

The Volatility of Capital Flows in Emerging Markets: Measures and Determinants

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Abstract

Capital flow volatility is a concern for macroeconomic and financial stability. Nonetheless, literature is scarce in this topic. Our paper sheds light on this issue in two dimensions. First, using quarterly data for 65 countries over the period 1970Q1-2016Q1, we construct three measures of volatility, for total capital flows and key instruments. Second, we perform panel regressions to understand the determinants of volatility. The measures show that the volatility of all instruments is prone to bouts, rising sharply during global shocks like the taper tantrum episode. Capital flows volatility thus remains a challenge for policy makers. The regression results suggest that push factors can be more important than pull factors in explaining volatility, illustrating that the characteristics of volatility can be different from those of the flows levels.

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I. INTRODUCTION³

Capital flow volatility is a major source of concern for macroeconomic and financial stability in emerging markets and developing economies (EMDEs). Over the last three decades, the emerging economies have liberalized their capital accounts and have become more integrated in international financial markets. However, as the Global Financial Crisis (GFC) has shown, reaping the benefits of capital account liberalization while containing the associated risks remains a key challenge for many countries for several reasons.

First, EMDEs tend to receive capital flows that, even in net terms, are large relative to their domestic economies and overall absorptive capacity in terms of the size and depth of their financial systems.

Second, EMDEs are more prone to shocks, partly because their economies are smaller and less diversified, and even because they have less domestic economic and political stability. In addition, shocks of any kind - positive or negative, domestic or external - are exacerbated and propagated more easily in EMDEs because of structural and institutional characteristics. In particular, large capital inflows, mostly intermediated through the banking system, tend to amplify the domestic financial and real business cycles to a greater extent than in Advanced Economies (AEs).

Finally, the onset of the GFC has prompted new concerns that flows to EMDEs are overly sensitive to some global (push) factors that are beyond the influence of domestic policies.

Given all this, financial integration poses serious challenges to economic and financial sector stability in EMDEs⁴. To the extent that there exists a positive link between the stability of capital flows and economic growth (see Easterly, Islam, and Stiglitz (2001) and Ramey and Ramey (1995)), maintaining a steady stream of capital flows is a policy priority in most EMDEs. Despite being a focus of policymakers, relatively few studies focus primarily on the issue of volatility. Moreover, capital flows volatility is usually quantified in policy and academic discussions using a crude measure of standard deviation of flows over a specified period. Given the importance of this issue, a better understanding of volatility in capital flows is warranted. This paper aims at providing a deeper understanding of volatility of capital flows by contributing to the existing literature along three important dimensions:

1) **Measurements**: The first step of this study consists of deriving measures that can accurately describe volatility. Our paper builds upon Broto et al. (2011) to provide updated capital flows volatility measures using three methodologies: rolling window standard deviation, GARCH(1,1) conditional variance and ARIMA(1,1,0) estimates.

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⁴ For instance, Broner and Ventura (2016) point out that financial globalization has sometimes led to capital flows that are volatile and procyclical.

2) **Determinants:** In order to pursue policies to increase resilience and help manage capital flows volatility, it is important to understand the drivers of capital flow volatility. We perform panel regressions to understand what are the key variables driving volatility, by disentangling between, on the one hand, global or push factors and, on the other hand, domestic or pull factors.

3) **Components:** We analyze the evolution of volatility across a wide array of instruments. In particular, the high level of granularity of our dataset allows us to achieve a greater precision in the study of particular categories of flows.

Using quarterly data for 37 EMDEs over the period 1970Q1-2016Q1, we use three measures of volatility to document its evolution over time. Our measures show that net capital flows to EMDEs tend to be more volatile than that of AEs, as gross outflows tend to dampen the impact of gross inflows in the latter group but not in the former. Our computed measures for gross inflows in EMDEs suggest that portfolio and other investments are respectively around two and four times more volatile than FDI. In addition, amongst portfolio flows, portfolio debt is more volatile than portfolio equity. As to other investment flows, private flows are much more volatile than the official sector ones. Within private flows, bank flows usually tend to be more volatile than non-bank flows, but there are periods where this does not hold.

For policymakers, it is not only the level of volatility but also the changes in volatility that matter. Therefore, we use our estimates to document the changes of volatility since 2000. Our computed measures suggest that, after a spike during the GFC, capital flows volatility in EMDEs is now back to pre-crisis levels. However, volatility has sharply risen in response to some after-crisis global shocks, particularly during the taper tantrum episode. Moreover, after accounting for the global slowdown in capital flows witnessed since 2012, EMDEs capital flows volatility has either increased or remained the same as before the crisis. There exists, however, a degree of heterogeneity in the results, depending on the type of flows targeted. Indeed, while foreign direct investments (FDIs) display a more clear-cut and stable volatility pattern over time, the same does not hold for other instruments, like portfolio or other flows. In particular, debt-generating instruments, notably portfolio debt and bank flows, were the main drivers of the large swings in volatility observed soon before and in the aftermath of the GFC.

One of the major contributions of our paper is that we produce capital flow volatility estimates, both for total flows and different instruments, for 65 individual countries⁵. The individual country estimates suggest that there can be significant variation amongst countries, both in terms of the evolution over time and the relative magnitude across instruments, underscoring the importance of monitoring volatility of individual countries. These estimates can thus be useful tools in future studies dealing with cross-country comparisons. As an example, we present heat maps comparing the volatility of individual countries before and after the crisis. These maps suggest that the volatility of total gross inflows has remarkably decreased since GFC in countries like Canada and Russia, as well as the smaller Latin America economies. On the other hand, it has increased in Eastern European economies and in some of the oil exporting economies. Overall, cross-country comparison of volatility estimates displays a high degree of heterogeneity of experiences, both across regions and across instruments.

⁵ 37 EMDEs and 28 AEs. See Appendix A for a list of countries.

We, then, use the volatility estimates at the country level to run panel regressions with the aim of understanding the determinants of volatility. Our regression analysis shows that push factors like the US monetary policy stance, the US economic performance and global risk aversion do influence the volatility of capital flows in EMDEs to an extent which, in certain cases, is greater than the effect of domestic and structural variables. These findings are interesting against the backdrop of recent studies (e.g. IMF (2016)) that show how the recent capital flow slowdown can be predominantly attributed to the broader emerging markets economic growth slowdown. Our results suggest that the determinants of capital flow volatility can be quite different from the determinants of capital flow levels.

Our analysis also shows the varying sensitivity of different instruments towards the push and pull factors. For instance, while indicators of the US monetary policy and global risk aversion have a consistently positive effect over the volatility of the majority of inflows, this effect is much higher for the volatility of FDI compared to other instruments. Among the domestic factors, trade openness⁶ is undoubtedly the most relevant driver of volatility for all instruments, with the notable exception of bank inflows.

The remainder of this paper is structured as follows: Section 2 provides some stylized facts concerning the evolution of capital flows to EMDEs and discusses the different types of data included in the dataset; Section 3 reviews the existing literature; Section 4 contains an overview of the methodological approaches adopted and analyses the evolution of volatility of capital flows over time, across instruments and countries; Section 5 deals with the identification of the main drivers of volatility via panel regressions; Section 6 concludes.

II. EVOLUTION OF CAPITAL FLOWS

A. Heterogeneity across groups and flows: AEs vs EMDEs, gross vs net.

International capital gross inflows have experienced a remarkable surge from the mid-1990s to the first half of 2000s, both in EMDEs and AEs (Figure 1). Following the GFC in 2008, inflows dropped sharply in 2008 for both groups and regained their upward momentum in 2009, only to fall again in late 2011 as the European sovereign debt crisis intensified. Within this broader trend, there exist key differences across income groups. While net flows in AEs are influenced by both gross inflows and gross outflows, their patterns for EMDEs is mainly determined by gross inflows (Figure 1). This is because capital flows to EMDEs have been generally driven by foreign investments into domestic assets, while the amount of domestic investments abroad has played a reduced role⁷. Given this background, when it comes to evaluate the volatility of capital flows, it is crucial to make a clear distinction not only across groups, but also between gross and net flows.

⁶ See Appendix B for the definition of trade openness.

⁷ In the last decade, however, EMDEs have started to increasingly invest abroad as well (see Obstfeld (2012)).

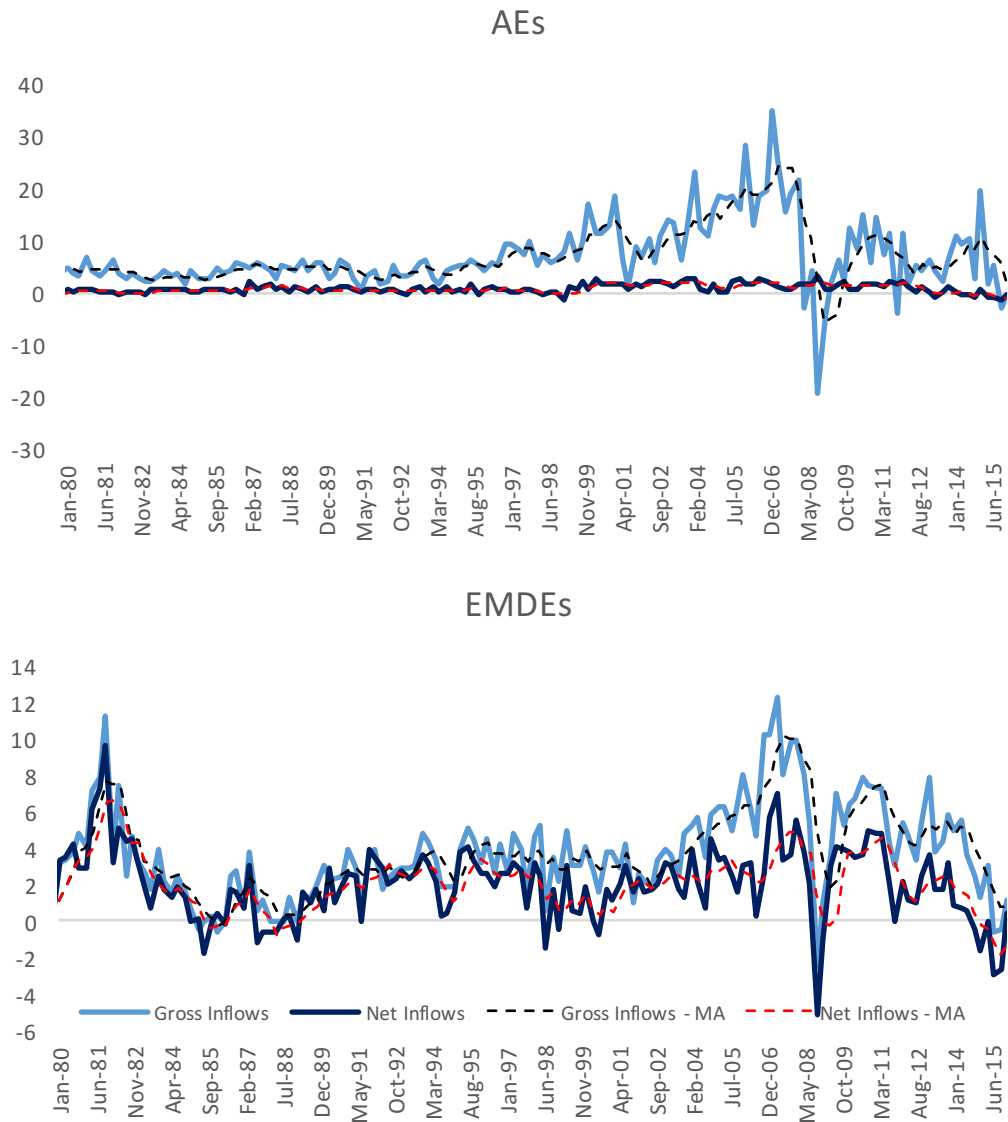


Figure 1: Cross border capital flows in AEs and EMDEs. *Notes:* flows are expressed as % share of group GDP. Dashed lines are quarterly moving averages. Data are quarterly over the period 1980Q1:2016Q1. Source: IMF, *International Financial Statistics*.

Table 1 reports some basic volatility measures of gross and net flows for both groups, computed over the period 1990Q1:2016Q1. The measures of volatility considered are two: the standard deviation of capital flows as a % share of GDP and the coefficient of variation, that is the ratio between the standard deviation and the absolute value of the mean of the flows. Standard deviation is a measure suitable for making comparisons across groups whose average levels of flows are similar. When the means are widely different, however, it is the case that the higher the mean the higher could be the dispersion of observations around it. In order to address this issue, the coefficient of variation is often a preferred measure to make comparisons across groups⁸.

In AEs, capital flows volatility, as indicated by the coefficient of variation, has increased over the period 1990-2016, by 0.25, 4.82 and 0.3 for gross inflows, gross outflows and net inflows respectively. In all cases, there has been a slight decrease in volatility up to the GFC, while it has increased during and after it.

In EMDEs, on the other hand, the volatility of gross and net inflows has decreased both before and after the GFC, by 0.44 and 0.14 respectively in the overall sample. The same holds for gross outflows (-0.01 in the overall sample), even if their volatility has experienced an increase during the period 2000-2016. However, this has not impacted the decrease in volatility for net inflows over the same period. Hence, even if EMDEs are moving towards a greater financial integration, they still attract inflows from foreign investors that more than outweigh investments of domestic agents abroad⁹. Therefore, the paper focuses primarily on the analysis of the volatility and its determinants for gross (or net) inflows, as evidence suggests these are of greater importance for EMDEs

⁸ See Bluedorn, Duttagupta, Guajardo, and Topalova (2013). Another common practice is to linearly detrend the series to account for observed increases in the level over time. As a robustness check, we computed the estimates with linearly detrended data and we got very similar results.

⁹ The differences in the behavior of net flows between AEs and EMDEs is also due to the fact that while in AEs capital flows are used for both risk-sharing and portfolio diversification, for EMDEs, by contrast, capital flows are not only instrumental for risk-sharing, but also to have access to greater external financing (see Canuto and Ghosh (2013), Ch. 3).

