Why are capital flows so much more volatile in developing than in developed countries? The (non) role of fundamentals

VERY PRELIMINARY

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I. Introduction

One of the most studied subjects in open macroeconomics is the determinants of capital flows. In general, most papers are concerned with the estimation of the following regression:

$$K_{i,t} = c_i + X_{i,t}A + \varepsilon_{i,t}$$

where the left hand side is some measurement of the capital flows (as a percentage of GDP, or as changes), and where in the right hand side several controls are introduced, such as GDP growth, the real exchange rate deviations, the international interest rate, the terms of trade, the availability of international funds, some measures of credit constraint, etc. In this context, almost entirely, the literature studies the properties of A. In other words, the questions are usually what are the signs and significances of the coefficients. In this paper, we take a very different perspective: we concentrate on the properties of the residuals of that regression.

This new dimension allows us to uncover a pattern that has escaped the literature: although the fundamentals do have a sizeable explanation of the capital flows (meaning that the R-squares of the regressions are relatively high), the ratio of variances between emerging market residuals to developed economies residuals is almost constant and equal to 4.

This pattern is robust to different data sets, different controls, as well as non-linearities.

The paper is organized as follows: Section II reviews some of the theories and summarizes the variables that usually have been used to explain capital flows both to emerging and developed markets. Section III, presents the preliminary view of the excess volatility of emerging markets capital flows. This section is an informal analysis of the puzzle, but indeed offers most of the economic intuition. Section IV studies formally the differences across country volatilities. Section V concludes and offers directions for future research.

II. What are the fundamentals?

There are many variables that can, in principle, affect capital flows into a country. The easiest analysis is to realize that the capital account is the difference between investment and savings decisions by domestic agents. In this perspective, we consider the following variables, classified into whether they affect investment or savings.

A. Determinants of investment:

The determinants of investment have mainly two strands of the literature. Those that are associated with the supply – i.e. growth, terms of trade, etc. – and those that are associated with the degree of credit constraint faced by the country.

Assume that a country's output Y_t is well described by the aggregate production function $Y_t = A_t F(K_t, L_t)$, where A_t denotes the level of productivity, K_t denotes the capital stock, L_t denotes the labor supply, and $F(\cdot)$ is constant returns to scale. There is no depreciation. The marginal product of capital satisfies

$$\frac{\partial Y_t}{\partial K_t} > 0, \ \frac{\partial^2 Y_t}{\partial K_t^2} < 0, \ \frac{\partial^2 Y_t}{\partial A_t \partial K_t} > 0, \ \frac{\partial^2 Y_t}{\partial L_t \partial K_t} > 0. \qquad (1)$$

The optimal capital stock is given by the condition that the after tax marginal product of capital be equal to the world interest rate r^*, namely

$$(1-\tau_t) A_t F_K(K_t, L_t) = r^*, \qquad (2)$$

where τ_t denotes the capital tax. As a result, the optimal capital stock is increasing in productivity A_t and labor supply L_t, and decreasing in the world interest rate r^* and capital taxes τ_t.

The first order condition is not only affected by fundamentals but also by the availability of funds when the country suffers from some sort of asymmetric information moral hazard, etc. Under these

circumstances, collateral values, cash availability, and others, become crucial variables that determine the level of investment.

This suggests the following variables to include in our analysis:

- *Productivity growth:* If the optimal capital stock is increasing in the level of productivity, then investment is increasing in productivity growth. The objective would be to include the expected productivity increase – the total factor productivity increase. However, data on capital stocks is limited for a panel analysis, and in general they measure past productivity gains rather than expected ones. Therefore, in general, the literature uses proxies to compute the expected productivity growth – starting from the actual growth of GDP as a proxy. Labor productivity has being approximated by education attainment (See Jeanne-Gourinchas. They use Barro Lee and UNESCO World Education Report). Furthermore, total factor productivity is usually approximated by either labor productivity (Y/L), or just the growth rate of per-capita GDP.

- *Terms of trade:* A positive terms of trade shock is analogous to a productivity shock. It means that we can exchange a unit of exports for more units of imports, so an improvement in the terms of trade should lead to investment in the export sector.

- *Interest rates:* Other things equal, an increase in interest rates should lead to lower investment. But this is true in partial equilibrium. Empirically, increases in world interest rates are correlated with capital flows from developing to developed countries. This is probably due to interest rates being determined by developed countries (they are much bigger) and, so, being more correlated with those countries excess demand for funds. On the other hand, the business cycle of developed countries is less correlated so one might expect that the smaller but more correlated business cycles of developing countries should affect world interest rates as well. (Domestic interest rates, international interest rates).

- *Prices:* In the presence of sticky prices and/or wages, nominal variables can affect the return to capital and, thus, investment. We might want to look at prices, wages, and real exchange rates as possible determinants of capital flows.

- *Capital-labor ratio:* Other things equal, capital would flow from capital abundant to capital scarce countries (Heckscher-Ohlin). Unfortunately there is no good measure of K/L, and the

literature has looked at Y/L instead. The problem is that in the end this is exactly as if we were estimating productivity increases instead of capital-labor ratios.

- *Taxes:* Taxes should have a similar effect as lower productivity as investors care about after-taxes profits.

- *Stock market:* The stock market might summarize all of the above (q theory), but more importantly, the stock market also summarizes other aspects that determine capital flows, such as credit constraints, enforcement problems, etc.

- *International Reserves:* One of the most common measures of liquidity constraints is the size of the international reserves relative to GDP or the financial sector. The idea is that more illiquid countries might face a smaller capital inflow.

- *Financial Development:* In the same line of thought, the degree of financial development can affect the availability of funds for investment; and therefore, it clearly is part of the variables to be considered to determine capital flows.

- *Quality of Institutions:* Finally, we control for the quality of institutions both in terms of the rule-of-law but also in terms of doing business in the country.

