E C O N O M I C S   B U L L E T I N

Volatile capital flows: Interactions between de jure and de facto financial liberalization

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Abstract

Utilizing a panel data set for 13 developed economies, this paper examines the volatility of capital flows following the liberalization of financial markets. The paper focuses on the response of foreign direct investment, portfolio flows, and other debt flows to both financial liberalization and increased capital flows. The regression analysis examines how capital volatility is affected by the interaction between de jure financial liberalization (an index of liberalization) and de facto liberalization (the volume of capital flows). At average and high volumes of capital, financial liberalization is found to increase capital volatility as expected. At lower volumes of capital, financial liberalization reduces capital volatility, particularly for foreign direct investment and other flows, indicating there may be a threshold level of capital flows below which financial liberalization reduces volatility.

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1. Introduction

Financial liberalization is often seen as a two-edged sword, providing much-needed capital inflows for domestic investment but also leaving countries vulnerable to the vagaries of the market and sudden capital outflows. Recently, researchers have attempted to uncover the responses of economies to financial liberalization in terms of volatility. Most of these studies have focused on the volatility of consumption and output (e.g., see Bekaert *et al.* 2006), with only a few focusing directly on the volatility of the capital flows themselves (e.g., see Alfaro *et al*. 2005, Broner and Rigobon 2004, Neumann *et al*. 2007). This study takes a new approach to the volatility of capital inflows by examining the effects of financial liberalization and the concomitant capital flows that are expected to accompany liberalization. To this end, we focus on the interaction between a *de jure* measure of financial liberalization (an index of liberalization) and a *de facto* measure (the volume of capital flows) and how this interaction might impact the volatility of capital flows.

At average and high volumes of capital, financial liberalization is found to increase capital volatility as expected. At lower volumes of capital, financial liberalization reduces capital volatility, particularly for foreign direct investment and other flows, indicating there may be a threshold level of capital flows below which financial liberalization reduces volatility.

2. Analysis

International financial integration is a complex process that can be defined and quantified by different measures, which can be categorized as *de jure* or *de facto* approaches. Possible *de jure* measures of financial liberalization include indexes of the rules and laws governing international capital flows, such as the commonly used zero-one index formed from the International Monetary Fund's (IMF) Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The liberalization measure we use here is a *de jure* measure that attempts to capture the intensity of the rules governing capital flows. By contrast, *de facto* measures of financial openness circumvent the quite limited range of values that *de jure* measures inherently take on as well as any subjectivity that may be present in their determination by focusing on the actual financial flows that occur across countries. The volumes of capital inflows on which we focus here are posited to be larger with higher levels of financial openness and can be regarded as *de facto* measures of financial integration.

We examine three distinct private capital inflow variables relative to GDP: FDI, portfolio investment flows that include both equity and debt investments, and other inflows that include bank loans and other short-term debt. We use the following data from the IMF's International Financial Statistics (IFS): FDI measured by DIE (direct investment in the economy, IFS 78bed), inward portfolio investment measured by PIL (portfolio investment liabilities, IFS 78bgd), and other inward flows measured by OIL (other investment liabilities, IFS 78bid). To generate volatility measures of capital flows, we compute standard deviations of each capital flow relative to GDP over 5-year overlapping periods.[1] In the regression analysis, we account for the moving

[1] We have also explored standardizing the standard deviation of flows relative to mean capital flows, essentially calculating a coefficient of variation. This measure, however, is problematic because i.) it may not be well behaved when mean flows are small or negative (see Wei (2006) for a similar argument), and ii.) we include average capital flows as an explanatory variable in our estimated equation and thus do not want to include average flows as part of the derivation of the dependent variable.

average component introduced by the overlapping data and utilize heteroskedastic-consistent standard errors following the procedure in Bekaert *et al.* (2006).

The countries chosen correspond to a set of developed economies for which Kaminsky and Schmukler (2003) have computed a chronology of liberalization, leading to a financial liberalization variable that captures the intensity of liberalization. This variable averages liberalization over three components: the capital account, the domestic financial system, and stock markets, with values ranging from 1 (no liberalization) to 3 (full liberalization). The first and third components of the index correspond to international openness. For example, the capital account component categorizes regulations on offshore borrowing, multiple exchange rates, and controls on capital outflows while the stock market component measures regulations on the acquisition of shares by foreigners along with restrictions on the repatriation of capital. The second component, on the domestic financial system, examines regulations on deposit and lending rates as well as foreign currency deposits and reserve requirements. These three measures may be interrelated and are all expected to affect international capital; for example less regulation of the capital account and higher domestic interest rates may both attract international capital. Thus, we utilize this broad index as the *de jure* measure of capital liberalization. To match the annual capital flow data, we average Kaminsky and Schmukler's monthly values over each year to get an annual value of the intensity of liberalization.[2]