	Average (% of GDP)			Standard deviation (% of GDP)			Coefficient of variation		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
<i>AEs</i>									
1990-1999	3,75	0,38	3,37	1,86	0,30	1,84	0,50	0,79	0,55
2000-2007	14,49	1,52	13,03	5,15	0,42	5,25	0,36	0,27	0,40
2008-2015	5,77	0,77	5,12	4,32	4,33	4,34	0,75	5,62	0,85
$\Delta_{2000/07-1990/99}$	10,75	1,14	9,67	3,29	0,11	3,41	-0,14	-0,52	-0,14
$\Delta_{2008/15-2000/07}$	-8,72	-0,75	-7,92	-0,83	3,91	-0,91	0,39	5,35	0,44
$\Delta_{2008/15-1990/99}$	2,02	0,39	1,75	2,46	4,02	2,50	0,25	4,82	0,30
<i>EMEs</i>									
1990-1999	2,21	1,62	0,76	1,79	1,56	0,57	0,81	0,96	0,74
2000-2007	4,94	2,40	2,55	2,40	1,10	1,61	0,48	0,46	0,63
2008-2015	4,81	1,85	2,92	1,77	1,77	1,77	0,37	0,95	0,60
$\Delta_{2000/07-1990/99}$	2,73	0,77	1,79	0,60	-0,46	1,04	-0,33	-0,50	-0,11
$\Delta_{2008/15-2000/07}$	-0,13	-0,54	0,38	-0,63	0,66	0,16	-0,12	0,49	-0,03
$\Delta_{2008/15-1990/99}$	2,60	0,23	2,16	-0,03	0,20	1,20	-0,44	-0,01	-0,14

Table 1: Statistics for quarterly moving averages. *Notes:* average and standard deviation are expressed as % share of group GDP; (1) Gross Inflows; (2) Gross Outflows; (3) Net Inflows. $\Delta_{y_1/y_2-x_1/x_2}$: difference between the averages computed over periods x_1/x_2 and y_1/y_2 .

B. Heterogeneity across instruments: FDI, portfolio and Other flows

Besides the heterogeneities related to income groups and to the comparison between gross and net flows, another powerful source of heterogeneity stems from the composition of the aggregate flows. The overall dynamics of capital flows depend upon the dynamics of the specific components and, by analyzing the composition of the financial account, one can infer interesting information about the behavior of international investors in different scenarios as well as detect some potential threats to a country's financial stability.

The three instruments that are usually closely monitored are:

1. *Foreign Direct Investments (FDI)*, “a category of cross-border investments associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy”;
1. *portfolio flows*, “defined as cross-border transactions and positions involving debt or equity securities, other than those included in direct investment or reserve assets”;
2. *Other flows*, “a residual category that includes positions and transactions other than those included in direct investment, portfolio investment, financial derivatives and employee stock options, and reserve assets”, classified in government-related flows, private flows and bank flows¹⁰.

Figure 2 shows the evolution of gross and net inflows for EMDEs, broken down by instruments. While FDI represent the majority of capital inflows for EMDEs, the surge and the subsequent collapse in inflows following GFC was mainly driven by other flows, that include bank flows. Even the post crisis pick-up in capital flows was led by debt-creating (bank and portfolio debt) instruments, with some reversals between 2015 and 2016. Therefore, one would expect different results when estimating volatility for different categories, with portfolio and other flows being characterized by a higher volatility.

¹⁰ Definitions are taken from the sixth edition of the Balance of Payments and International Investment Position Manual (BPM6).

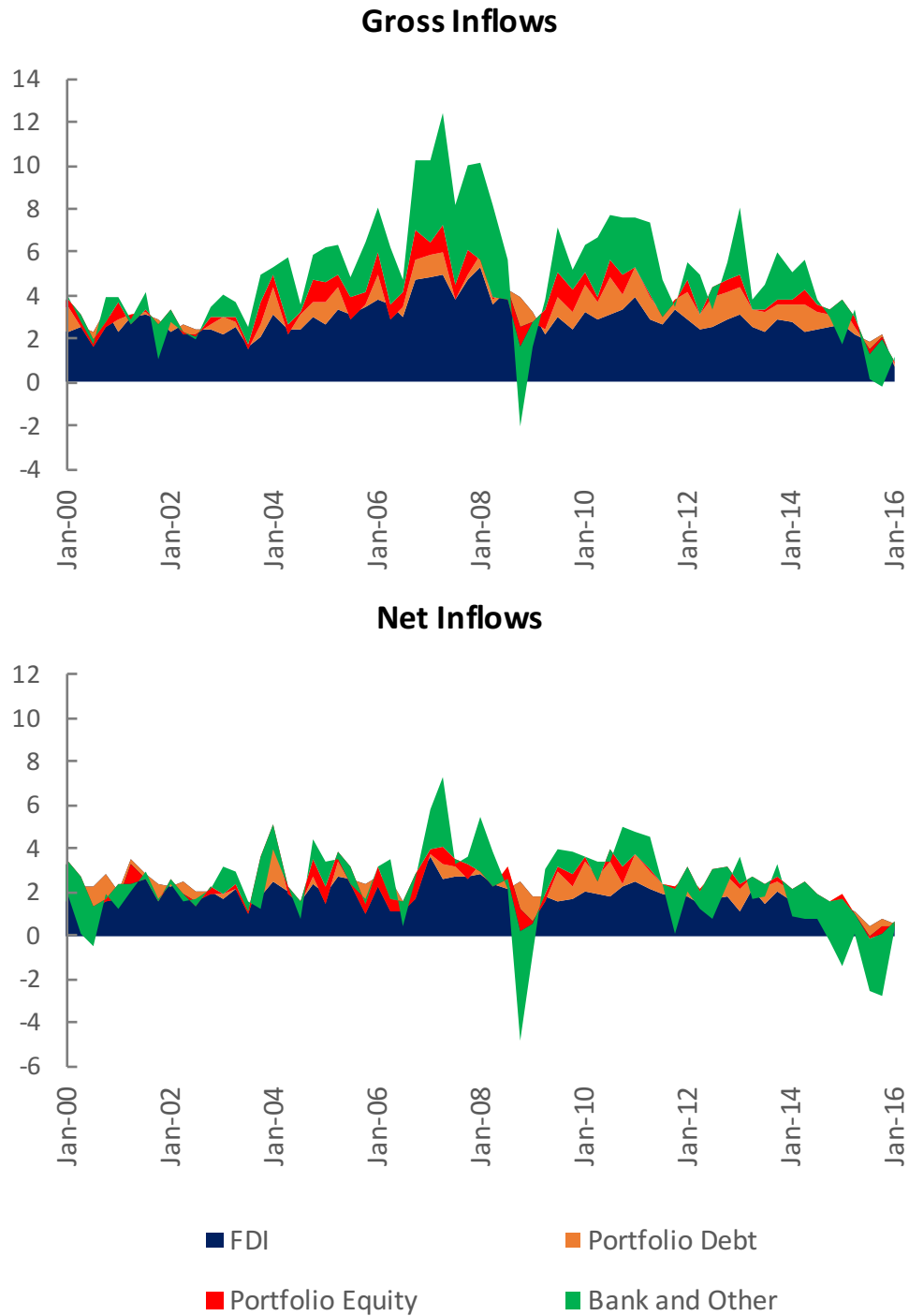


Figure 2: Quarterly moving average of Gross and Net Capital Inflows in EMDEs *by instrument*. Notes: flows are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*.

Another aspect of particular relevance concerns the correlation across instruments and whether it has changed over time. In this regard, Figure 3 shows how the correlation coefficients across different types have evolved over time for EMDEs. The correlations across instruments are significantly different from 0 in certain periods. The most interesting case is provided by the correlation between FDI and portfolio flows, whose sign has switched from negative to positive and vice versa several times in the period covered. By comparing this picture with Figure 2, it is evident that episodes of surges coincide with a positive correlation between FDI and portfolio flows, while the same correlation turns negative soon after a stop. By contrast, this does not seem to be the case when it comes to co movements of both FDI and portfolio with other investments. The key message, however, is that there exists a degree of heterogeneity across instruments which has to be accounted for.

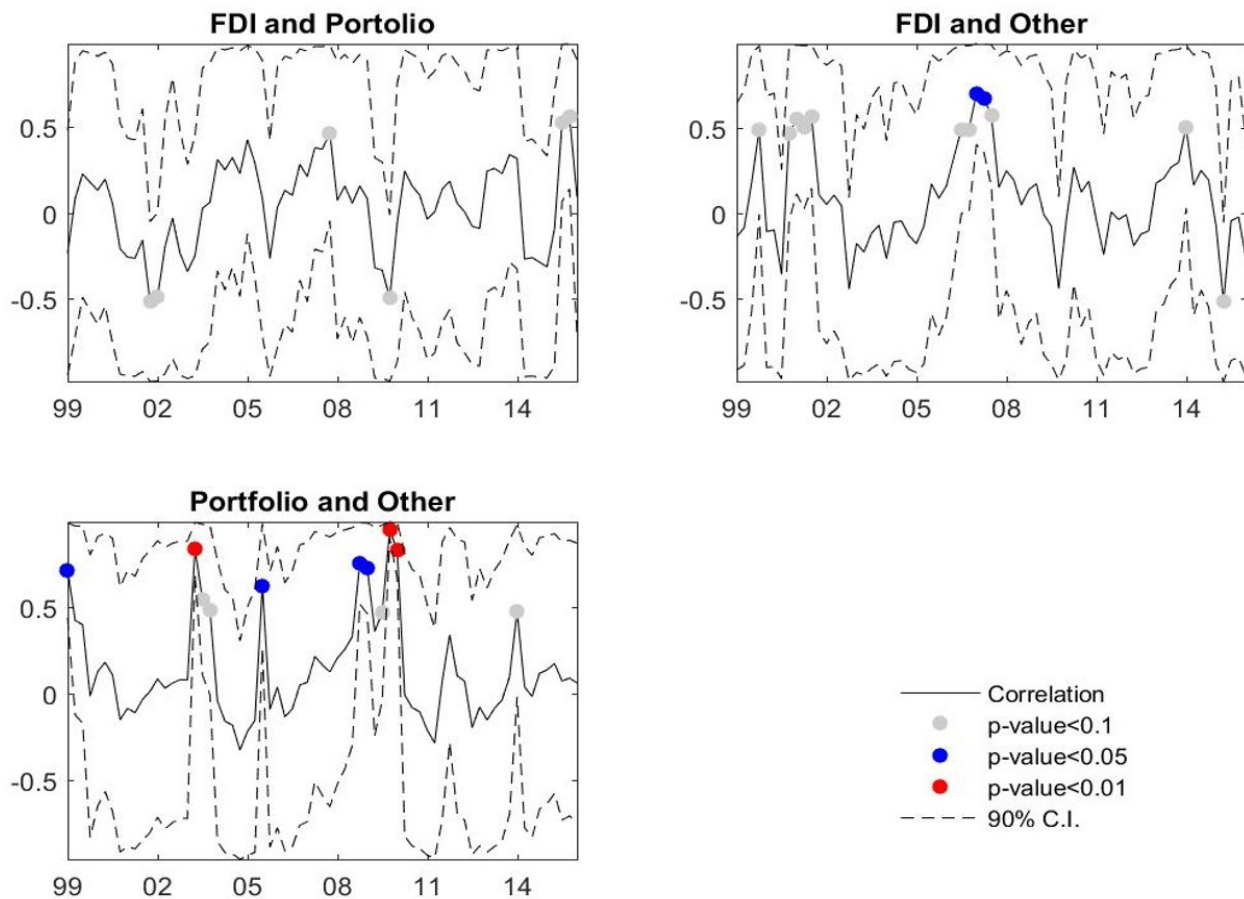


Figure 3: Evolution of the correlation coefficient across different types of Gross Inflows. Notes: the grey, blue and red dots indicate estimates significant at 10%, 5% and 1% respectively. Source: IMF, *International Financial Statistics*, authors' computations.

III. LITERATURE REVIEW

There exists a vast literature aimed at, on the one hand, identifying the main drivers of the evolution of international capital flows, and, on the other hand, measuring the potential gains from financial integration¹¹.

A. The Determinants of Capital Flows

Most of the literature classifies the main determinants of capital flow developments in country-specific (pull) and global (push) factors. Among the latter, the most commonly identified are indicators of global risk appetite and US monetary stance. Reinhart et al. (1993) and Reinhart et al. (1996), for instance, argue that capital inflows to Latin America in the 1990s were influenced by conditions originated outside the region, a fact that increased the macroeconomic vulnerability of the economies in that region.

More recent literature explores whether push or pull factors determine capital flows. Fratzscher (2012), by means of a factor model, shows how push factors were overall the main drivers of capital flows during the crisis, while pull factors have been dominant in accounting for the dynamics of global capital flows in 2009 and 2010, in particular for EMDEs. In their analysis of episodes of “surges”, “stops” (sharp increases and decreases, respectively, of gross inflows), “flight” and “retrenchment” (sharp increases and decreases, respectively, of gross outflows), Forbes and Warnock (2012) find out that global risk is significantly associated with extreme capital flow episodes. Moreover, contagion, whether through trade, banking, or geography, is also associated with stop and retrenchment episodes, whereas domestic macroeconomic characteristics are generally less important. Agrippino and Rey (2014) find that one global factor explains an important part of the variance of a large cross section of returns of risky assets around the world. They interpret this global factor as reflecting the time-varying degree of market wide risk aversion and aggregate volatility, represented by the VIX, the Chicago Board Options Exchange Volatility Index. On top of that, they show that US monetary policy is a driver of this global factor in risky asset prices, the term spread and measures of the risk premium. Passari and Rey (2015) present evidence on the existence of a global financial cycle in gross cross-border flows, asset prices and leverage and identify the VIX as a suitable proxy for such cycle. This implies that there exist significant spillovers from the US monetary policy on capital flows to the emerging market and developing economies (EMDEs).

Other findings are provided by Ahmed and Zlate (2014), who highlight how growth and interest rate differentials between EMDEs and AEs and global risk appetite are statistically and economically important determinants of net private capital inflows to EMDEs. They also show that there is a positive effect of unconventional US monetary policy on EMDEs inflows, especially portfolio inflows, and that there have been significant changes in the behavior of net inflows from the pre-crisis to the post-crisis period, partly explained by the greater sensitivity of such flows to

¹¹ Notably, the literature has attempted to measure gains from financial integration mainly in two ways: by testing for growth effects and better risk-sharing following financial account opening using either panel data or event studies and by calibrating standard international macroeconomic models and computing gains when going from autarky to financially integrated markets. See Jeanne et al. (2012) for a survey of the related empirical literature. See Kose et al. (2009) for an example of theoretical contribution.

interest rate differentials. Similarly, Ghosh et al. (2014b) find that global factors like US interest rates and VIX play a crucial role in determining capital surges to EMDEs. However, the occurrence and magnitude of a surge towards a particular EMDE also largely depend on domestic factors such as its external financing need, capital account openness, and exchange rate regime. Nonetheless, surges driven by exceptional behavior of liability flows are relatively more sensible to global factors and contagion.