Obviously, this is not an exhaustive list of variables to be included in the determinants of capital flows. We will expand further in the empirical section. However, because we will control for fixed effects at the country level, it is important to highlight that most of the cross-sectional differences in the determinants of capital flows will be controlled for in the specification.

B. Determinants of savings:

The other side of the capital inflows is the savings decision. Here we discuss some of the variables that we considered necessary to determine savings by consumers.

Consider the following 2-period model. At $t=1$, the economy produces $Y_1 = A_1 F(K_1, L)$, where K_1 is predetermined. At $t=2$, the economy produces $Y_2 = A_2 F(K_2, L)$, where $K_2 = I_1$ and A_2 is

known as of $t = 1$. We assume there exists perfect capital mobility. Let the international interest rate be r^*. The level of investment I_1 is determined by equilibrium in international capital markets

$$A_2 F_K(I_1, L) = r^*. \tag{3}$$

Consumers maximize $u(C_1) + \beta u(C_2)$. At $t = 1$, consumers allocate income Y_1 between consumption C_1 and savings S_1, namely $Y_1 = C_1 + S_1$. The country borrows from foreigners the difference between savings and investment $B_1 = I_1 - S_1$. It is easy to show that the consumers' first order condition can be written as

$$u'(Y_1 - S_1) = \beta(1 + r^*)u'(Y_2 - r^* B_1 + S_1). \tag{4}$$

As a result, the level of savings is increasing in present productivity A_1, decreasing in future productivity A_2, and increasing in the weight placed on future consumption relative to present consumption β. Interest rates have a positive substitution effect on savings and an income effect that is positive if the country is a debtor ($B_1 > 0$) and negative if the country is a creditor ($B_1 < 0$). (The substitution effect should dominate.) This suggests the following variables to include in our analysis:

- *Income:* Income shocks should affect savings decisions, especially if transitory. We should look at Y/L. Perhaps we should also include a variable about expected income growth such as the stock market and/or future income growth.

- *Demographics:* Life cycle considerations imply that countries with low dependency ratios should save more.

- *Interest rates:* Other things equal, an increase in interest rates should increase savings. However there is an endogeneity problem as in the case of the effect of interest rates on investment.

- *Taxes:* They should have an effect similar to that of income, as consumers care about disposable income.

- *Discount rate:* It is difficult to measure, but it may be accounted for by country fixed effects.

- *High marginal utility:* Wars and natural disasters should temporarily increase the benefit of current consumption (or government expenditure) and lead to current account deficits.

- *Interest rates:* Other things equal, an increase in interest rates should increase savings. However there is an endogeneity problem as in the case of the effect of interest rates on investment.

- *Budget deficit*: Both private and public savings matter, so we need to include public savings (if Ricardian equivalence does not hold).

C. Some issues:

Investment and savings might be interdependent. Given home bias, an increase in savings might lead to an increase in investment. So we might want to interact determinants of savings with share of foreign assets in total assets. See Ventura and Kraay (2000).

There are variables that even if reasonable from a neoclassical perspective, might end up explaining a lot of the volatility in capital flows for other reasons. For example, stock market, real exchange rate, and domestic interest rates.

An important difference between savings and investment is that, even though they might respond to similar variables, the effect of persistence is very different for investment and savings behavior. For example, in the case of productivity the more persistent the shock is the more investment should respond but the opposite is true for savings. The reason is that, given adjustment costs, it might not be worthwhile to invest if the shock is transitory, where the more transitory the shock is, the more consumers would want to save it to smooth consumption.

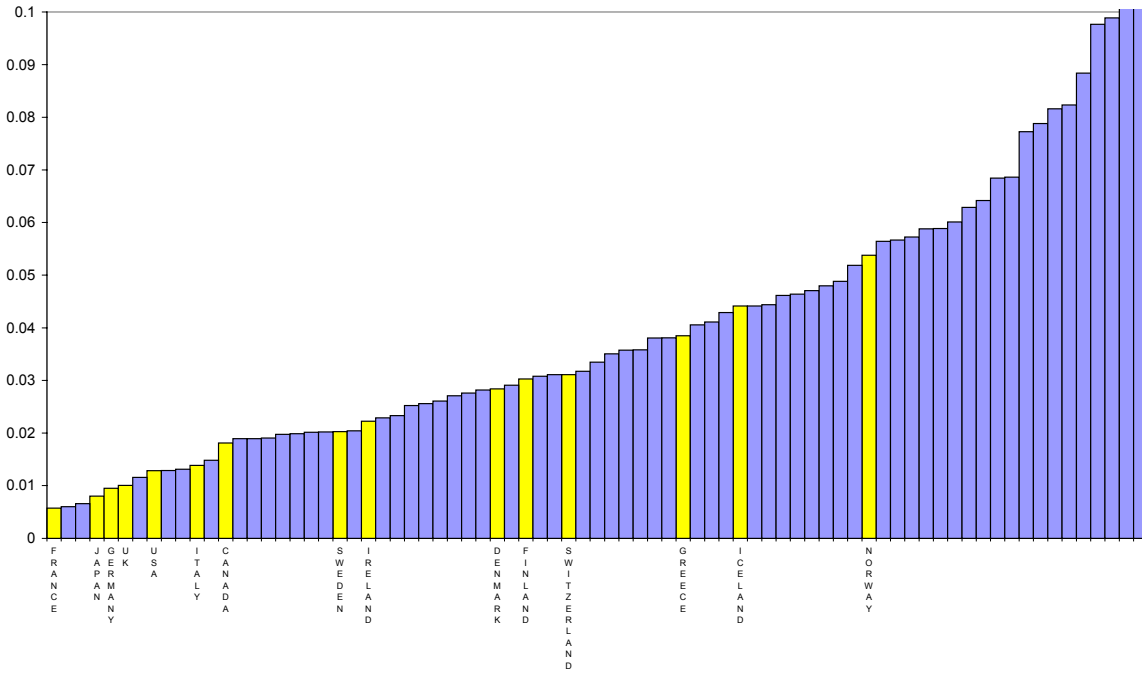
III. Excess Volatility of capital flows: a first view.