We define the developed economies following the classification in Demirguc-Kunt and Levine (1999), using 1995 GNP per capita and the high income category as provided by the World Bank. The countries in the sample include Finland, France, Germany, Ireland, Italy, Japan, Korea, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.[3] Of the high-income countries for which the Kaminsky-Schmukler index is available, Denmark is dropped due to missing data prior to 1981 and Canada is dropped due to a lack of variation in the liberalization variable. While the Kaminsky-Schmukler index is also available for a set of developing countries, we focus here on the developed economies partly due to data limitations on the developing countries and to highlight the interaction between liberalization and the volume of flows.[4] Studying the patterns of capital flows for these economies can provide evidence of the behavior of different types of flows at the later stages of development.

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[2] See Kaminsky and Schmukler (2003) for the chronology of financial liberalization that went into forming the liberalization index. The index is available at http://www.worldbank.org/research/bios/schmuklerpdfs/financial_liberalization_index.xls. While other indexes exist, we focus here on the Kaminsky-Schmukler index because it measures the intensity of liberalization. Miniane (2004) provides an alternative measure, based on the IMF's AREAER, that measures the intensity of capital account restrictions. However, the Miniane data cover 1983-2000 while our data cover 1977-2000. For the period over which they overlap, the correlation between the two measures is approximately 0.75.

[3] Using a different classification, Kaminsky and Schmukler (2003) categorize Korea as a developing economy. Our results are quite robust to the exclusion of Korea.

[4] The developed economies for which the liberalization variable is available show significant interactions between the volume of capital flows and the measure of liberalization. Thus, we draw out the conclusions regarding this interaction in the current paper. Conversely, the interaction term is not significant for the developing economies for which the liberalization variable is available. See Neumann *et al.* (2007) for a comparative analysis of the impact of financial liberalization on the volatility of capital flows for a set of developed and developing countries. While incorporating a broader range of explanatory variables, the results from that paper highlight the fact that the volume of flows appears to be a primary driver of the

We explore the relationship between the two measures to capture the response of capital volatility to both *de jure* and *de facto* liberalization. Greater financial liberalization and larger capital inflows are expected to increase the volatility of these capital flows. However, the relationship may be more complicated in that financial liberalization and capital inflows may not move step-for-step with one another. A country may have limited access to foreign capital even if it is financially open. Conversely, a country that is not deemed to be financially open to capital by *de jure* measures may, in fact, have large capital flows due to the circumvention of these capital controls. Thus, we explore the interaction between the *de jure* and *de facto* measures.

Regressions take the following general form:

$$Stdev_{i,t+k,k} = \alpha + \beta_1 LIB_{i,t+k,k} + \beta_2 AVE_{i,t+k,k} + \beta_3 (LIB_{i,t+k,k} AVE_{i,t+k,k}) + \upsilon_{i,t+k,k}$$

where $Stdev_i$ is our measure of volatility, calculated as the standard deviation of each capital flow relative to GDP estimated over $k=5$ year rolling windows. LIB_i is the financial liberalization variable from Kaminsky and Schmukler (2003), and is included as the average liberalization over each 5-year period. AVE_i is the average capital flow over each 5-year period.[5]

The inclusion of an interaction term between *LIB* and *AVE* into the regression equation permits us to examine whether the regression of *Stdev* on each of the measures of financial openness is a function of the other. A statistically significant interaction term implies a different regression relationship between *Stdev* and *LIB* for each value of *AVE*. Similarly, a different regression equation will exist for each value of *LIB* when *Stdev* is regressed on *AVE*. This can be seen by restructuring the regression equation into either of two formulations (dropping time subscripts for convenience):

$$Stdev = (\alpha + \beta_2 AVE) + (\beta_1 + \beta_3 AVE) LIB + \varepsilon \qquad (1)$$

or

$$Stdev = (\alpha + \beta_1 LIB) + (\beta_2 + \beta_3 LIB) AVE + \varepsilon \qquad (2)$$

The response of *Stdev* to changes in the predictor (i.e., the 'simple slope') is now a function of the level of the other predictor. We see that in (1) the marginal effect of *LIB* on *Stdev* depends on the values that *AVE* takes. Likewise, the 'simple slope' of *AVE* in (2) is a function of the level of *LIB*. The regression formulations in (1) and (2) each generate a series of regression equations of *Stdev* on one variable at specific values of the other variable. Before creating their interaction, we center the variables *LIB* and *AVE* by subtracting the mean from each series, where the means are calculated over the full panel of countries and years. Centering LIB and

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volatility of flows for developing economies, with the interaction between financial liberalization and the volume of flows playing very little role.

