for country political risk ratings, regional differences, and political events.

Table 10: Classification by Number of Economic and Financial Explanatory Variables*

Number	Frequency
3	2
5	4
6, 8, 9	2
10	1
12	4
17, 19, 30	1
TOTAL	20

*Country credit risk indicators are treated as economic and/or financial variables.

Table 11: Classification by Number of Socio-political Explanatory Variables*

Number	Frequency
0	13
1	4
2, 4, 5	1
TOTAL	20

*Regional differences are treated as socio-political variables.

The unavailability of the required data means that proxy variables have frequently been used in place of the unobserved variables. Tables 12 and 13 are concerned with the important issue of omitted explanatory variables in each of the 20 studies. It is well known that, in general, omission of relevant explanatory variables from a linear regression model yields biased estimates of the coefficients of the included variables, unless the omitted variables are uncorrelated with each of the included explanatory variables. For non-linear models, consistency replaces unbiasedness as a desirable statistical characteristic of an estimation method. In some studies, there is an indication of the various types of variables that are recognised as being important. Nevertheless, some of these variables have been omitted because they are simply unavailable. The classification in Table 12 is by recognition of omitted explanatory variables, where the recognition is explicitly stated in the study. Such an explicit recognition of omitted explanatory variables is used primarily as a check of consistency against the number of proxy variables used. Of the 20 studies in Table 12, only 6 did not explicitly recognise that any variables had knowingly been omitted, with the remaining 14 recognising that 34 explanatory variables had been omitted. The number of explanatory variables explicitly recognised as having been omitted varies from 1 to 5. Including and excluding the 6 zero entries for omitted explanatory variables give a mean number omitted of 1.7 and 2.4, respectively, median of 1.5 and 2, and mode of 0 and both 1 and 2, respectively. Four of the 14 studies which explicitly recognised the omission of explanatory variables noted that a single variable had been omitted, while another 4 studies noted that two variables had been omitted. The classification in

Table 13 is given according to the type of omitted explanatory variable, which is interpreted as predominantly economic or socio-political. Virtually all of the omitted explanatory variables are economic in nature, with only 3 of the 34 omitted variables in total being predominantly socio-political. Perhaps somewhat surprisingly, few studies stated dynamics as having been omitted from the analysis, even though a number of studies did not explicitly incorporate dynamics into the estimated specifications.

Table 12: Classification by Recognition of Omitted Explanatory Variables*

Number Omitted	Frequency
0	6
1, 2	4
3	3
4	2
5	1
TOTAL	20

*The classification is based on explicit recognition of omitted explanatory variables, and is used primarily as a check of consistency against the number of proxy variables used in the corresponding studies.

Table 13: Classification by Type of Omitted Explanatory Variables*

Omitted Variable	Frequency
Economic Factors	31
Socio-political Factors	3
TOTAL	34

*The various omitted variables are classified according to whether they are predominantly economic or socio-political in nature.

As some important economic, financial and socio-political explanatory variables have been omitted from 14 of the 20 studies, proxy variables have been used in 13 of these studies. Tables 14 and 15 are concerned with the issues of the number and type of proxy variables used. The problems associated with the use of ordinary least squares (OLS) to estimate the parameters of linear models, which dominate the literature on international capital flows, in the presence of one or more proxy variables are generally well known in the econometrics literature. As a guide for analysis, the basic results are outlined below. These results are of special concern as 70% of the studies explicitly recognise the omission of at least one explanatory variable. In the case where only one proxy variable is used to replace a variable which is unavailable, the basic results are as follows: (1) the absolute bias in the estimated coefficient of the proxy variable is less than the case where the proxy variable is excluded; (2) the absolute bias in the estimated coefficient of the correctly measured variable is less than in the case where the proxy variable is excluded; (3) a reduction in measurement error is beneficial; and (4) it is preferable to include the proxy variable than to exclude it. When two or more proxy variables are used to replace two or more variables which are unavailable, it is not necessarily the case that the four basic results stated above actually hold. Thus, among other outcomes, the absolute bias in the estimated coefficients of both the correctly measured and incorrectly measured variables may be higher if two or more proxy variables are not used than when they are used, a reduction in measurement error may not be beneficial, and it may not be preferable to include two or more proxy variables than to exclude them. The reason for the different outcomes is that the covariation in two or more measurement errors may exacerbate the problem of measurement error rather than reducing it.