Capital flows to developing countries are very volatile, much more so than capital flows to developed countries. This fact is illustrated in Figure 1, in which we show the standard deviation of annual capital

flows for a large set of countries. We define capital flows as the capital account normalized by GDP.[1] The standard deviations are calculated over the period 1979-2000. We sort the countries from the smallest to the largest volatility. It is important to mention that if a country has capital controls and their inflows are zero or very small we treat those observations as true values and not missing values. However, the exact same patterns are found if we drop those realizations.

In the figure we highlight the developed economies. The yellow bars correspond to the developed countries and the blue bars correspond to all other countries. We only identify the yellow countries with their initials. The data presented here was collected from the WDI, although similar results are obtained if IFS data is used. We constructed a panel of countries.

Raw Data. Capital Flows/GDP



As can be seen, the standard deviation of developed economies is smaller than the developing countries, and it is located mainly in the left hand side of the figure. In fact, the average standard

[1] Should we use some smooth version of GDP such as a moving average?

deviation of the developing countries is 7.71 percent, while the average for the developed economies is only 4.95 percent. This is a 1.6 to 1 ratio in their standard deviations.[2] In other words, this means that as a share of GDP capital flows to emerging markets are 60 percent more volatile than in developed markets.

What can explain this pattern? Obviously we have not controlled for any of the shocks that are hitting the economies, nor we have taken care of fixed effects, nor looked into different specifications and explanations of capital flows volatility. It is indeed the case that emerging markets are more volatile because the variables that are hitting them are also more volatile.

In order to assess the stochastic properties of capital flows we proceed as follows: we first take a "statistical view" of the problem. In other words, we concentrate entirely on the stochastic properties of the capital inflows, describing them entirely by their own characteristics. For example, we allow for different trends in each country, different coefficients of auto-correlation, etc. Second, we introduce external controls and determine how different the patterns are. This is the "fundamentals view" of the capital inflows.

The first candidate in the "statistical view" is that we have not controlled for fixed effects and country specific trends. It is possible that capital flows are more volatile in emerging markets, because they have different trends. For instance, assume that capital flows to country *i* are described by the following relationship

$$K_{i,t} = c_i + a_i t + \varepsilon_{i,t}$$

In this model, if we impose a common trend but the true data has country specific trends, then in the end, the group that has more dispersion in their trends will exhibit residuals with larger volatility. To evaluate this possibility we de-mean and de-trend the capital flows to GDP ratio country by country and compute the standard deviations of the residuals. Again, we sort them from the smallest standard

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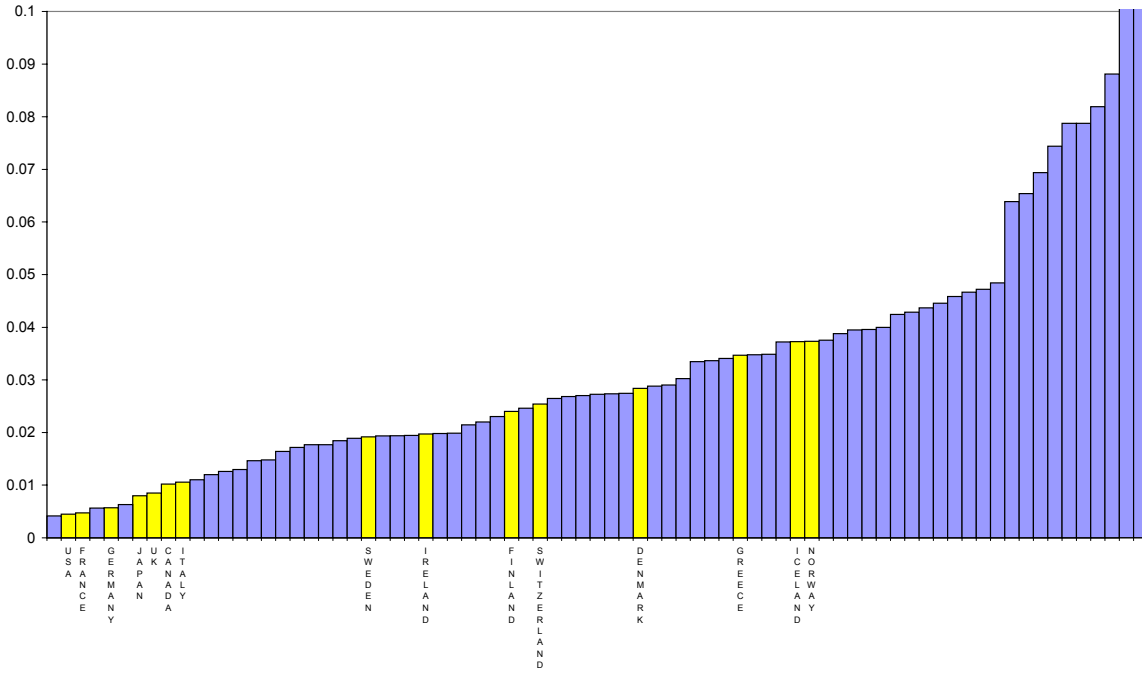
[2] There are some emerging economies that have very small volatilities. These countries in general have capital accounts that are close to be zero

deviation to the largest and highlight the developed economies. The following figure presents the results.

Capital Flows/GDP with constant and time trend



As can be seen, although developed countries change their positions the general message is exactly the same as before. Furthermore, it seems, at least to the naked eye, that the differences are exacerbated. This perception is in fact found in the results.

In this case the standard deviations of developed countries is 2.27 percent, while the standard deviation of the emerging economies is 4.62 percent. The first point that should be highlighted is the fact that the country specifics intercept and trend explain a sizeable proportion of the variance. The implicit r-square of the developed country equation is 79 percent, while it is 64 percent for emerging markets. However, after controlling for fixed effects and trends, the ratio of the standard deviations still is extremely high: 2.03! In other words, after allowing for country differences in trend and constant terms the innovations to emerging markets are twice as big when measured in terms of GDP.