Siemer et al. (2015) study the relationship between stock market volatility as a proxy for uncertainty and capital inflows using panel regressions and a portfolio choice model. They decompose each country's market return volatility into two components: systematic volatility, measured by uncertainty betas, and country-specific volatility. While it is true that capital inflows generally respond to changes in both components, however in countries with higher uncertainty betas capital inflows tend to be more sensitive to risk.

B. The Volatility of Capital Flows

The existing empirical literature dealing with the volatility of capital flows can be classified into two strands¹². On the one hand, some papers focus on analyzing the difference in volatility between the capital flows to emerging and advanced economies. For instance, Rigobon and Broner (2005) show that the higher volatility in EMDEs is primarily due to these economies' propensity to build up mismatches, which generates more persistent shocks and a higher likelihood of international contagion. Similarly, Alfaro et al. (2007) emphasize the importance of domestic factors, such as institutional quality and the soundness of macroeconomic policies, in explaining these volatility differences. Discrepancies between EMDEs and AEs can also be characterized by type of investment. For instance, the gap between the volatility of FDI and portfolio flows is found to be smaller in AEs (Goldstein and Razin (2006)), whereas in EMDEs the share of FDI in total capital inflows is higher (Albuquerque (2003)), as is the volatility of their portfolio flows (Tesar and Werner (1995)).

Other contributions use panel data models to analyze the impact of financial integration on volatility. In this regard, Neumann et al. (2009) show that financial integration tends to increase the volatility of FDI in emerging economies, while reducing that of other debt flows in mature economies. In addition, Bekaert and Harvey (1997), Lagoarde-Segot (2009) and Umutlu et al. (2010), by focusing on prices rather than volumes, conclude that financial liberalization reduces the volatility of stock market returns in emerging economies¹³. In a more recent study, Broto et al. (2011) analyze the determinants of the volatility of various types of net capital inflows to EMDEs, by using annual data over the period 1980-2006. Their main finding is that, since 2000, global factors have become increasingly significant relative to country-specific drivers. However, they also identify some domestic macroeconomic and financial factors that appear to reduce the volatility of certain instruments without increasing that of the others.

¹² Previous theoretical contributions include Bacchetta and Van Wincoop (1998), Aghion et al. (2004) and Martin and Rey (2006).

¹³ See Chuang et al. (2009) and Jinjark et al. (2011) for an analysis of the relationship between stock returns and volumes.

Alberola et al. (2016) investigate the role of international reserves as a stabilizer of international capital flows, in particular during periods of financial distress. They show that international reserves facilitate financial disinvestment overseas by residents. This partially offsets the drop in foreign capital inflows observed in such periods. Moreover, larger stocks of international reserves are linked to higher gross inflows and lower gross outflows.

In a more recent paper, Broner and Ventura (2016) investigate the effects of financial globalization in EMDEs. By emphasizing the role of imperfect enforcement of domestic debts and the interactions between domestic and foreign debts, they show that financial globalization can produce three different outcomes: i) domestic capital flight and ambiguous effects on net capital flows, investment and growth; ii) capital inflows and higher investment and growth; iii) volatile capital flows and unstable financial markets. These effects ultimately depend on the level of development, productivity, domestic savings and the quality of institutions. In this paper we empirically investigate some of these aspects by expanding the work of Broto et al. (2011) to include the GFC period.

IV. VOLATILITY MEASURES

The first way to expand the existing literature consists of building a dataset that features a broader coverage, in terms of both the time period considered and the instruments included. The empirical papers previously cited make use of *annual* data that go until 2010 at latest and do not cover all the different categories included in the balance of payments. Our paper uses quarterly data, spanning from 1970Q1 to 2016Q1, and encompasses a wider set of capital flows instruments¹⁴. These features allow us to carry on a more in-depth analysis of how volatility has evolved both over time, across countries and across instruments. In addition, while current literature has focused on the capital flow slowdown witnessed since 2012 (IMF, 2016), our updated data sheds light on how capital flow volatility has evolved since then.

A. Methodology

In order to produce reliable estimates of capital flow volatility, we consider three approaches, building on Engle et al. (2005) and Broto et al. (2011):

1. *Standard deviations over a rolling window*

This consists of the standard deviation of capital flows computed over a rolling window as follows:

$$\sigma_{it} = \left(\frac{1}{n} \sum_{k=t-(n-1)}^t (flow_{ik} - \mu)^2 \right)^{1/2},$$

¹⁴Refer to the appendix for a list of countries included in the sample and a list with variables, time coverage and sources.

where $\mu = \frac{1}{n} \sum_{k=t-(n-1)}^t flow_{ik}$ and $flow_{ik}$ denotes capital flows in country i in period k . In these computations, $n = 4$ quarters.

As mentioned in Broto et al. (2011), there are some caveats associated to this measure:

- a) there is a loss of data at the beginning of the sample, whose entity depends on the window length (n);
 - b) σ_{it} is strongly persistent and this might entail problems of endogeneity and serial correlation;
 - c) the same weights are assigned to $flow_{i(t-1)}$ and $flow_{i(t-n)}$, which overly smooths volatility. As a result, volatility might be underestimated when a shock takes place and overestimated thereafter, compared to other measures.
2. ***Estimated standard deviations produced by a GARCH(1,1) model***

The second alternative measure makes use of estimated conditional volatilities of a GARCH(1,1) model. The process is defined as follows:

$$y_{it} = \varepsilon_{it} \sigma_{it}$$

$$\sigma_{it}^2 = \alpha_0 + \alpha_1 y_{i(t-1)}^2 + \alpha_2 \sigma_{i(t-1)}^2,$$

where $y_{it} \equiv \Delta flow_{it}$, ε_{it} is a Gaussian white noise process and σ_{it}^2 is the corresponding conditional variance.

Even this measure, however, is not completely free of drawbacks. Notably:

- a) data scarcity might lead to convergence errors;
 - b) Maximum-Likelihood estimates for small samples contain biases;
 - c) stationarity and positivity of estimates require that $\widehat{\alpha}_1 + \widehat{\alpha}_2 < 1$, $\widehat{\alpha}_0 > 0$, $\widehat{\alpha}_1 > 0$ and $\widehat{\alpha}_2 > 0$. If these conditions are violated for some country i , then the model fails to produce valid estimates for that country;
 - d) in some cases, the residuals do not present ARCH effects and that makes the GARCH model not suitable.
3. ***Estimated standard deviations produced by an ARIMA(1,1,0) model***

The third estimator is given by the standard deviation of the residuals obtained after fitting an ARIMA(1,1,0) to the data¹⁵. Notably, you first estimate the residuals from the following AR(1) process:

$$\Delta flow_{it} = c + \beta \Delta flow_{i(t-1)} + v_{it}$$

Then, a test is performed to detect the presence of any ARCH effects in the residuals. If the null hypothesis of heteroscedasticity is rejected, then:

$$\sigma_{it}^2 = \frac{1}{4} \sum_{j=t-(n-3)}^{t+(n-2)} (v_{ij})^2$$

¹⁵ The choice of the AR and the MA orders is suggested by the relevant literature, while the degree of differencing is set equal to 1 as the data series of interest are integrated of order one ($\sim I(1)$).

otherwise conditional volatility is estimated by fitting a GARCH(1,1) model to the residuals.

The heteroscedasticity checks on the ARIMA residuals constitute a deviation from the reference literature, as we deem this further step to be helpful in improving the robustness of the resulting estimates vis-à-vis possible misspecifications. Moreover, this procedure is useful in addressing the shortcomings related to the GARCH(1,1) procedure explained above.

B. Evolution of Volatility over Time

Using the volatility estimates from the three measures, this section considers how the volatility of capital flows has evolved over time. We first look at the aggregate flows both globally and for AEs and EMDEs separately¹⁶. We then study the evolution of volatility for the single components of gross inflows in EMDEs only.

Total flows

When discussing volatility, policy makers are interested in both the levels as well as the changes in volatility. Using our measures, we shed light on both aspects in this section.

Figures 4a, 5a and 6a show the evolution of volatility of net flows for World, AEs and EMDEs respectively, using the three different measures. As discussed in section IV.A, the charts clearly show that RW underestimated the spike in volatility at the onset of the crisis and overestimated the fall in volatility following the end of the crisis. This underscores the need for going beyond the crude RW measure and finding more accurate ones. Comparing the three measures, the GARCH estimates tend to lag slightly behind the RW and the ARIMA, and are on average higher than the estimates produced by the other two approaches. However, broadly speaking, the three estimates show similar results.

Comparing the levels of volatility across income groups, the charts suggest that net flows to EMDEs are more volatile than net flows to AEs. As discussed in the previous section, gross outflows tend to dampen the impact of gross inflows on net flows in AEs but not in EMDEs, resulting in higher volatility for net flows in EMDEs compared to AEs. Looking at the volatility of gross inflows and gross outflows in EMDEs separately, Figures 6b and 6c show that the volatility of inflows is on average higher than outflows, thereby driving up the volatility of net flows.

¹⁶ In this section, the aggregates represent total capital flows divided by total GDP. As a robustness check, volatility estimates have been computed for weighted aggregate capital flows series, using two different sets of weights. Notably, the first set is given by domestic GDP as a share of group GDP, while the second consists of each country's International Investment Position (IIP), measured as the sum of assets and liabilities, divided by the group's IIP. The series are available upon request. The final results are not qualitatively different from the outcome observed for unweighted data.

An interesting question is how the volatility has fared since the GFC, especially in EMDEs. The charts show that, barring several spikes in AEs and EMDEs, the biggest one corresponding to the GFC, the current level of volatility is comparable to the pre-crisis average. However, EMDEs volatility has been prone to bouts, as it has risen during global risk off episodes. In particular, the volatility spiked up during the taper tantrum episode. These bouts of increase in volatility thus remain a policy challenge for EMDEs, particularly in the current context of capital flows slowdown (IMF 2016), where even small swings in flows can lead to substantial net outflows or sudden stops. In fact, when adjusted for the level of flows, volatility has either increased or stayed at the same pre-crisis levels (Appendix D) and, hence, remains a major concern.

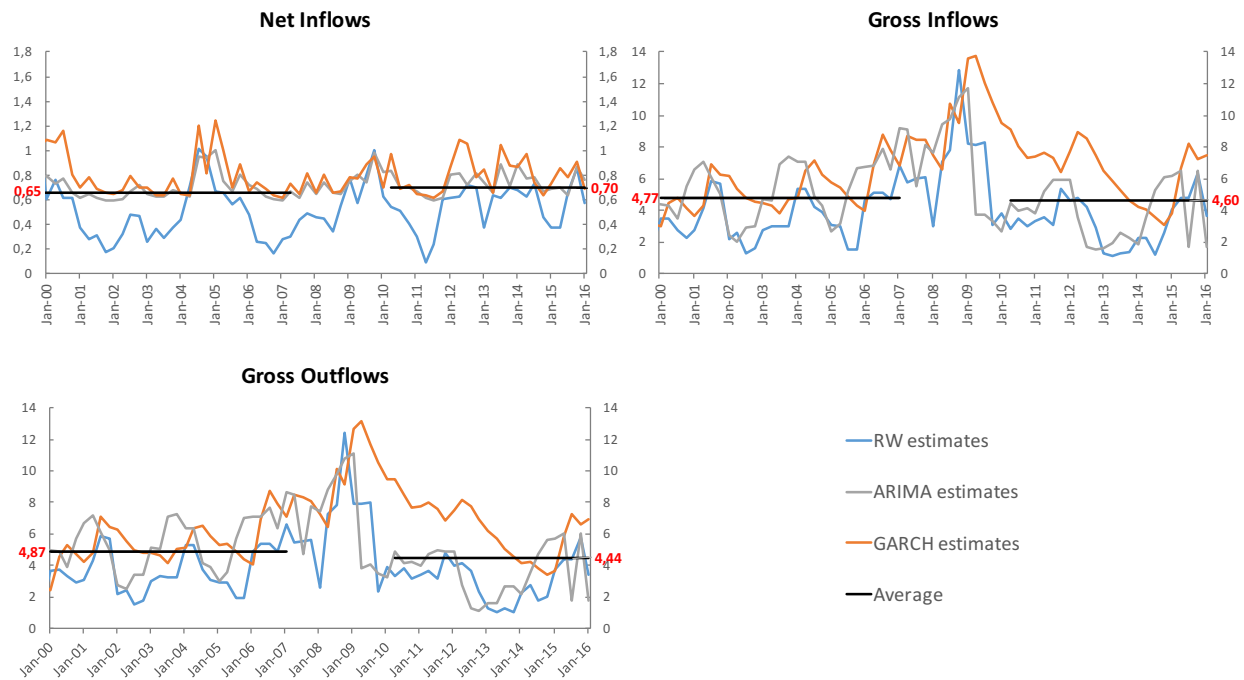


Figure 4: Evolution of the volatility of capital flows for the World aggregate. *Notes:* Measures are expressed as % share of total GDP. Source: IMF, *International Financial Statistics*, authors' computations.

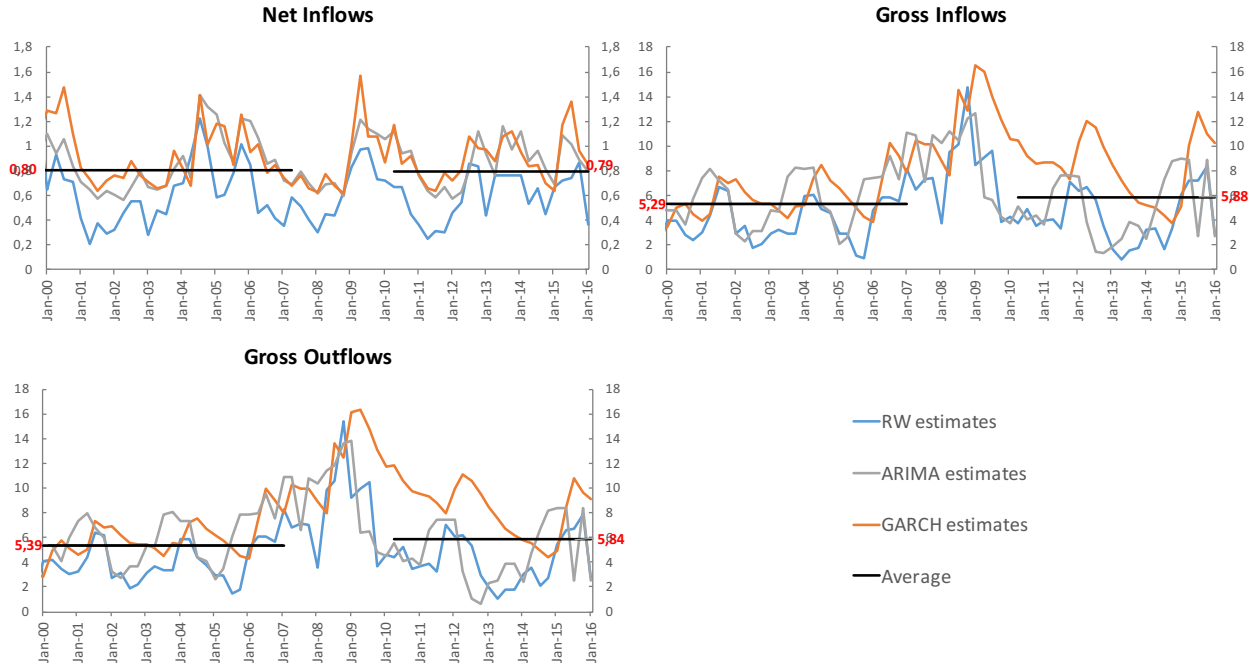


Figure 5: Evolution of the volatility of capital flows in AEs. *Notes:* Measures are expressed as % share of total GDP. Source: IMF, *International Financial Statistics*, authors' computations.