[5] While other potential determinants of the volatility of capital flows exist, there is little agreement in the literature as to the relevant set of variables to include. This is in contrast to the literature on the level of capital flows, where important determinants include institutional quality, levels of economic development, and default history (see for example Prasad *et al.* (2007) and Reinhart and Rogoff (2004)). Alfaro *et al.* (2005) and Broner and Rigobon (2004) have each looked at the effect of institutional quality on the volatility of capital flows. Since we focus on volatility over five-year periods, we do not include institutional quality as these variables are typically slow to change. In regressions not included here, we have examined a broader set of control variables (such as the variability in GDP growth rates and world interest rates) but find that the level of flows dominates these other factors in explaining the standard deviation of capital flows.

AVE in this manner facilitates interpretation of the estimated coefficients in the interaction analysis. For example, the coefficient of LIB denotes the response of the volatility measure to changes in LIB when AVE is at its mean value (i.e., centered AVE=0). Similar interpretation follows for the coefficient of AVE.[6]

We use a balanced pool of overlapping data from 1981-2000 to construct a 5 year rolling standard deviation series for each of the capital flow variables.[7] The use of overlapping observations, while allowing a larger sample from limited time series data, creates a problem for inference. The observations are no longer independent due to the induced serial correlation between the observations. The result is biased standard errors and possibly incorrect inferences. The moving average component that has been introduced into the residuals must be accounted for during the estimation process in order to correct for this bias. We follow the procedure in Bekaert, Harvey and Lundblad (2006, hereafter BHL), who develop a Generalized Method of Moments (GMM) estimator to account for the serial correlation induced by overlapping observations within a cross-section time-series framework. The GMM estimator of BHL (2006) builds on the Hansen-Hodrick (1980) and Newey-West (1987) correction procedures, and has the added benefit of accounting for country-specific heteroskedasticity and seemingly unrelated regression effects.

BHL (2006) conduct two Monte Carlo experiments to explore finite sample properties of the behavior of the t-statistics on their liberalization variable. Results from both experiments indicate that higher (absolute) critical values are required relative to the asymptotic normal distribution. A cutoff of 3 is suggested for a 5% test. We adopt this cutoff rule as a good standard for significance.

Tables IA-C present the results of the interaction analysis between the financial openness measures for each of the financial flow variables. We focus on the centered results but include the uncentered column (which maintains the original scale) for comparison. As a check on robustness, a trend term and a 1997 dummy are also added to the model. The trend is insignificant in all regressions, and may add to instability as it tends to be correlated with the liberalization variable. We consider the 1997 dummy because capital flows may have fled the developing economies, seeking a safe haven in the developed economies and adding to volatility of flows in these countries. The 1997 dummy is significant only for portfolio flows, perhaps indicating that these flows responded more strongly to the crisis.

Across all three financial flow volatilities, the centered results show the interaction term is significant with a positive coefficient. Since the variables are now centered at zero, this

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[6] The interaction term between LIB and AVE represents a multiplicative combination of these two predictors. As such, it carries features of both predictors and is likely to be highly correlated with either or both, potentially introducing a problem of multicollinearity. Neter *et al.* (1989) and Aiken and West (1991) argue that centering the variables can minimize the 'non-essential' multicollinearity introduced by including the interaction term, without affecting the 'essential' correlation that may already exist between LIB and AVE. By contrast, Brambor *et al*. (2006) argue that centering does not provide any additional information and does not change the statistical properties of the estimation. They note, however, that "problems associated with multicollinearity are often exaggerated in the context of multiplicative interaction models" (p. 70). For our purposes, since the simple slope coefficients (i.e., the conditional coefficients) are invariant to such an additive transformation, centering the variables can help with interpretation without changing the results.

[7] Note that each year uses the previous five for the rolling data, e.g., the first year in the sample (1981) uses data over 1977-1981.

implies that developed countries with a high degree of financial liberalization and large capital flows are associated with higher capital flow volatility. This is especially true for direct investment (DIE), where the interaction term is highly significant and robust to the inclusion of the trend or dummy term. Other capital flows (OIL) show a significant interaction term, with borderline significance when the trend is included. Notably, the magnitude of the coefficient stays the same across the specifications. The portfolio flows (PIL) show a just-significant result without the trend or 1997 dummy. The interaction term is no longer significant once the trend or dummy are included.