One of the most important aspects of the stochastic properties of capital flows is their degree of persistence. Indeed, it is possible that capital flows are more volatile in emerging markets, because for

the same shocks, they have more persistent deviations. For instance, assume that capital flows to country *i* are described by the following relationship

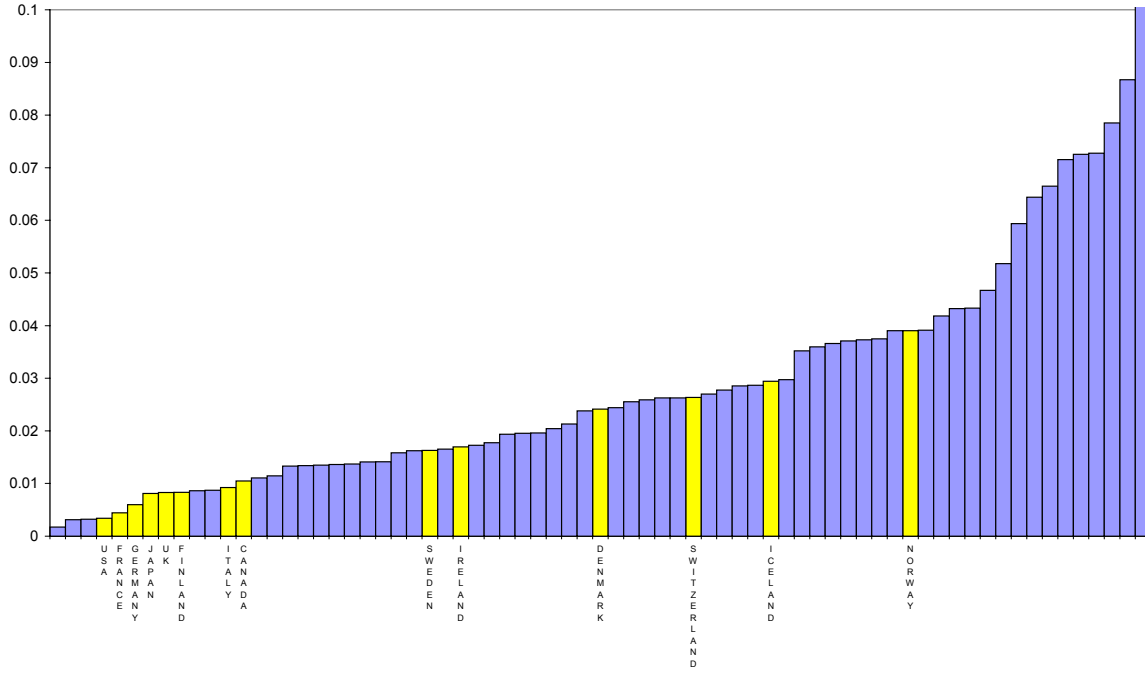
$$K_{i,t} = c_i + a_i t + b_i K_{i,t-1} + \varepsilon_{i,t}$$

For simplicity assume that the constant and the time trend are zero, then the variance of the observed capital flows is

$$Var\left(K_{i,t}\right) = \frac{Var\left(\varepsilon_{i,t}\right)}{1 - b_i^{\,2}}$$

In this case, it is likely that even though the variance of the innovations are the same across countries ($Var\left(\varepsilon_{i,t}\right) = Var\left(\varepsilon_{j,t}\right)$) the cross-sectional differences are due to the fact that in emerging markets shocks are more persistent (*b* for emerging markets are bigger on average than for developed economies). To evaluate this possibility we de-mean, de-trend and allow for different auto correlation coefficients country by country. In the end, the question is if the residuals of the regression exhibit a pattern different from those already shown in the capital flows. Again, we sort the standard deviations from the smallest to the largest. The following figure presents the results.

Capital Flows/GDP includes lags (constant and trend too).



Strikingly, the pattern does not move at all. The average standard deviation of emerging markets is 4.09 percent, which came down from 7.71. This implies that roughly 72 percent of the variation of emerging market's capital inflows is explained by the constant term, a time trend, and lags of the dependent variable. The standard deviation for developed markets is 1.82, coming down from 4.95. Again, this reflects a sizeable reduction in the variance. The constant, time trend, and lags explain 87 percent of the variance.

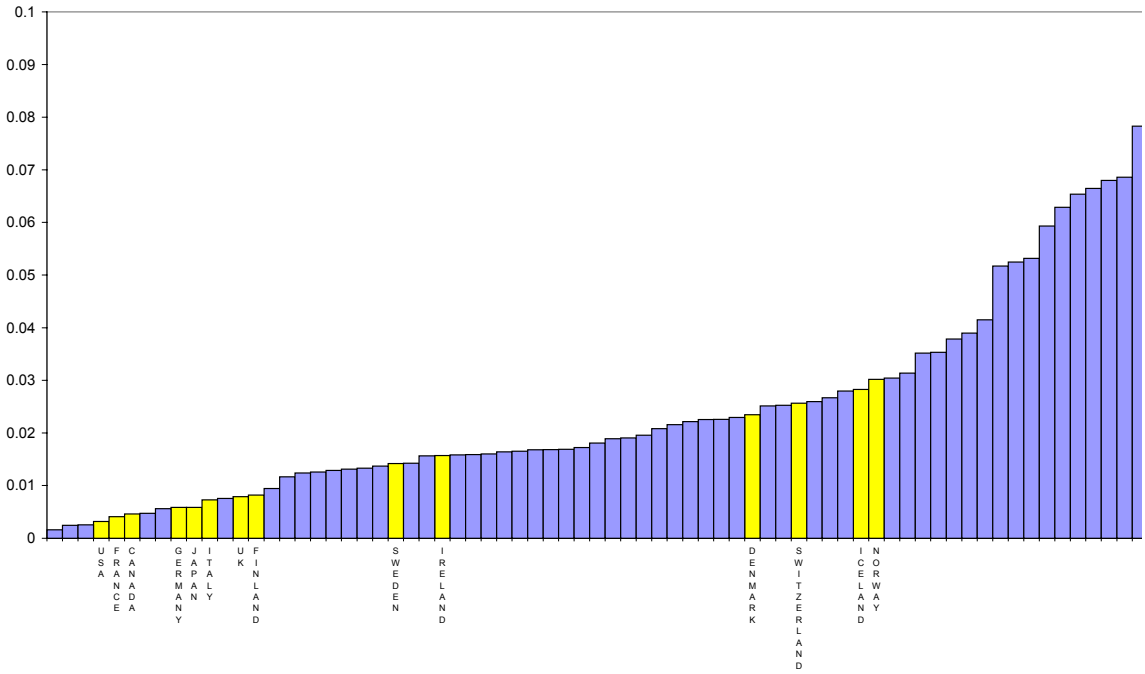
Still, even though there is a sizeable explanatory power in the regression, the developed countries continue to occupy the lowest ranks for the variances, and the ratio of the standard deviations increases to 2.25.