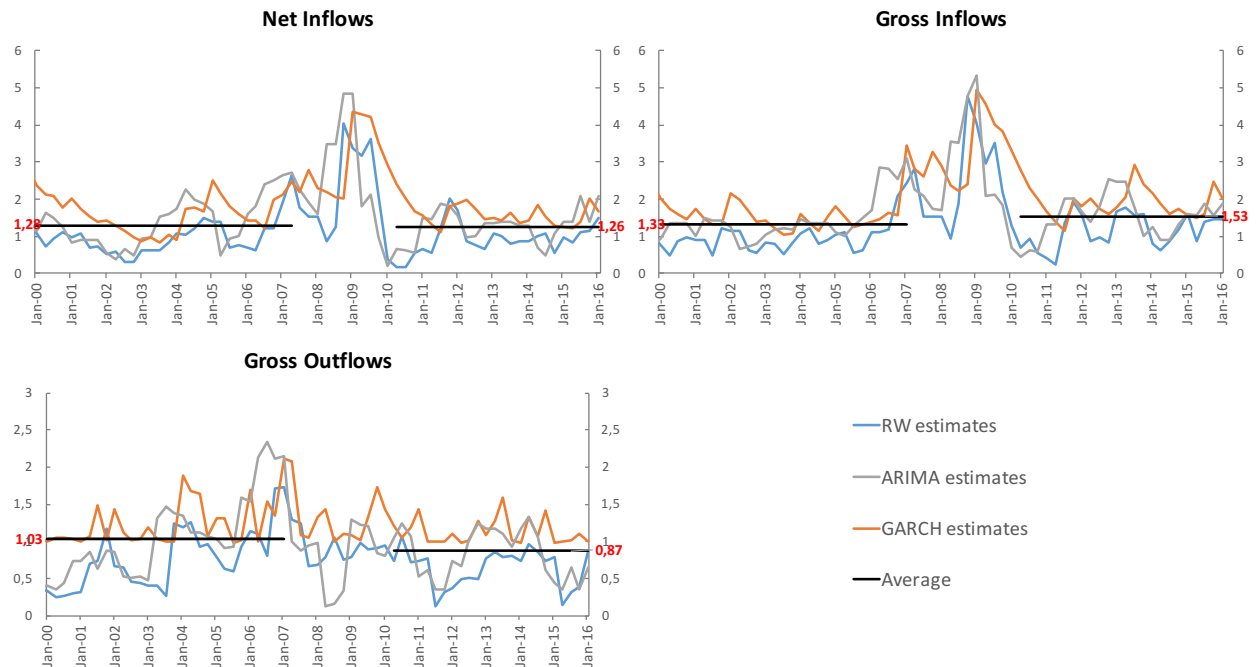


Figure 6: Evolution of the volatility of capital flows in EMDEs. *Notes:* Measures are expressed as % share of total GDP. Source: IMF, *International Financial Statistics*, authors' computations.

Given its size, China could have an impact in the overall capital flows volatility of EMDEs. Charts in Appendix F display the volatility of capital flows over time for World and EMDEs, excluding China. Broadly speaking, the evolution is not very different when China is excluded. However, the increases in volatility observed more recently are not as pronounced. The subsequent charts in Appendix F show that this discrepancy is associated with the volatility of other instruments.

Statistical tests

We perform some tests to detect whether the mean value of the estimates has significantly changed after the GFC compared to the pre-crisis period. Table 2 reports the results for the Geweke's separated partial means test performed over three groups (global, AEs and EMDEs) and the three different measures¹⁷.

Table 2 shows that the null hypothesis of equal mean values before and after the crisis¹⁸ is almost always rejected at 5% or 10% significance levels, indicating that there has been some shift in volatility, albeit very small in magnitude, since the GFC. There are, however, some results that show no statistical difference in mean values, notably for net flows in World (RW measure) and net flows in AEs (GARCH estimator). The same holds for the GARCH volatility of both gross and net inflows in EMDEs.

	RW			GARCH			ARIMA		
	GIs	GOs	NIs	GIs	GOs	NIs	GIs	GOs	NIs
<i>Global</i>									
Statistic	9,18	6,83	1,19	62,44	53,39	3,66	20,36	15,27	3,05
P-value	0,00	0,01	0,28	0,00	0,00	0,06	0,00	0,00	0,08
<i>AEs</i>									
Statistic	20,99	21,04	15,17	79,31	86,76	0,68	17,69	17,61	6,88
P-value	0,00	0,00	0,00	0,00	0,00	0,41	0,00	0,00	0,01
<i>EMDEs</i>									
Statistic	7,89	15,84	24,60	0,99	12,38	0,06	6,51	15,10	27,76
P-value	0,00	0,00	0,00	0,32	0,00	0,80	0,01	0,00	0,00

Table 2: results of the Geweke's separated partial means test for World, AEs and EMDEs aggregates, RW, GARCH and ARIMA volatility estimates. *Notes:* GIs: Gross Inflows; GOs: Gross Outflows; NIs: Net Inflows. Statistics are based on two separate means ($p=2$) and covariance functions tapered at 2%; the limiting distribution is a chi-squared with 1 dof; H_0 : means are equal, H_1 : means are different.

¹⁷ Refer to Geweke (2005). This test allows us to control for autocorrelation in the volatility estimates (see Appendix C).

Therefore, conclusions about evidence of a decrease or increase in volatility owing to the GFC depend on the type of flows targeted by the analysis and the methodology adopted. Broadly speaking, however, we can say that, in the aftermath of the financial crisis, EMDEs have experienced an *increase* in the volatility of gross inflows and a *decrease* in the volatility of gross outflows, on average by 0.2% and 0.16% of GDP respectively. These two effects have concurred to slightly decrease the volatility of net inflows by an average of 0.02% of GDP.

Individual components¹⁹

Figure 7 shows the evolution of volatility for individual components of EMDEs gross inflows. Portfolio and other investment flows are around two and four times, respectively, more volatile than FDI. Among portfolio flows, portfolio debt is more volatile than portfolio equity. These results are in line with literature showing that equity flows, both FDI and portfolio equity, are generally less volatile.

Looking at the evolution of each instrument, the volatility estimates for FDI present a clear-cut upward trend before the GFC and a downward trend afterwards, particularly for GARCH and ARIMA estimates. For portfolio, GARCH and ARIMA estimates are higher than RW. Broadly speaking, there is not a defined trend and estimates tend to hover around the long-run averages. However, the volatility for this instrument is lower in the subsample 2009-2016. As to portfolio equity, the ARIMA and RW estimates highlight a slight upward trend for volatility until the GFC and a downward trend thereafter. Finally, other investments display the highest volatility estimates among all instruments. Even in this case, GARCH produces higher values than the other approaches.

The volatility of individual components can help track down the dynamics underlying the evolution of volatility of total capital flows. Figure 8 plots the ARIMA estimates of total inflows and the individual components. The increase in volatility is, broadly speaking, driven primarily by the increase in the volatility of other investments, followed by the volatility of portfolio instruments (debt primarily). In the next section, we analyze in detail the volatility of the *subcomponents* of other investments.

Even if, in certain cases, volatility seems to have declined over time, the results can be different when estimated are adjusted by the levels. In particular, though net FDI volatility has gone down significantly for EMDEs, it is rising when adjusted for the levels (Appendix D, Figures 1 and 2). Similarly, net portfolio adjusted volatility has also increased in more recent periods.

¹⁹ We focus here on gross inflows only, as they are the most relevant in EMDEs. Measures for gross outflows and net inflows, however, are available upon request.

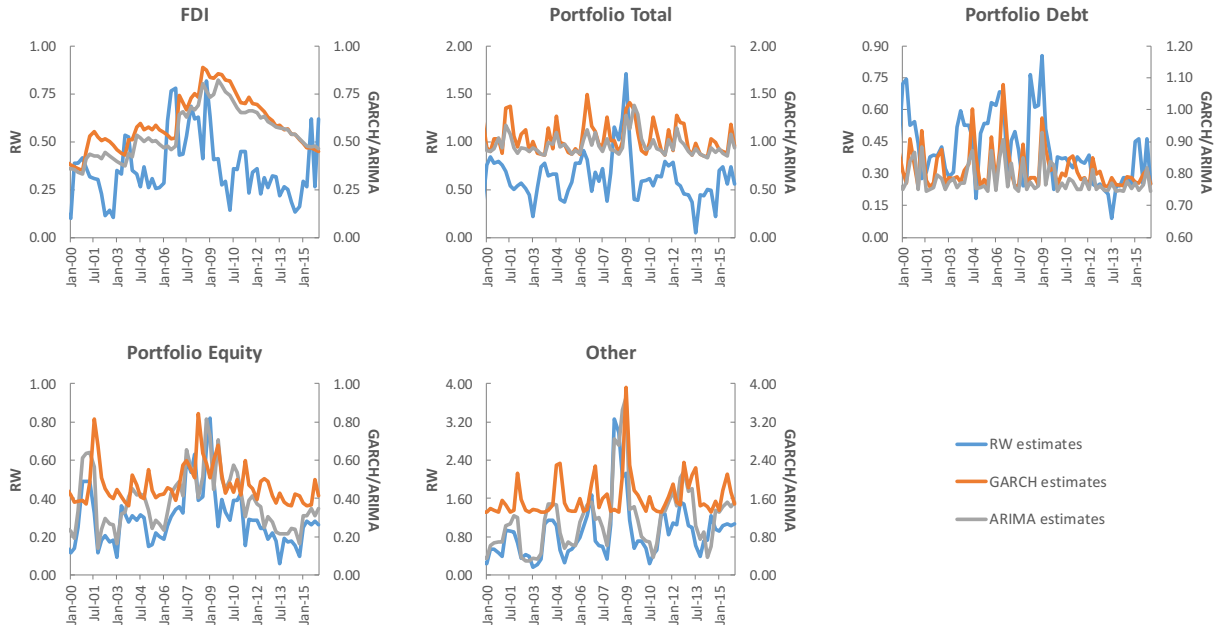


Figure 7: Evolution of the volatility of gross capital inflows for EMDEs *by components*. Note: measures are expressed as % of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

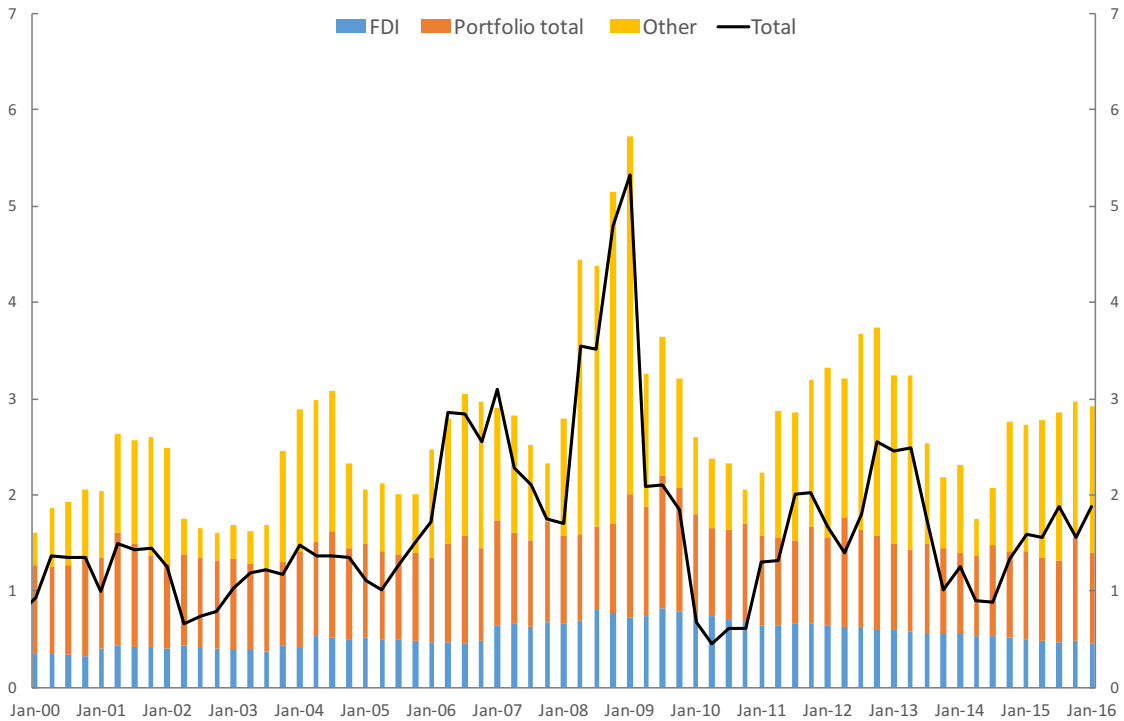


Figure 8: Evolution of the ARIMA volatility estimates of aggregate gross capital inflows and their components in EMDEs. *Notes:* measures are expressed as % of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

Statistical tests

	FDI	portfolio	Port. debt	Port. equity	Other
<i>RW</i>					
Statistic	153,78	4,18	17,06	1,90	10,76
P-value	0,00	0,04	0,00	0,17	0,00
<i>GARCH</i>					
Statistic	136,40	2,60	5,99	2,99	5,06
P-value	0,00	0,11	0,01	0,08	0,02
<i>ARIMA</i>					
Statistic	233,30	2,86	4,52	3,21	13,81
P-value	0,00	0,09	0,03	0,07	0,00

Table 3: results of the Geweke's separated partial means test for EMDEs gross inflows, RW, GARCH and ARIMA volatility estimates. *Notes:* Statistics are based on two separate means ($p=2$) and covariance functions tapered at 2%; the limiting distribution is a chi-squared with 1 dof; H_0 : means are equal, H_1 : means are different.