Tables II and III present a further analysis of the interaction between *LIB* and *AVE* since the previous results show fairly consistently significant interaction terms. For each financial flow variable, two separate analyses are presented based on equations (1) and (2). Table II provides the simple slope regression with *LIB* as the predictor variable, where the slope coefficients are functions of the average flows of each variable (*AVE*). In order to compute the response coefficient of *LIB*, unique values of *AVE* must be chosen. Cohen and Cohen (1983) suggest using three values – the mean, one standard deviation below the mean, and one standard deviation above the mean – to generate a set of three regression equations.[8] The standard errors can then be computed from the coefficient covariance matrix from the original regression results (Tables IA-C). As before, significance testing for the simple slopes uses a t-value of 3 for the 5 percent significance level as in BHL. Similarly, Table III provides the simple slope with *AVE* as the predictor variable, for three values of *LIB*.

The *LIB* analysis in Table II indicates that, at average and high levels of direct investment, there is a statistically significant positive relationship between the financial openness variable *LIB* and the volatility of capital flows. For low levels of direct investment volume, however, there is a statistically significant negative relationship between *LIB* and volatility. Thus, it appears that foreign direct investment flows increase in volatility from liberalization when there are already high volumes of investment but decrease in volatility due to liberalization at low levels of capital flows. The coefficient signs are similar for portfolio flows (PIL) and would be significant at standard significance levels. Using the significance levels indicated by BHL (2006), however, the response by portfolio flows is insignificant, thus indicating that liberalization may have little relationship to the volatility of these flows. Other capital flows (OIL) show an insignificant response to liberalization when capital flows are large but face significant reductions in volatility due to liberalization at average and lower levels of capital flows.

Overall, the results in Table II provide evidence of increases in volatility from financial liberalization only when capital inflows are high. Liberalization may actually reduce volatility when capital inflows are lower, perhaps indicating some threshold below which financial liberalization reduces volatility.

For the alternative specification, Table III generally shows that increases in capital flows are positively related to the volatility of these flows for any level of liberalization. This is particularly true for other flows, where any level of liberalization provides evidence of increased volatility from increased capital inflows. Likewise, volatility increases with greater flows of direct investment and portfolio capital, at average and higher levels of liberalization. At low

[8] An alternative procedure could be implemented using a different additive transformation of the predictors (as in Braumoeller, 2004). Using the deciles of each centered predictor as the additive factor, the results obtained (available from the authors) are markedly similar qualitatively to those found in Tables II and III.

levels of liberalization, however, the increase in capital flows for direct investment and portfolio flows are both insignificantly related to capital volatility.

3. Conclusions

We take a new approach to the study of volatility as a result of international capital flows. Focusing on 13 developed economies, we investigate whether the interaction between a *de jure* measure of capital liberalization and a *de facto* measure based on the volume of capital flows influences the volatility of those capital flows. The paper examines foreign direct investment, portfolio capital, and other debt flows. Finding a significant interaction term between liberalization and the volume of flows, we estimate the effect of each predictor at three different levels of the other predictor, i.e., the mean and plus/minus one standard deviation. We find that the volume of capital flows generally corresponds to an increase in the volatility of flows regardless of the level of liberalization. More interesting results are found for the liberalization variable. At average and high levels of capital flows, financial liberalization is associated with increases in capital volatility. At low levels of capital flows, however, financial liberalization is associated with declines in volatility, pointing to a threshold effect. Thus the *de jure* measure of financial openness implies that volatility for all three capital flows will decline with a lessening of capital controls if the flow volume at the time of increasing financial openness is relatively low. As a consequence, in the earlier stages of development, countries may be able to take advantage of increased capital flows from financial liberalization without incurring the costs associated with increased volatility of capital flows. As countries develop, further financial liberalization may lead to increased capital volatility. This increased volatility may not necessarily be detrimental as countries may then be able to weather sufficiently the increased volatility.

TABLE IA Dependent variable: SDIE (Stdev of direct investment)

	Uncentered	Centered	Centered	Centered
CONSTANT	1.0742 (3.0743)	0.5424 (12.8174)	0.4912 (4.6161)	0.5366 (12.0846)
LIB	-0.4561 (-3.7364)	0.2889 (3.3645)	0.4191 (3.6598)	0.3336 (3.9596)
AVEDIE	-1.4275 (-2.8883)	0.5494 (11.2719)	0.5367 (8.0379)	0.5393 (11.6104)
LIB*AVEDIE	0.7313 (4.3767)	0.4508 (4.6471)	0.5138 (3.9503)	0.4375 (4.8043)
TREND			0.0086 (1.4497)	
1997DUMMY				0.1199 (1.9546)

TABLE IB Dependent variable: SPIL (Stdev of portfolio investment)