So, in fact, shocks are more persistent in developed economies and therefore the differences in the average volatilities of emerging markets is larger.

These first three figures have dealt with just the "statistical view" of the stochastic properties of capital flows. But there are several fundamental variables that should be included in the analysis that are not related to the trend or the lags. In fact, these are the variables that we argued in the previous section. Due to data limitation it is impossible to run a regression country by country including all the

possible controls. In the end, the degrees of freedom would not be enough. Hence, in this first pass, we include variable by variable. We consider: inflation, nominal depreciations, real growth of per capita GDP, financial development and level of development (measured as log of per capital GDP), measure of financial vulnerability, terms of trade, and the real exchange rate depreciations.

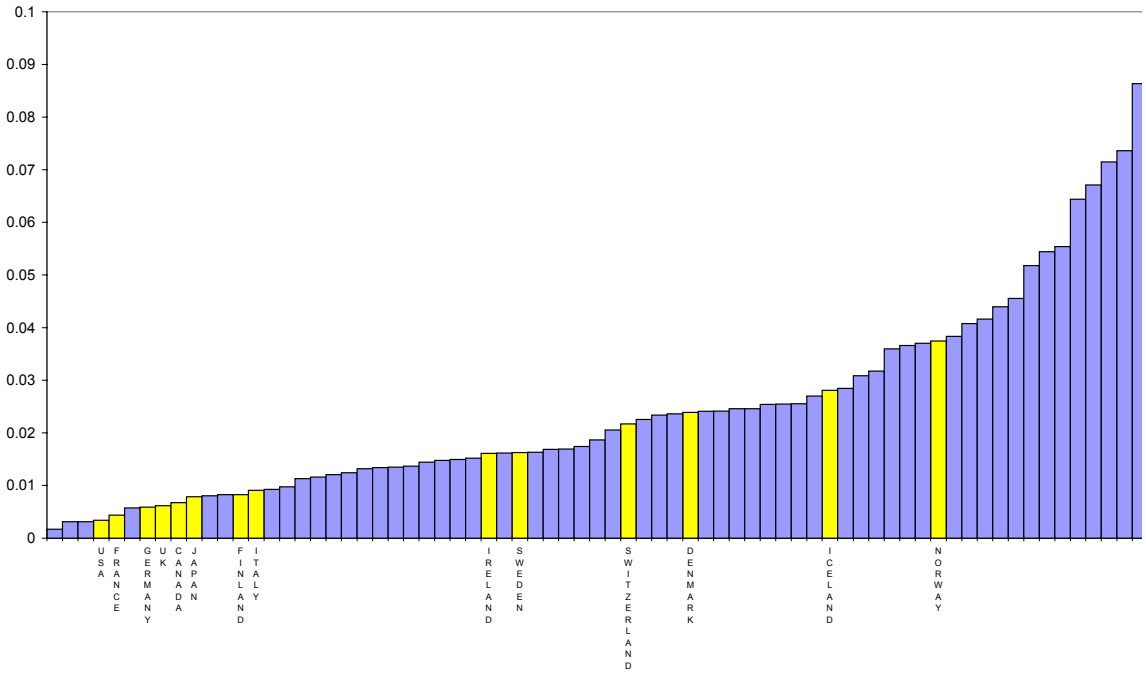
Capital Flows/GDP includes inflation (+ const, trend, and lags).



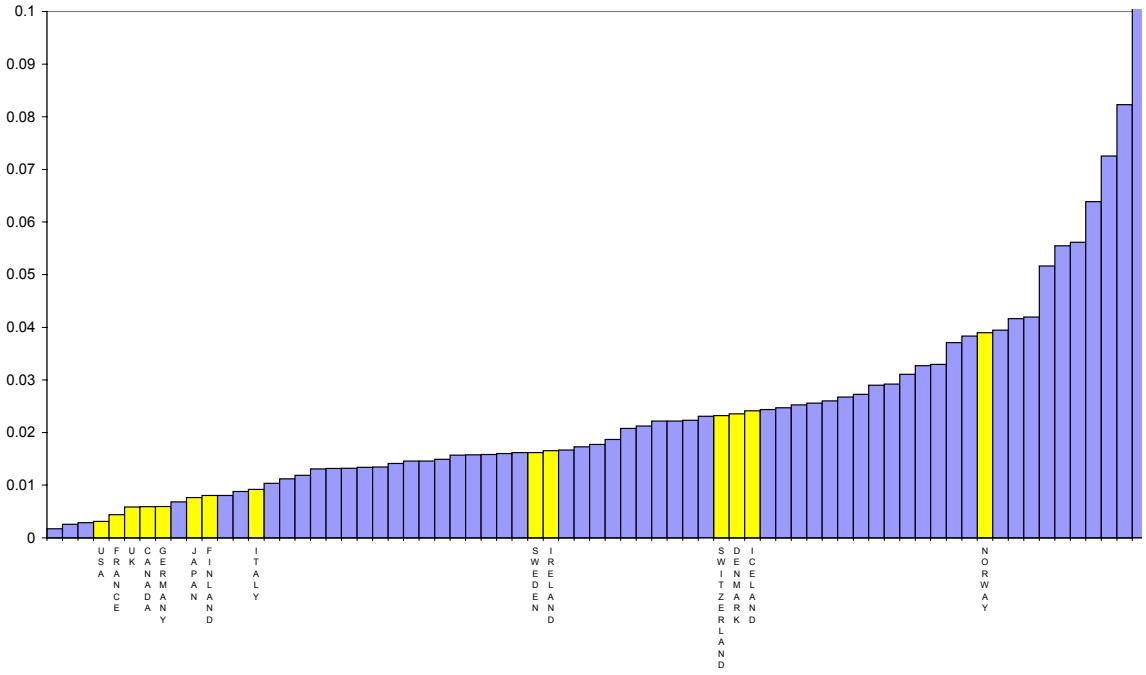
The previous figure is the one in which inflation (as well as trends and lags) is included in the specification. Again, the pattern is identical. The average standard deviation in emerging economies is 3.16 percent while it is 1.66 percent for developed economies. This is a ratio equal to 1.90. Furthermore, the r-squares of the regressions are 83 and 89 percent for emerging and developed economies, respectively.