Table 3 reports the partial means test results for gross inflows in EMDEs, broken down by instruments. While the null hypothesis of equal means is rejected for FDI, portfolio debt and other investments across all the estimators, the volatility of portfolio inflows (GARCH) and the volatility of portfolio equity flows (RW) have means that are not statistically different before and after the GFC. Using ARIMA estimates, we can conclude that, in the aftermath of the financial crisis, EMDEs have experienced a change in the volatility of FDI, portfolio and other investments, on average, by 0.086%, -0.014% and 0.249% of GDP respectively.

Delving Deeper into Other Investment Flows

Even though other investments are, on average, smaller in levels than equity instruments like FDI, the previous section shows that they are very relevant in determining the volatility developments for capital inflows to EMDEs. Hence, this section looks in detail at the individual components of other investment flows. Notably, other investment flows can be classified in: i) bank flows; ii) private non-bank flows; iii) official sector flows.

Composition of Other Investment Flows

Before discussing the volatility measures, Figure 9 depicts the evolution of other gross inflows and shows their composition (in levels), by disentangling between flows to the public sector and flows to the private sector. Private flows - which make up most part of the aggregate other flows - reversed and experienced a temporary stop during the GFC, which resulted in the sudden stop of aggregate gross inflows to EMDEs over the same period. After the GFC, the level of flows to private sector appears markedly lower than before, with two episodes of reversal experienced in 2015 and 2016. This behavior broadly coincides with the general slowdown in aggregate capital flows to EMDEs after the crisis.

Figure 10 shows the evolution of other gross inflows by decomposing the flows to private sector in flows to banks, flows to non-banking companies and unclassified private flows. The latter are basically flows to countries for which data are not classified between banking and non-banking sectors. Before the crisis, most of other flows consisted of private flows to both banking and non-banking sectors, which contributed to the surge of gross capital inflows to EMDEs over the same period. On the other hand, after the GFC, both these types experienced a sudden stop and, in certain periods, they almost disappeared from the capital account (e.g. in the second half of 2009). After the GFC, unclassified private flows have started to become more prominent, to the point that they have been the major driver of the two contractions in 2015 and 2016. Figure 11, which splits the generic aggregate by individual countries, shows that unclassified private flows are basically given by investments to China.

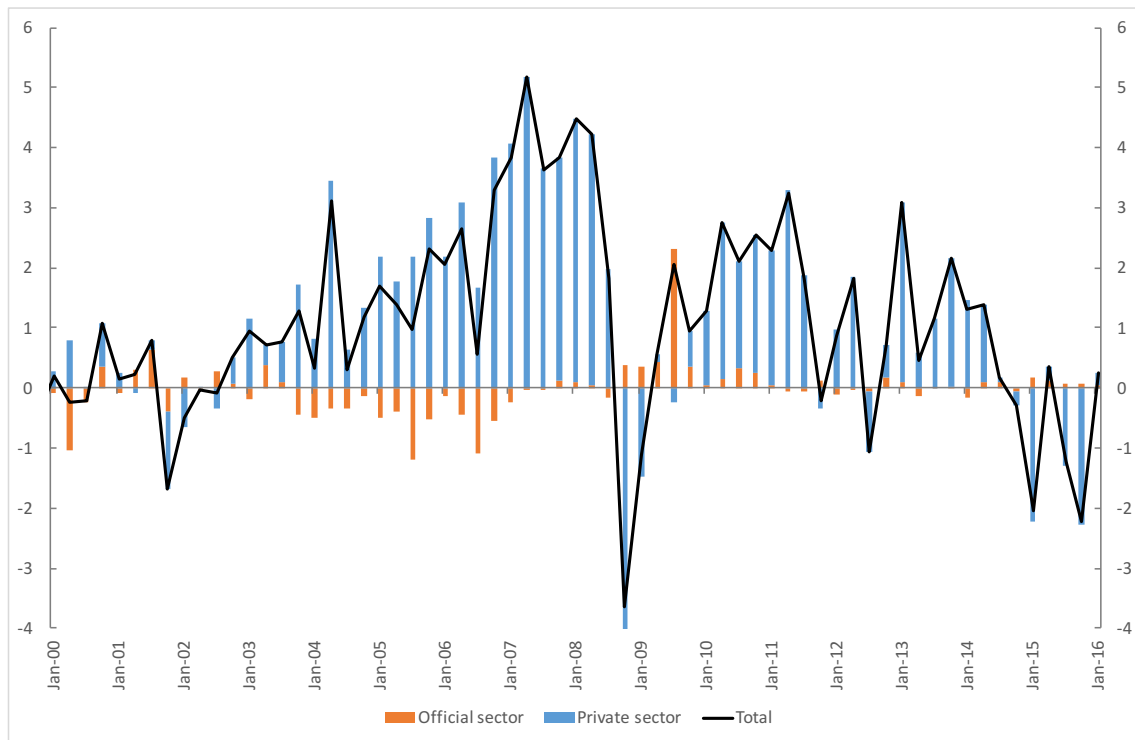


Figure 9: Other gross capital inflows in EMDEs *by sector*. *Notes:* measures are expressed as % share of group GDP; private sector flows are the sum of banking flows and flows to non-banking companies. Source: IMF, *International Financial Statistics*, authors' computations.

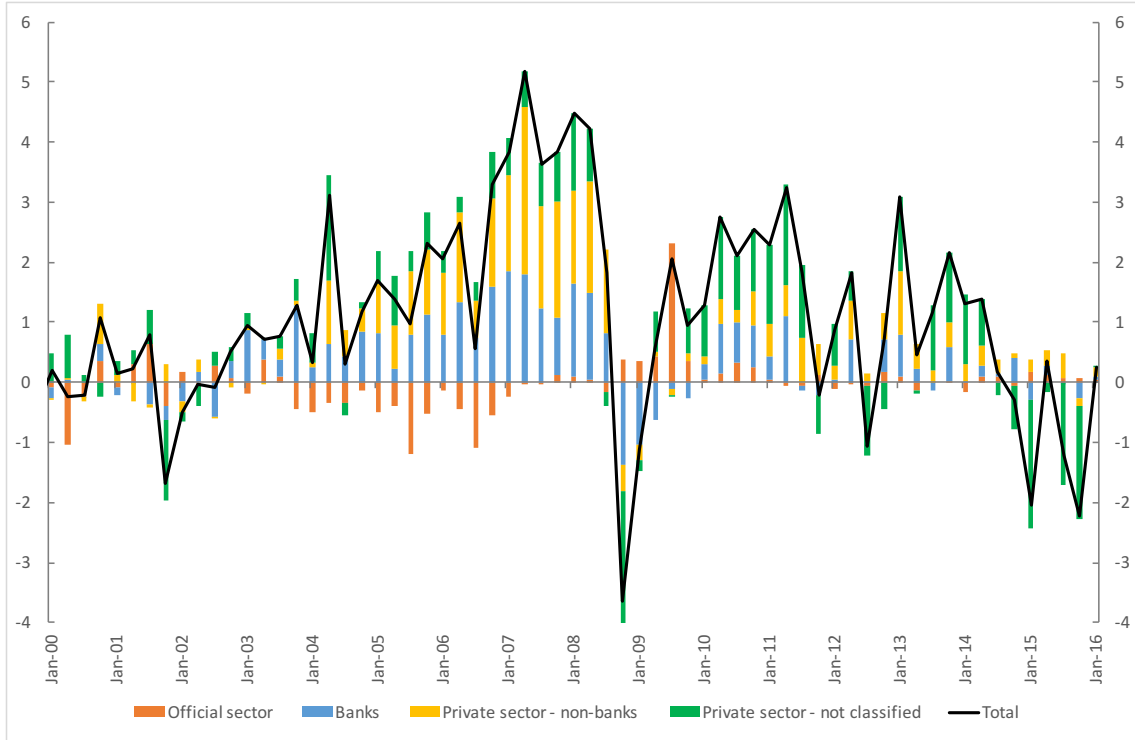


Figure 10: Other gross inflows in EMDEs by sector. Notes: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

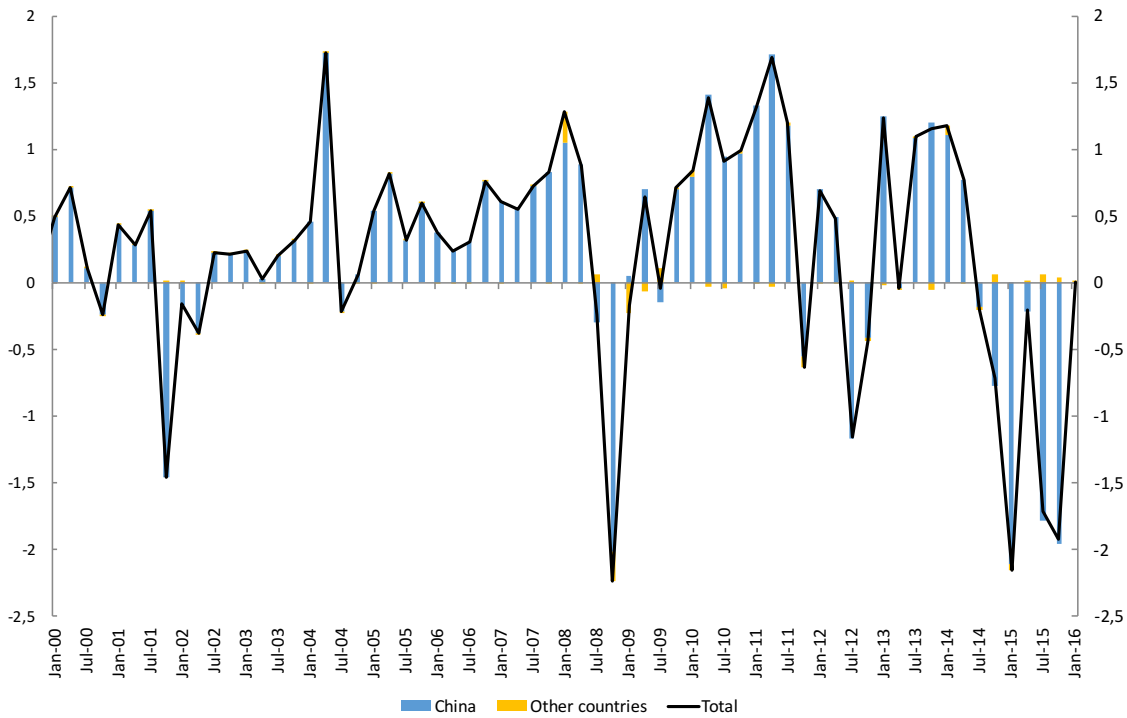


Figure 11: Not classified other gross private inflows by country. Notes: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

Volatility of Other Investment Flows

Figure 12 below shows the evolution of volatility for the other gross inflows²⁰ broken down by their subcomponents. It can be noticed that the volatility of private flows is much higher than the volatility of flows through the official sector. The latter, indeed, after a spike during the crisis, has stabilized around a level which is close to 0.

In the private sector, flows to banks display a slight decrease towards the end of the time period considered, while the volatility of flows to the non-banking sector has stabilized around a lower long-run average after the crisis. All in all, we can say that the volatility of other investments is almost completely driven by the volatility of private flows and, for these latter ones, volatility is equally distributed across the banking and non-banking sectors.

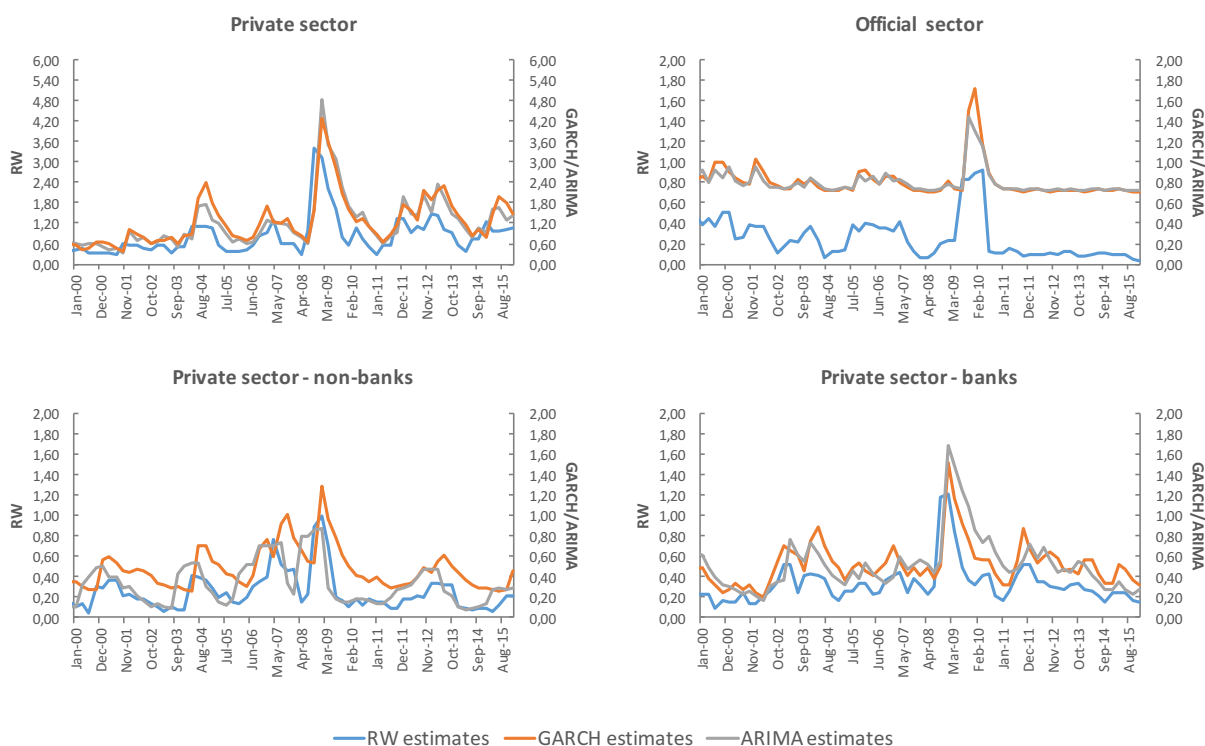


Figure 12: Volatility estimates for other gross capital inflows in EMDEs *by components*. *Notes:* measures are expressed as % share of group GDP; aggregates for flows to the banking and non-banking sector do not include China. Source: IMF, *International Financial Statistics*, authors' computations.