	Uncentered	Centered	Centered	Centered
CONSTANT	1.0735 (1.2977)	1.4588 (13.0339)	1.6935 (4.1802)	1.4933 (8.7221)
LIB	-0.4132 (-1.3346)	0.4766 (2.1476)	0.1126 (0.2015)	0.1865 (0.5666)
AVEPIL	-0.1057 (-0.1761)	0.5859 (8.6613)	0.6107 (3.5243)	0.6725 (6.8053)
LIB*AVEPIL	0.3015 (1.4692)	0.3502 (2.9813)	0.0453 (0.1446)	0.2438 (1.3381)
TREND			-0.0286 (-0.9984)	
1997 DUMMY				-0.8377 (-3.0769)

TABLE IC Dependent variable: SOIL (Stdev of other investment liabilities)

	Uncentered	Centered	Centered	Centered
CONSTANT	2.9264 (4.4239)	1.9552 (24.9165)	1.9241 (7.9849)	2.1903 (19.6224)
LIB	-0.8903 (-3.8920)	-0.4367 (-3.2539)	-0.9853 (-4.7959)	-0.3605 (-2.0531)
AVEOIL	-0.1754 (-0.8562)	0.3320 (10.6578)	0.2895 (7.3792)	0.3062 (8.1800)
LIB*AVEOIL	0.1892 (2.6397)	0.2512 (5.0141)	0.1956 (2.8991)	0.2298 (3.7368)
TREND			0.0406 (1.9150)	
1997 DUMMY				0.1409 (0.6422)

Notes: t-statistics are in parentheses. LIB and AVE have been centered (mean subtraction) in the 'Centered' columns. The interaction term LIB*AVE in these columns is the product of the LIB and AVE variables after each has been centered. Tables II and III also use these centered variables.
SDIE, SPIL, SOIL are the 5-year rolling standard deviations of each capital flow (DIE, PIL, OIL) relative to GDP. Countries include Finland, France, Germany, Ireland, Italy, Japan, Korea, Norway, Portugal, Spain, Sweden, United Kingdom, and United States. Number of observations: 260.

TABLE II: LIB Analysis

$$SDIE = (0.5424 + 0.5494 AVEDIE) + (0.2889 + 0.4508 AVEDIE) LIB$$

AVEDIE	Simple Slope of LIB	Standard Error	T-statistic
1 Std. Dev. Below Mean	-0.369	0.079	-4.67
Mean	0.289	0.086	3.36
1 Std. Dev. Above Mean	0.947	0.220	4.30

$$SPIL = (1.4588 + 0.5859 AVEPIL) + (0.4766 + 0.3502 AVEPIL) LIB$$

AVEPIL	Simple Slope of LIB	Standard Error	T-statistic
1 Std. Dev. Below Mean	-0.731	0.252	-2.90
Mean	0.477	0.222	2.15
1 Std. Dev. Above Mean	1.685	0.603	2.79

$$SOIL = (1.9552 + 0.3320 AVEOIL) + (-0.4367 + 0.2512 AVEOIL) LIB$$

AVEOIL	Simple Slope of LIB	Standard Error	T-statistic
1 Std. Dev. Below Mean	-1.677	0.226	-7.42
Mean	-0.437	0.134	-3.25
1 Std. Dev. Above Mean	0.803	0.327	2.46

See notes for Table I

TABLE III: AVE Analysis

$$SDIE \quad = \quad (0.5424 + 0.2889 LIB) \quad + \quad (0.5494 + 0.4508 LIB) AVEDIE$$

LIB	Simple Slope of AVEDIE	Standard Error	T-statistic
1 Std. Dev. Below Mean	0.260	0.108	2.41
Mean	0.549	0.049	11.27
1 Std. Dev. Above Mean	0.838	0.029	28.90

$$SPIL \quad = \quad (1.4588 + 0.4766 LIB) \quad + \quad (0.5859 + 0.3502 LIB) AVEPIL$$

LIB	Simple Slope of AVEPIL	Standard Error	T-statistic
1 Std. Dev. Below Mean	0.362	0.125	2.90
Mean	0.586	0.068	8.62
1 Std. Dev. Above Mean	0.810	0.070	11.57

$$SOIL \quad = \quad (1.9552 - 0.4367 LIB) \quad + \quad (0.3320 + 0.2512 LIB) AVEOIL$$

LIB	Simple Slope of AVEOIL	Standard Error	T-statistic
1 Std. Dev. Below Mean	0.171	0.053	3.23
Mean	0.332	0.031	10.66
1 Std. Dev. Above Mean	0.493	0.035	14.09

See notes for Table I

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