The exact same pattern is found when we include the other variables. We present the figures and a table in the end that summarizes all the facts.

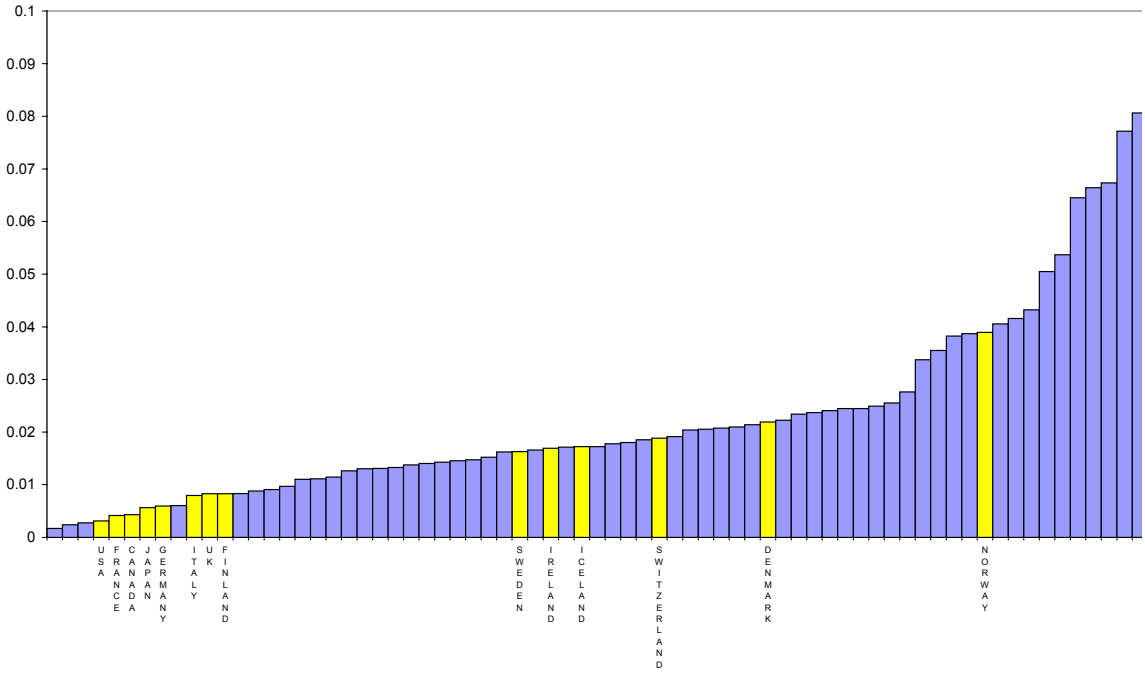
Capital Flows/GDP includes nominal depreciation (+ const, trend, and lags).



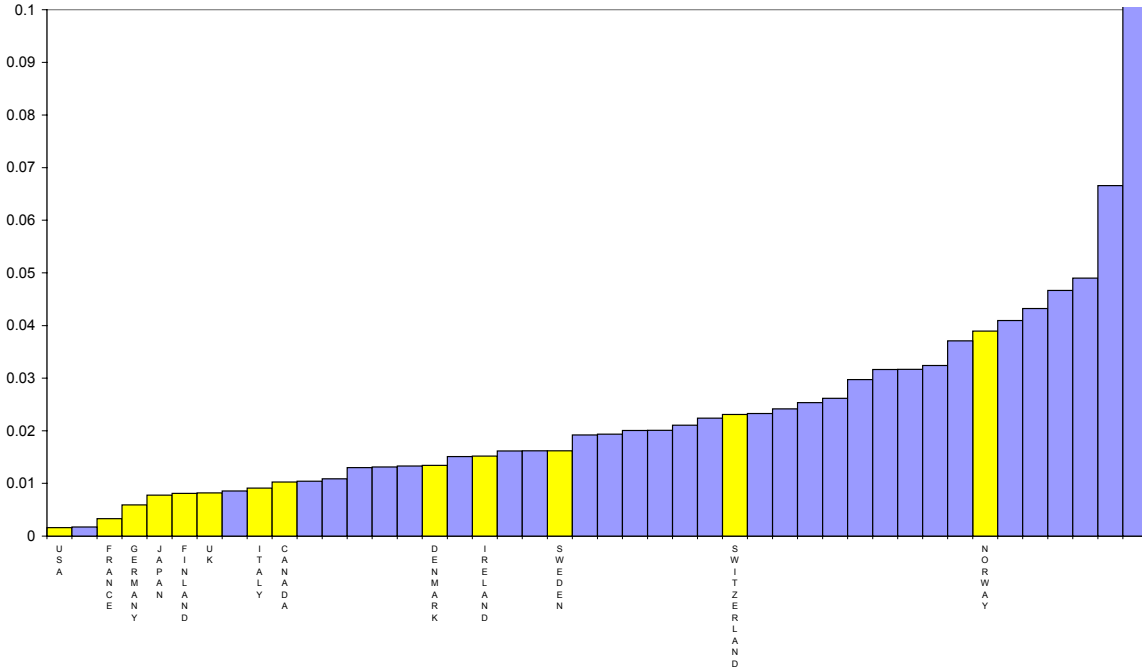
Capital Flows/GDP includes GDP per capita growth (+ const, trend, and lags).