Composition and Volatility of Other Investment Flows to EMDEs, excluding China

Composition. Figures 3 and 4 in Appendix E display the composition for other flows in EMDEs once China has been removed from the sample. The proportions of overall other inflows accounted for by official and private sectors is not that different, but for the period 2015-2016. However, the magnitude of flows as a share of total GDP is higher in the pre-crisis period and lower after the

²⁰ Estimates for net inflows and gross outflows are available upon request.

GFC, compared to earlier results. This suggests that other investments to China is one of the main drivers of the episodes of stops registered in 2015 and 2016.

Volatility. From Figure E6 it seems that the volatility of flows to the private sector is lower when China is removed from the sample. In spite of this, the volatility of flows to the non-banking sector is higher and displays much more variation. Conversely, the downward trend detected in the last part of the sample for bank flows is not there anymore. However, data for the private flows to China are not classified into flows to banking and non-banking sectors and this impedes us to establish whether the evidence observed is imputable to Chinese banks or other types of private companies.

C. Volatility Measures for Individual countries

Given what was already explained in section IV.A, the ARIMA methodology is more reliable and robust than the other measures. Furthermore, the previous section has also showed how the three approaches produce estimates that are very similar across different types of flows and instruments. The analysis carried out in the remainder of the paper, then, will be based on the ARIMA estimates only.

Apart from computing volatility of aggregate series, the same three measures are used to calculate the volatility for the individual EMDE countries. The volatility measures of individual countries are useful for several reasons. First, they can be important tools in policy discussions related to understanding and mitigating undesirably high volatility in a particular country. Second, the volatility measures of single components will inform policymakers about which instruments they should monitor more closely. Third, these measures can be extremely useful in studies and research geared towards understanding and comparing volatility across countries and regions, as they can shed light on the instruments responsible for possible shifts in volatility. Fourth, as shown in our subsequent analysis, the estimates of individual countries can help understand the relationship between EMDEs and AEs capital flow volatility, as well as the determinants of EMDEs capital flow volatility.

Figure 13 shows the median values of volatility estimates for each country by instruments for gross inflows²¹. The green bar represents the median value for each group. As expected, median volatility is higher for portfolio flows than other types, in line with the findings witnessed for aggregate series. The median variance of overall portfolio flows is lower than the sum of variances of portfolio debt and portfolio equity flows, suggesting that there might be a negative correlation between these two subcategories. These charts also highlight the presence of a great degree of heterogeneity across countries, that is concealed when looking at the trend of aggregate flows. Moreover, this exercise allows us to understand whether the results at the aggregate level are driven by outliers. For instance, while the conclusion that, *on median*, portfolio flows are much more volatile than FDIs, however there are some countries (e.g. Chile) whose FDIs are much more volatile than Portfolio inflows, or for which, at least, the volatility measures are of comparable magnitude across the two instruments (e.g. Latvia and Kazakhstan).

²¹ The underlying time series for each country is available upon request. In addition, the time series for volatility of net and gross outflows for each country are also available upon request.

In addition, Figure 14 displays the empirical distributions of the median volatilities for each instrument. The density functions of the median volatilities are a mixture of multiple distributions and this suggests the presence of important outliers in the series, something which is also underlined by the positive skewness and the high kurtosis of the density functions²². In particular, the distributions of median volatilities for portfolio and portfolio debt are shifted to the right, compared to the other ones, indicating how median volatilities are generally higher for these types of instruments. Moreover, the kurtosis of the same distributions is the highest among all the instruments (closely followed by other investments). This indicates that the probability of observing extreme values (outliers) is greater in these cases than for FDI or Portfolio Equity, making the aggregate results more prone to be influenced by extreme observations.

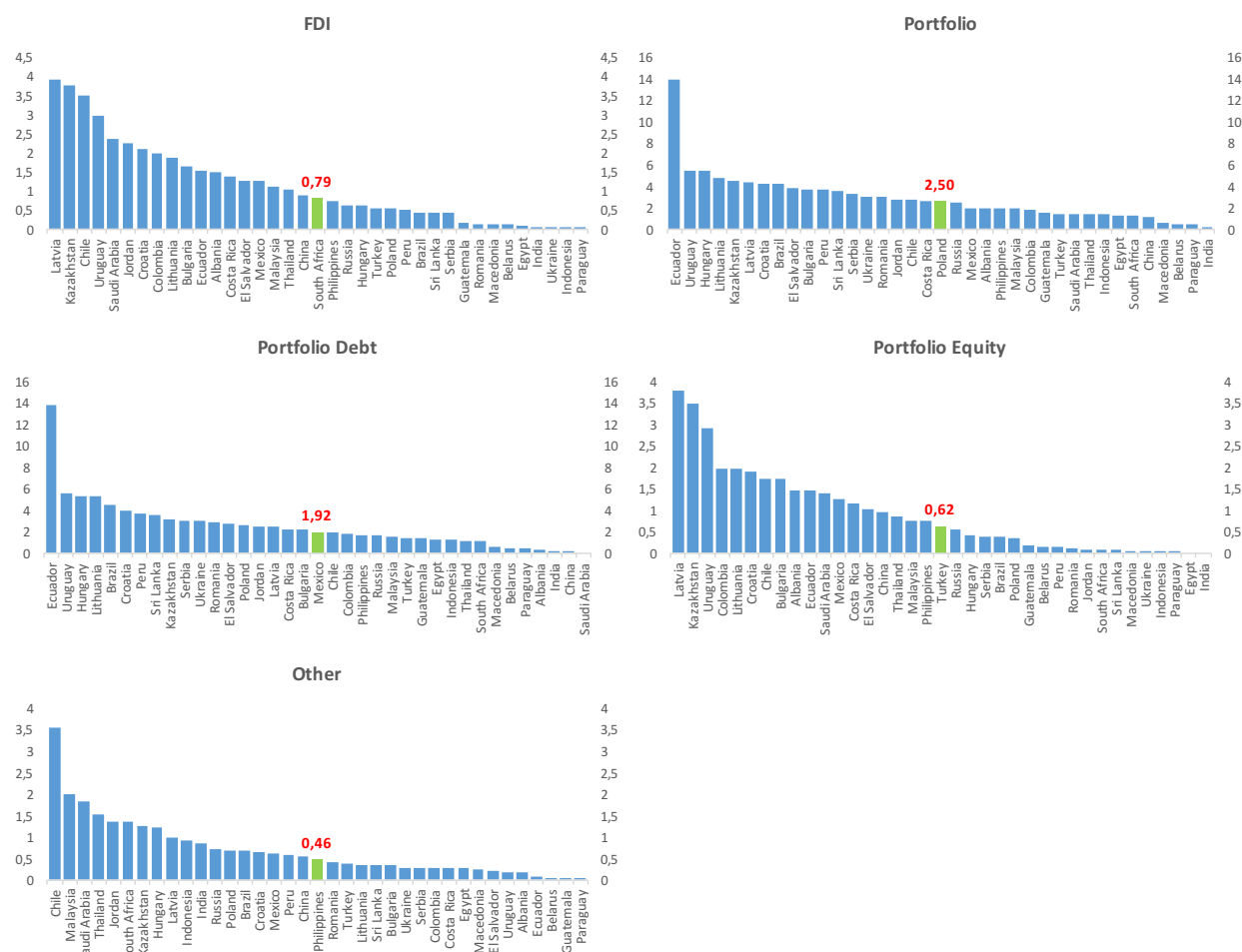


Figure 13: Medians of ARIMA volatility estimates for gross inflows by instrument and across countries. Notes: measures are expressed as % of GDP. Source: IMF, *International Financial Statistics*, authors' computations.

²² The skewness values are 1.0770, 2.8565, 2.8875, 1.2858, 2.1120 for FDI, portfolio, portfolio debt, portfolio equity and other investments respectively. The kurtosis values are 3.3431, 14.3172, 14.0942, 4.1295 and 8.5991 for FDI, portfolio, portfolio debt, portfolio equity and other investments respectively.

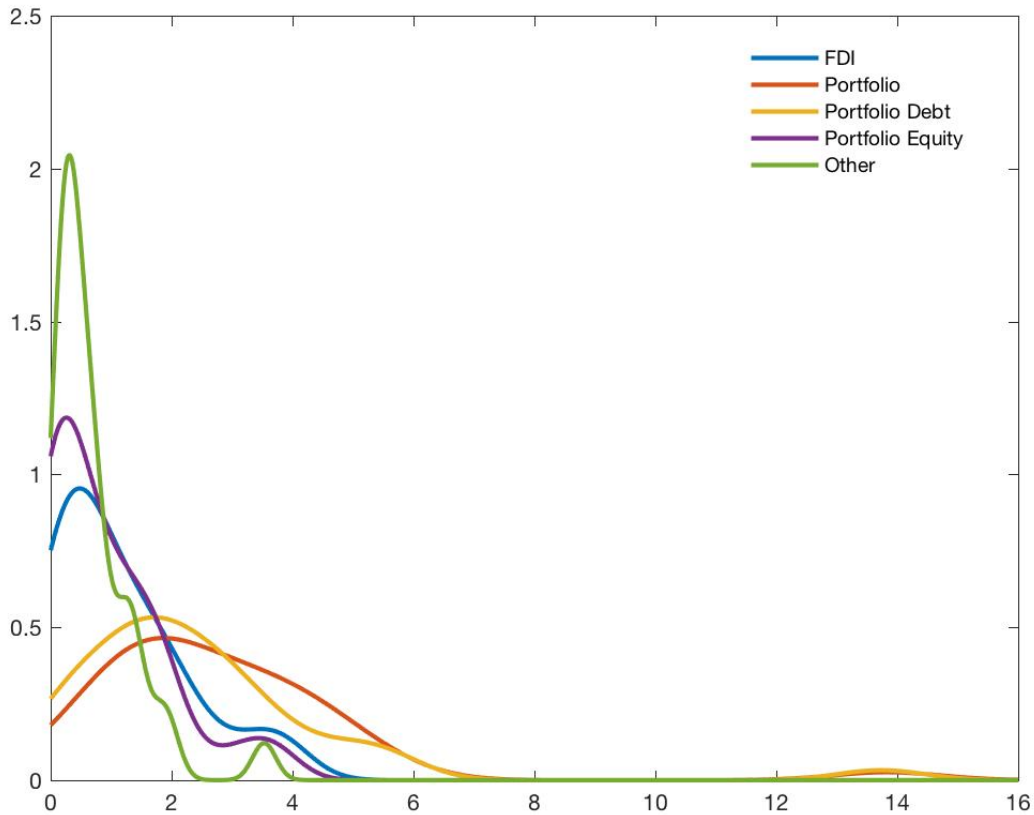


Figure 14: Cross-sectional Empirical Probability Density Functions of median ARIMA volatility estimates for gross inflows *by instrument*. Source: IMF, *International Financial Statistics*, authors' computations.

Figure 14 provides a *static* picture of how median volatility is distributed across countries. In order to get a better sense of how capital flows volatility can react to global shocks and how risk is redistributed across regions thereafter, Figures 15-20 display a heat map for the ARIMA volatility estimates before and after the GFC, for gross inflows and other gross private inflows, across all the countries (AEs and EMDEs) in the sample²³.

²³ We just display results for these two types, because, as already mentioned previously, gross inflows are the main components of the financial account of EMDEs, while other investments essentially drove the capital flows slowdown in the aftermath of the GFC. However, charts for other types of flows and instruments are available upon request.

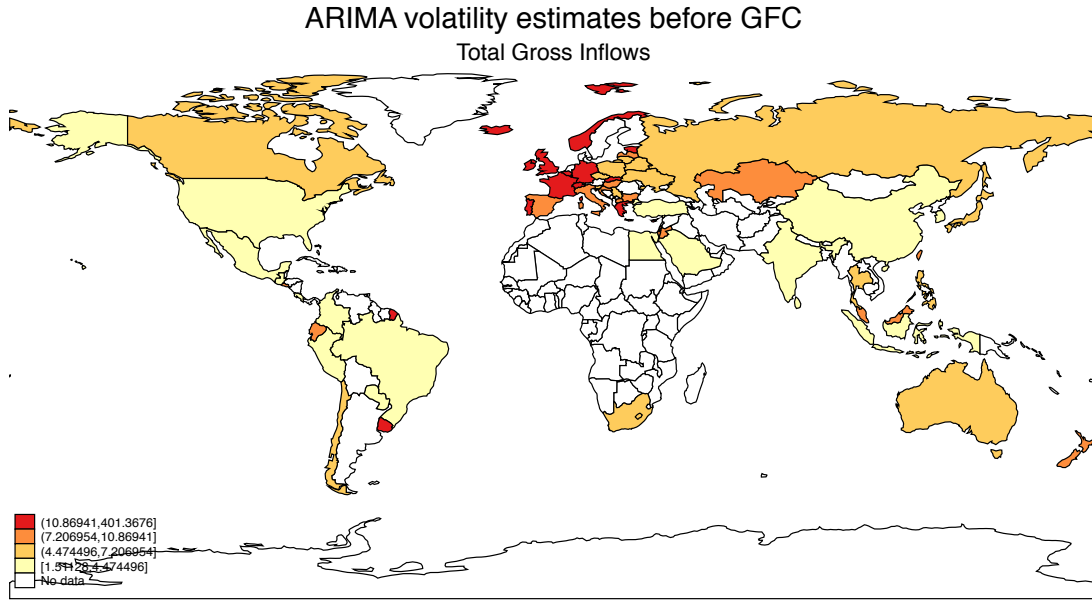


Figure 15: ARIMA volatility estimates for gross inflows *by country* over the period 2000Q1-2007Q2. Source: IMF, *International Financial Statistics*, authors' computations.