Table 14 classifies the 14 studies by the use of proxy variables, which ranges from 1 to 5. Including and excluding the single zero entry for the number of proxy variables used give a mean number omitted of 2.6 and 2.8, respectively, median of 2.5 and 3, respectively, and mode of 2 in each case. A comparison with Table 12 shows that the results in Table 14 are reasonably similar. The classification in Table 15 is given according to the type of proxy variable used, which is interpreted as comprised of predominantly economic or socio-political factors. Virtually all of the proxy variables are predominantly economic in nature, with the remaining 2 of 37 proxy variables being predominantly socio-political, which is very similar to the results given in Table 13.

Table 14: Classification by Number of Proxy Explanatory Variables Used*

Number	Frequency
0	1
1	2
2	4
3	3
4, 5	2
TOTAL	14

*One study explicitly recognized the omission of explanatory variables but used no proxy variables.

Table 15: Classification by Type of Proxy Explanatory Variables Used*

Proxy Variables	Frequency
Economic factors	35
Socio-political factors	2
TOTAL	37

*Some studies used both economic and socio-political variables.

In Table 16 the classification is by method of estimation, in which more than one estimation method is used in some studies. Six categories are listed, namely OLS, maximum likelihood (ML), variance decomposition method, generalised least

squares (GLS), limited dependent variable method, and others, which includes 2 entries for Kalman filter and the Engle-Granger two-step procedure. These results are very similar to what would be expected on the basis of the model specifications in Table 9.

Table 16: Classification by Method of Estimation*

Method	Frequency
OLS	11
ML	6
Variance decomposition method	3
GLS	4
Limited dependent variable method, Other**	2
TOTAL	28

*More than one estimation method was used in some studies. **Includes one entry for each of Kalman filter, and Engle and Granger two-step procedure.

Finally, the classification in Table 17 is by use of diagnostics to test one or more auxiliary assumptions of the models. The role of diagnostic tests has become well established in the econometric literature in recent years, and plays an increasingly prominent role in modern applied econometrics [see McAleer, 1994 for further details]. Most diagnostic tests of the auxiliary assumptions are standard, and are available in most modern econometric software packages.

Table 17: Classification by Use of Diagnostics*

Type of Diagnostics	Frequency
None	6
ADF	5
DW, Johansen, Wu-Hausman	3
Heteroscedasticity, Ljung-Box, Non-normality, Phillips-Perron	2
Other**	5
TOTAL	33

*More than one diagnostics was used in some studies. **Includes one entry for each of variance ratio, functional form, autocorrelation, causality, and KPSS tests.

As some studies used more than one diagnostic, there are 33 diagnostics reported in the 20 studies. Only 6 of the 20 studies did not report any diagnostic tests whatsoever. Of the remaining 14 studies which reported diagnostic tests, there were 5 studies in which the augmented Dickey-Fuller (ADF) test of a unit root was reported, 3 studies in which the Durbin-Watson (DW) test of serial correlation, the Johansen likelihood ratio test of cointegrating relations, and the Wu-Hausman test of weak exogeneity were reported, and 2 studies in which a heteroscedasticity test, Ljung-Box test for serial independence, test of non-normality, and Phillips-Perron test of a unit root, were reported. It is important to check the assumptions of the models using diagnostics, particularly in studies where ML is used because the ML method is known to lack robustness to departures from the stated assumptions. As the assumptions seem to be checked, in general, in the international capital flows literature, the empirical results can be interpreted without too much cause for caution and/or scepticism.

5. CONCLUDING REMARKS

This paper evaluated the significance of 20 published empirical papers in the international capital flows literature according to established statistical and econometric criteria used in estimation, evaluation and forecasting. Such an evaluation permits a critical assessment of the relevance and practicality of the literature.

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