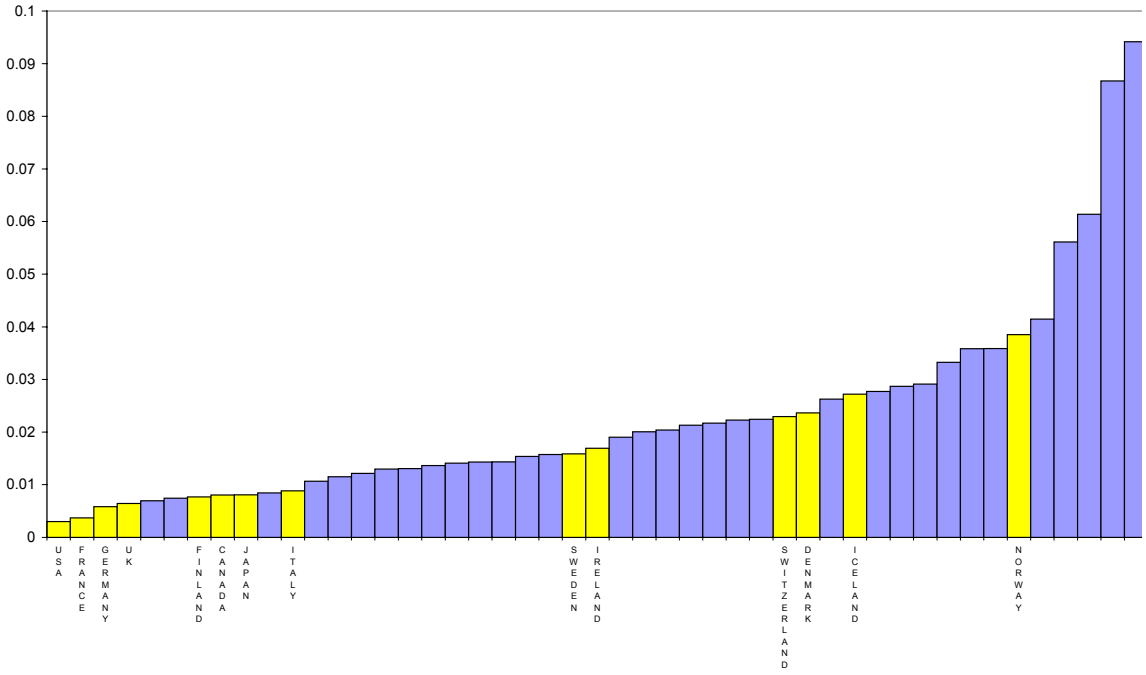
Capital Flows/GDP includes log of per capita GDP (+ const, trend, and lags).



Capital Flows/GDP includes TOT (+ const, trend, and lags).



Capital Flows/GDP includes RER depreciation (+ const, trend, and lags).



In the following table we present a summary statistic of what we have done. It includes the average standard deviation in the sample, the ratio of the standard deviations, and the r-squares..

Summary of results.

		StDev.			R2	
	# Count.	Developed	Emerging	Ratio	Developed	Emerging
Benchmark	77	4.95%	7.71%	1.56		
+ mean and trend	77	2.27%	4.62%	2.03	79%	64%
+ lags	71	1.82%	4.09%	2.25	87%	72%
+ inflation	71	1.66%	3.16%	1.90	89%	83%
+ nominal depreciation	71	1.58%	3.24%	2.06	90%	82%
+ level of development	71	1.50%	3.01%	2.01	91%	85%
+ growth	71	1.64%	3.33%	2.03	89%	81%
+ rer depreciation	47	1.57%	3.40%	2.17	90%	81%
+ terms of trade	44	1.60%	3.33%	2.09	90%	81%

A. What does this mean so far?

We are estimating a regression of this class

$$K_{i,t} = c_i + X_{i,t} A_i + \varepsilon_{i,t}$$

where we are allowing the coefficients to differ country by country and still, even though we allow for a tremendous degree of flexibility, and even though these regressions have r-squares that are satisfactory, the fundamentals included in the right hand side have no bearing identifying the reasons why emerging markets have capital flows that are more volatile than developed economies.

Therefore, even though the *A's* are significant, they explain some of the differences in the *means*, but they explain little to nothing the differences in the volatilities.

B. Can this be contagion?

No, it is not.

One interpretation is that there is a misspecification in the regression that is explaining the cross-country heteroskedasticity. This is sort of an omitted variable that explains the differences in variance. It is interesting to analyze the properties of these omitted variable. For example, we could compute the principal component of the capital flows, this would have given an indication of the importance of the common component implied by the misspecification. Indeed, this is a measure of the degree of contagion that could exist among the variables.

Unfortunately, principal components cannot be computed when the number of observations per country is smaller than the number of principal components. In this case, this data limitation makes this strategy unfeasible. Hence, the alternative is to compute average correlations among the subsamples pair by pair. The results are summarized in the following table.

Average Correlations in each sub-sample.