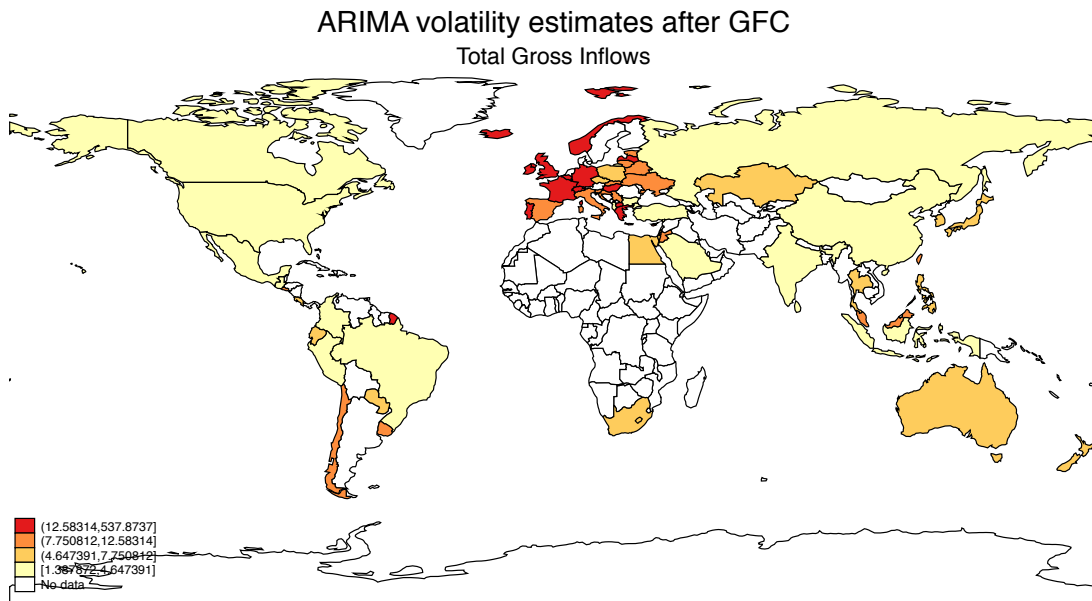


Figure 16: ARIMA volatility estimates for gross inflows *by country* over the period 2009Q3-2016Q1. Source: IMF, *International Financial Statistics*, authors' computations.

The heat maps suggest that the volatility of total gross inflows has remarkably decreased since GFC in countries like Canada and Russia, as well as the smaller Latin America economies. On the other hand, it has increased Eastern European economies, Kazakhstan, Egypt and New Zealand. Although the rough visual comparison across the pre and post-crisis periods does not seem to display much change, it can be noticed from the boundary values that define the intervals (in the legend) that there has been an upward shift in the entire distribution, meaning that the median

value of volatility in the sample has increased over time. So, in spite of few single-case exceptions, we can say that, on average, volatility of gross inflows has increased after the GFC²⁴.

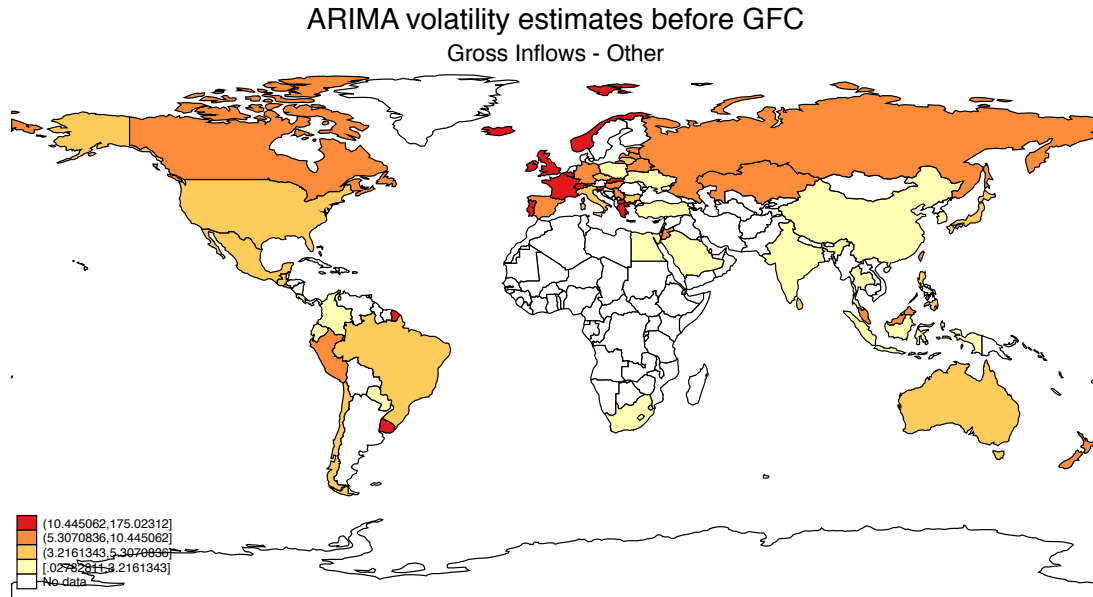


Figure 17: ARIMA volatility estimates for other gross inflows *by country* over the period 2000Q1-2007Q2. Source: IMF, *International Financial Statistics*, authors' computations.

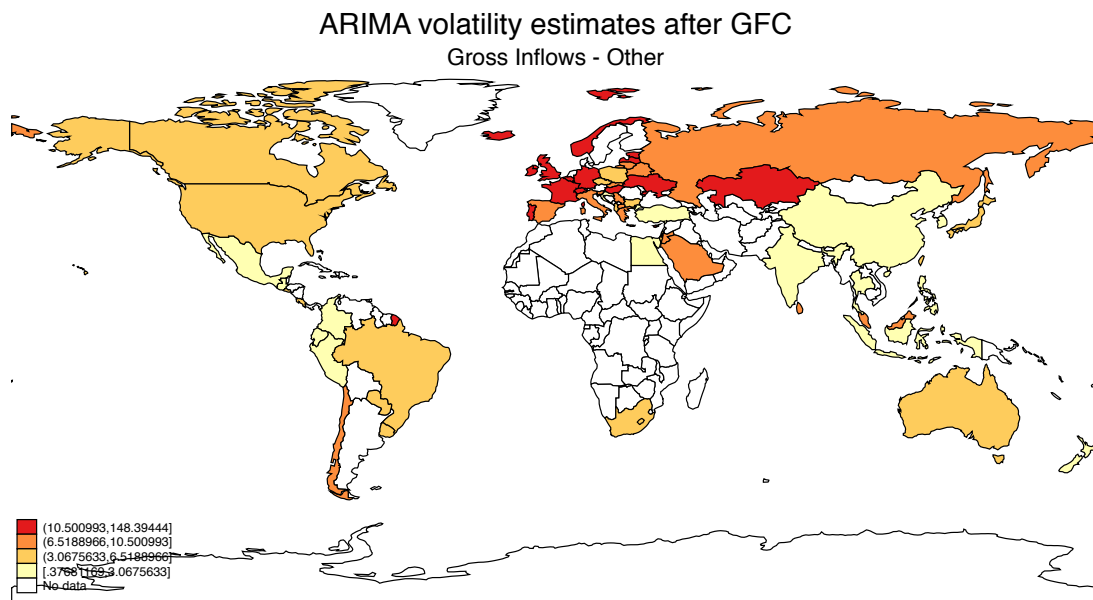


Figure 18: ARIMA volatility estimates for other gross inflows *by country* over the period 2009Q3-2016Q1. Source: IMF, *International Financial Statistics*, authors' computations.

²⁴ This conclusion holds also if outliers are excluded from the sample.

Comparing the pre and post-GFC periods, the volatility of other investment has somewhat decreased in several American economies, with the exception of Chile, while it has remarkably increased in Europe. In Asia, the picture does not seem to have changed at all, except for Kazakhstan, whose other inflows volatility has moved to the top end of the distribution compared to the other economies.

From this, we might infer that the slowdown in capital flows observed since the GFC has predictably decreased their volatility as well in certain areas of the world, while the observed increase in other regions might be related either to some region-specific shocks that did not take place elsewhere (e.g. the Euro Area debt crisis) or to other exogenous shocks that were likely to affect only some countries and not the others (e.g. shocks to commodity prices played a major role for small commodity-exporting economies like Chile, Ecuador, Kazakhstan and Saudi Arabia).

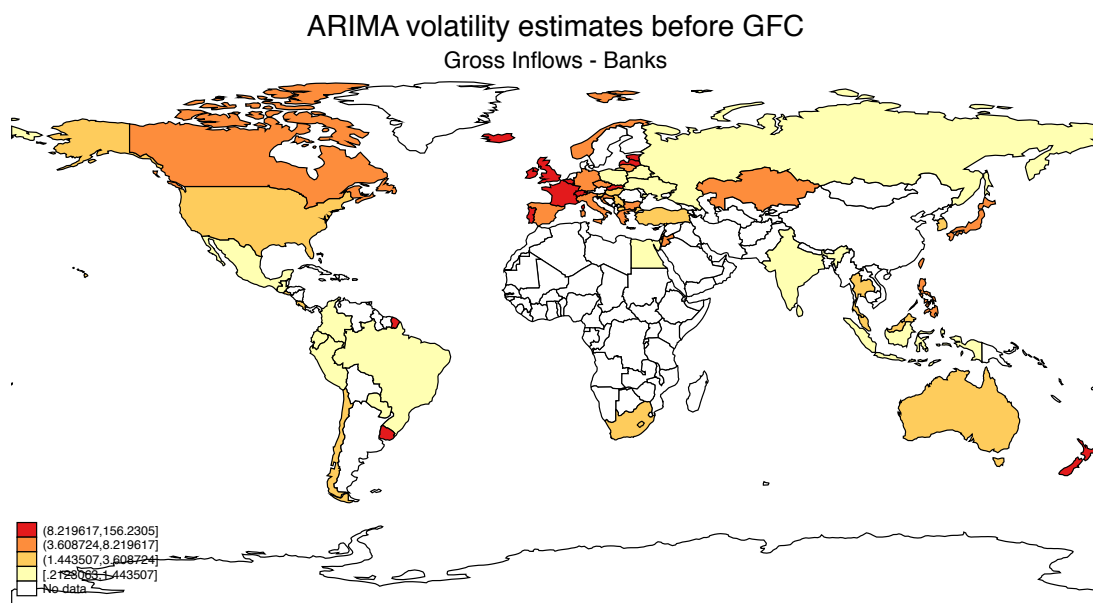


Figure 19: ARIMA volatility estimates for bank gross inflows *by country* over the period 2000Q1-2007Q2. Source: IMF, *International Financial Statistics*, authors' computations.

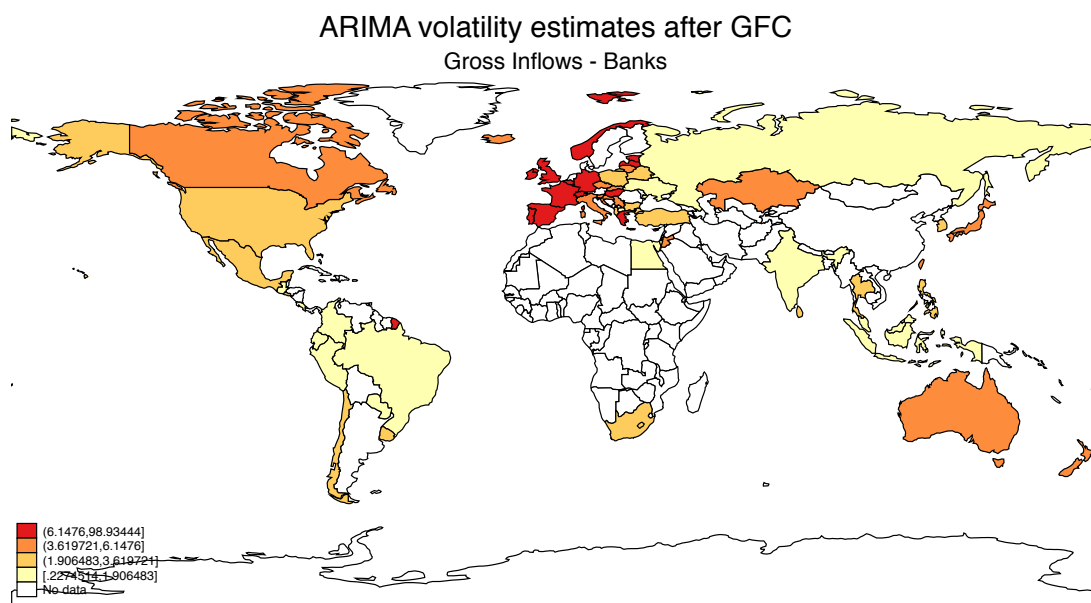


Figure 20: ARIMA volatility estimates for bank gross inflows *by country* over the period 2009Q3-2016Q1. *Notes:* data not available for China and Saudi Arabia. Source: IMF, *International Financial Statistics*, authors' computations.

A closer look at the subcomponents of other investment inflows reveals that flows to the banking sector are the major drivers of the general trends observed above. Again, the comparison between the two periods highlights how the peripheral Euro Area sovereign debt crisis has exacerbated the volatility of bank flows towards the Western European economies²⁵. Besides this, however, the entire distribution curve of volatility has shifted downwards, meaning that, on average, the volatility of bank inflows has decreased after the GFC.

Box 1: Do more financially developed countries have more volatile capital flows?

We here provide an example of how to make use of our volatility estimates to address some policy-related questions. Notably, we want to study the relationship between the volatility of capital flows and the degree of development of a country's financial system, as measured by the Financial Development Index²⁶.

Figure 1.1 plots the volatility of capital flows by instrument vis-à-vis the value of the Financial Development Index for each country. In some cases, the correlation is almost 0 (e.g. FDI, portfolio and other investments), whereas it is far more relevant and positive for portfolio equity. It is also interesting to notice how the GFC has led to an increase in the significance of these correlations (higher R^2) for all the instruments, except for portfolio equity. In addition, in the case of portfolio flows, especially portfolio debt, the sign of the correlation has switched from negative to positive during the GFC and, afterwards, it has moved back to negative.

²⁵ Other examples of increase in volatility are provided by Mexico and Australia.

²⁶ The higher the value of the index, the more financially developed is a country (see Svirydenka (2016)). Basically, the overall index of financial development is the result of the aggregation of nine sub-indices that summarize how developed financial institutions and financial markets are in terms of their depth, access, and efficiency in a particular country.

Generally speaking, the idea that a country with a more developed financial system is subject to more volatile capital flows²⁷ and, hence, uncertainty, is not confirmed by our simple exercise, with the exception of portfolio equity flows (whose size in the financial account of EMDEs, however, is much reduced compared to other instruments). This finding is in line with existing literature (see Bekaert and Harvey (1997), Lagoarde-Segot (2009) and Umutlu et al. (2010)).