Average Correlations	Developed	Developing	Ratio
Benchmark	-3.02%	20.61%	6.82
+ mean and trend	0.90%	0.17%	0.19
+ lags	3.22%	0.15%	0.05
+ inflation	1.58%	0.49%	0.31
+ nominal depreciation	3.17%	0.87%	0.28
+ level of development (GDP)	-0.48%	-0.10%	0.21
+ growth	2.47%	-0.16%	0.07
+ rer depreciation	2.30%	0.49%	0.21
+ terms of trade	2.64%	-2.53%	0.96

As can be seen, in the raw data there seems to be a strong common component among emerging markets. The average correlation is around 20 percent, while the average correlation among developed economies is –3 percent. However, this difference disappears the first moment we include a country specific trend.[3] Notice that the lack of correlation is maintained through out all the other specifications in which other control variables are included.

It is important to highlight that even if the correlations are corrected by the heteroskedasticity in the data, these results are almost identical. The reason is that the average correlations are close to zero, and the bias introduced by the heteroskedasticity in those cases is minimal. The results presented here are without the correction.

The interpretation of these findings is important in the search of the missing variable in the specification. If the variables causing the high volatility in emerging markets were related to contagion, for instance, then the correlation among emerging markets should be larger than the correlation among the countries not suffering contagion. Notice that this is indeed found in the raw data – or our benchmark. The correlation is order of magnitude larger in emerging markets than in developed economies. However, all the contagion seems to be captured by a time trend. And therefore, the

[3] In fact, in some of the simulations we performed we only computed the regression allowing for the intercept to vary across countries but not the trend. It is the case, that if we force the trend to be the same, the misspecification implies a large correlation among the residuals of the developing countries.

remaining cross-country differences in volatility cannot be thought of a common shock type of variable.

Obviously more has to be done to disregard contagion as the possible explanation. We come back to these issues in the ARCH section of the paper where we estimate formally variance equations and study the role of time dummies and other proxies of contagion more formally.

C. Can the results be explained by non-linearities?

One possible explanation for the different patterns is that the high volatility is due to a non-linearity in the specification. It is possible that, for example, emerging markets respond differently to negative shocks than positive shocks and we are forcing both to have the same effect.

To test for the different forms of non-linearity the following regression is estimated country by country, and variable by variable.

$$K_{i,t} = c_i + a_i t + b_i X_{i,t} + c_i \left| X_{i,t} \right| + d_i K_{i,t-1} + \varepsilon_{i,t}$$

Although we found that the non-linearities indeed exist in most of the emerging economies (specially those of middle income) the pattern of residuals is identical to the ones found before.

We also tried with a quadratic term of the controls

$$K_{i,t} = c_i + a_i t + b_i X_{i,t} + c_i X_{i,t}^{\ 2} + d_i K_{i,t-1} + \varepsilon_{i,t}$$

and the results were almost the same as those where the absolute value was used. Furthermore, the explanatory power of the non-linear models on average did not improve those of the linear specification hence it is unlikely that they are part of the story.[4]

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[4] We do not present all the tables with these non-linearities to save space. They truly provide very little additional information to what we have already shown.

Finally, there is one non-linearity that we had problems estimating – non-linear terms of the lag dependent variable. For example, a specification of the following type:

$$K_{i,t} = c_i + a_i t + b_i X_{i,t} + d_i K_{i,t-1} + e_i \left| K_{i,t-1} \right| + \varepsilon_{i,t}$$

Although, it is possible to estimate these equations by OLS, without restrictions it is possible that the variables estimated are non-stationary. We estimated the model without restrictions and they had little effect on the variance across the two groups. We conjecture (though we plan to do so) that the estimation imposing stationarity will have even less explanatory power and the ratio of variances will remain the same.

D. What are the "our" possible explanations?

There are several possibilities. First, it is possible that the quality of institutions is affecting the variances beyond their effect on the means. The reason is that we have introduced in the regression fixed effects; and therefore, the different quality of institutions is already captured in the specification.[5] Therefore, For institutions to be part of the explanation we require a theory in which institutions affect the variances of the capital flows beyond their impact on the means. This is a distinct possibility and one that we explore in the next section.

Second, the results found here have also been found in real exchange rates (See Hausmann, Panizza, and Rigobon (2004)). However, we have controlled in the specification for the real exchange rate and still we do not eliminate the pattern. In fact, the explanation of HPR is based on capital flows and the two should be intertwined. This is also an important interconnection that we explore more carefully in the next section although the impact of the real exchange rate to the capital flows have to go through different channels.

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[5] There are some models of the financial sector in which these effects appear (See Hausmann and Rigobon (2003)).

Third, is this pattern the result of one type of capital inflows, or all of them share the same properties? So, far we have concentrated on net capital flows and clearly there is something to be learned by looking at the composition and gross flows. [**to be done**]

IV. Excess Volatility: A formal view

In this section, we estimate ARCH models as well as unconditional variance models to understand the determinants of the differences in volatility across countries. We first reproduce the findings from the previous section, and then explore the other possible explanations.

[**to be done**]

V. Final remarks

If the volatility of capital flows to developing countries is explained by non-fundamental factors, which are these? The literature has placed financial conditions at the top of the list of candidates to explain this volatility. We try to answer two related questions.

1. Is the volatility of capital flows due to volatility in the demand for capital in developing countries or due to volatility in the supply of capital to these countries?

2. What is the role of contagion? Is this volatility due to idiosyncratic factors or due to factors that affect many countries at once?

Question 1 can be answered by looking at the correlation of capital flows and cost of capital in the developing country. If inflows were correlated with low cost of capital, this would be an indication of supply of capital shocks. If inflows were correlated with high cost of capital, this would be an indication of demand for capital shocks. It is difficult to get data on cost of capital though. Domestic interest rates are a (very) imperfect proxy, since high interest rates could reflect inflation and/or default expectations and have little to do with expected repayments.

Question 2 can be answered by looking at the explanatory power of time dummies. For example, if we can explain a substantial part of the residual variance by just adding to our panel regression a time dummy for developing countries, this would be very persuasive. Such a dummy probably does not explain much for developed countries. We have done some of this already by looking at the average correlation in the sample. Our preliminary results seem to indicate that the explanation is NOT contagion, that those effects are already captured in the country specific trends.