Another argument that has been debated is whether EMDEs with stronger financial systems are more prone to contagion on the part of AEs. In this regard, we perform a simple exercise, where a measure of possible contagion is provided by the correlation between our volatility estimates for EMDEs and the same estimates for AEs, across different instruments. We find that a higher and more significant degree of correlation exists between volatilities of other investments and this correlation is stronger the more financially developed is a country. As an example, the scatter plot in Figure 1.2 displays correlations between other investments volatility in EMDEs and AEs versus the Financial Development Index. It can be concluded that more financially developed economies present a higher degree of exposure towards the developments on the international financial markets.

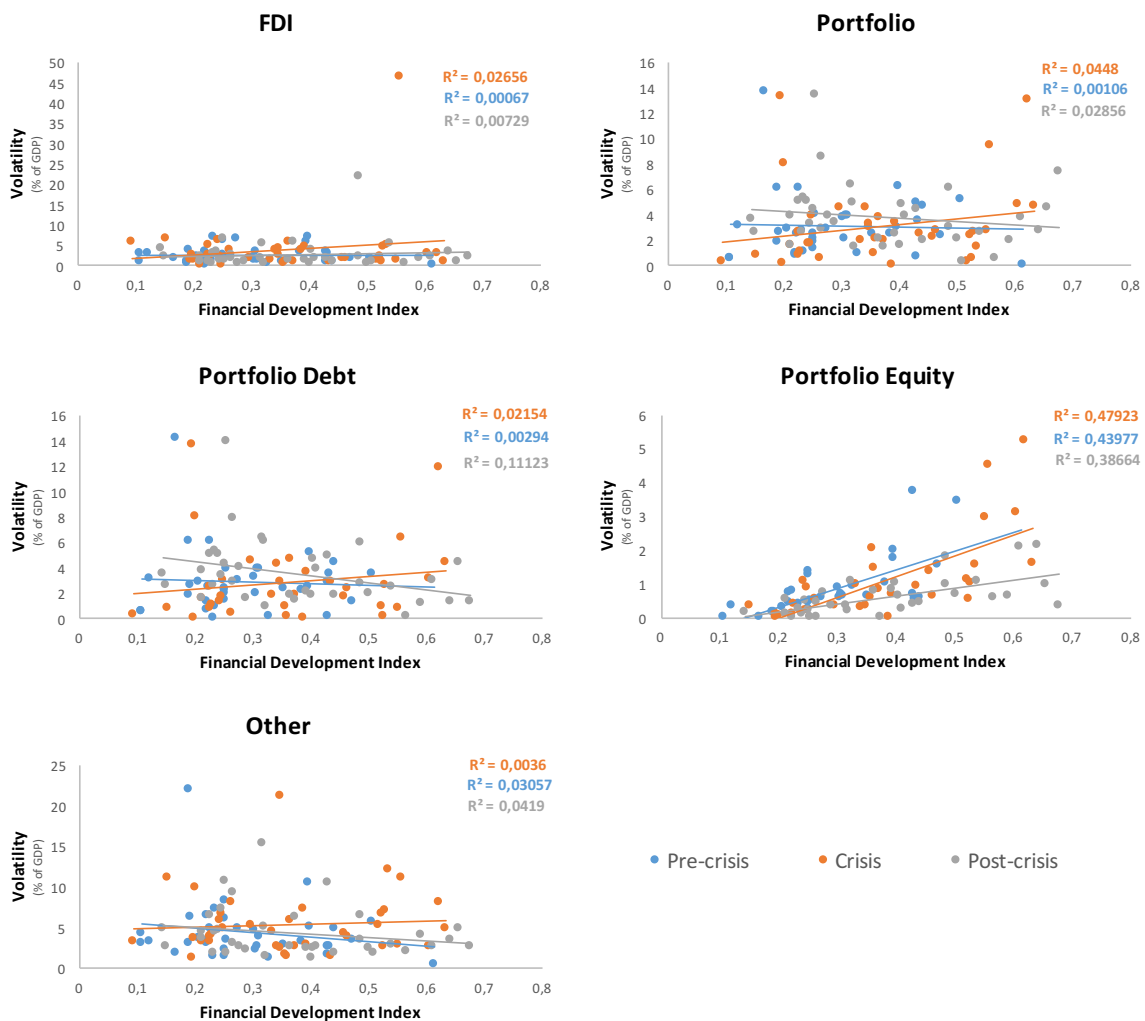
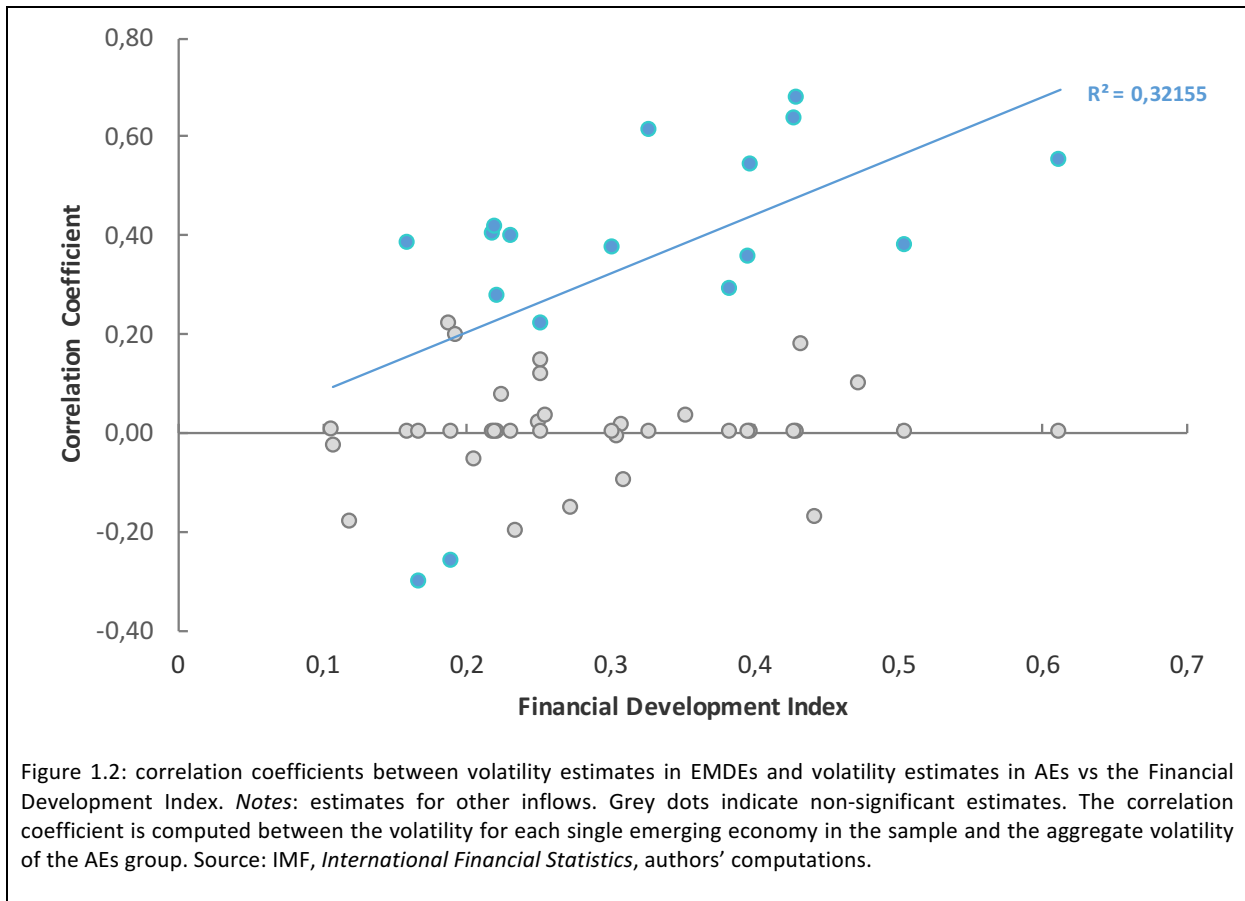


Figure 1.1: Volatility of capital flows in EMDEs vs the Financial Development Index by instrument. *Notes:* volatility is expressed as % share of GDP. Sources: IMF, *International Financial Statistics* and Svirydzienka(2016), authors' computations.

²⁷ See, for instance, Neumann et al. (2009) and Broner and Ventura (2016).



V. EXPLAINING VOLATILITY – PANEL REGRESSIONS

A. Regression framework

To understand the determinants of the volatility of gross inflows in EMDEs over the period 1980Q1-2016Q1, we construct some panel regressions, where the dependent variables are the ARIMA volatility estimates for both total flows and different types of instruments. The independent variables comprise a large set of regressors grouped in three categories: 1) global factors, 2) domestic macroeconomic factors, and 3) domestic structural factors. The global variables include the US shadow rate²⁸, the US real GDP growth, S&P 500 volatility as a proxy of global risk aversion²⁹, the US inflation and the log price of oil. The domestic macroeconomic variables include real GDP growth, domestic policy rate, and per capita income to capture the level of economic development. The domestic structural variables comprise capital account openness as measured by the Chin-Ito index, trade openness and reserves as a share of GDP³⁰. Moreover, the set of independent variables include also a dummy for the period 2007Q3-2009Q2 (GFC) and a dummy for the period 2009Q3-2016Q1.

Our approach is very similar to the previous work by Broto et al. (2011). Notably, the regression framework includes country fixed effects³¹, while the explanatory variables on the right-hand side are lagged by one quarter, in order to minimize possible endogeneity issues. Moreover, we correct the covariance matrix as suggested by Driscoll and Kraay (1998), to account for both serial and spatial (cross-sectional) correlations³².

B. Results

Table 4 reports the estimation outcomes using different instruments of capital flows as dependent variable. The results suggest that global factors like risk aversion, the US growth and shadow rate are important drivers of capital flow volatility.

As expected, an increase in global risk aversion will also increase EMDEs capital flow volatility, and this impact seems to be statistically significant across most of the instruments. For example, one percentage point increase in global risk aversion is associated with an increase by 0.85% of GDP in the volatility of total flows to EMDEs.

²⁸ The use of the shadow rate instead of the policy rate (Fed Fund rate) is preferred as it allows to capture changes in US monetary policy even when the official rate is at the ZLB. Following the literature, we consider short-term interest rates as the only relevant factors. As a robustness check, we also ran regressions with long-term interest rates, but they turned out not to be significant. In our framework, indicators of US monetary policy and economic performance are used as proxies for the world economy's stance (see also Broto et al. (2011)).

²⁹ Ideally, VIX should be used. However, the series for VIX is available only from 1990 on. Following Ghosh et al. (2012), we use the S&P 500 realized returns' volatility instead.

³⁰ See Appendix B for a complete list of variables.

³¹ There is no statistical evidence of the presence of time fixed effects in this case.

³² We also report clustered standard errors.

On the other hand, US growth negatively affects EMDEs capital flow volatility and this in line with the common belief that, in general and all else equal, an increase in the US growth implies greater stability in the global financial system. This impact is significant for all the instruments considered, with the exception of portfolio flows.

Another important global factor that influences volatility of different components of capital flows is given by commodity prices as proxied by oil price. An increase in the price of oil, for instance, decreases the volatility of portfolio equity and other flows through the official sector, while it increases the volatility of flows through the banking sector. Notably, an increase in the oil price by 1% lowers the volatility of portfolio equity and other investments through the official sector by 0.9% and 2.85% of GDP respectively, while it increases the volatility of other investments through the banking sector by 1.34% of GDP³³. These results are basically driven by oil-exporters. A positive oil shock, indeed, increases bank investments to these countries, whose financial institutions, in turn, reinvest their increased revenues into the international financial markets, to diversify their portfolios³⁴.

Table 4 also shows that domestic factors can be important drivers of capital flow volatility. An increase in domestic growth can decrease capital flow volatility by attracting more stable flows, and this impact is present in other investment flows and portfolio debt flows. While cyclical growth is not important for FDI volatility, in this case income per capita matters. This suggests that longer term structural factors have a more determinant impact over the stability of FDI flows. Trade openness is also an important driver of volatility across all the instruments, with more open economies, as expected, facing more volatile capital flows.

In addition, the volatility of total gross inflows, portfolio equity inflows and other investments through both the official sector and private non-banking sector were significantly higher during the GFC (by 1.47%, 0.39%, 0.94% and 0.52% of GDP respectively), while there is no such evidence for other instruments.

Table 4 suggests a confluence of global and domestic factors influence over the volatility of capital flows to EMDEs. In order to get a sense of the magnitude of each variable's impact, we compute the contribution of the most relevant factors to total capital inflows volatility, by multiplying the estimated coefficients by the corresponding series³⁵. Results are pictured in Figure 21. Among the global factors, the risk index is contributing the most to volatility, whereas the impact of the US shadow rate is more relevant before GFC. After the US policy rate hit the zero lower bound, the contribution of the shadow rate has lost its relevance, while the negative impact of US growth is more consistent over time, except for the period between 2009 and 2010, when it has turned positive. Among the domestic factors, trade openness is playing a major role in driving volatility, with more open economies experiencing higher volatility as expected. The income per capita is also important, with richer economies exhibiting greater volatility *ceteris paribus*. Interestingly,

³³Note that the specification of the regression framework is such that the coefficient for the log oil price on the right hand side represents the semi-elasticity of capital flows volatility to oil price.

³⁴ See Arezki, Mazarej, and Prasad (2015) and Arezki, Obstfeld and Milesi-Ferretti (2016).

³⁵ For the domestic variables, the actual values represent the average of the values across countries for each quarter.

the contribution of real GDP growth is usually close to zero from below (even more so after the crisis), with an isolated positive spike at the end of the GFC.

Our results provide interesting information as to the role of push versus pull factors in influencing capital flow developments. Recent studies, e.g. IMF (2016), have found that the real GDP growth differentials vis-à-vis advanced economies play an important role in determining capital flow movements. In particular, the recent capital flow slowdown can be predominantly attributed to the broader emerging market growth slowdown. IMF (2016, Figure 2.17) also shows that the positive contribution towards capital flows (in level terms) from growth differential is higher than the negative contribution from global risk aversion. Our results suggest that the determinants of capital flow volatility can be quite different from the determinants of their levels. For instance, we find that a global factor like risk aversion can be more important than domestic macroeconomic variables like GDP growth in driving volatility.

We also caution, however, that the R^2 is not very high for any of the instruments (the maximum being 0.176). While this is normal for regressions whose dependent variables are measures of volatility, however it also implies that there are other relevant factors beyond the ones considered by the literature, whose identification provides an interesting direction for future research.

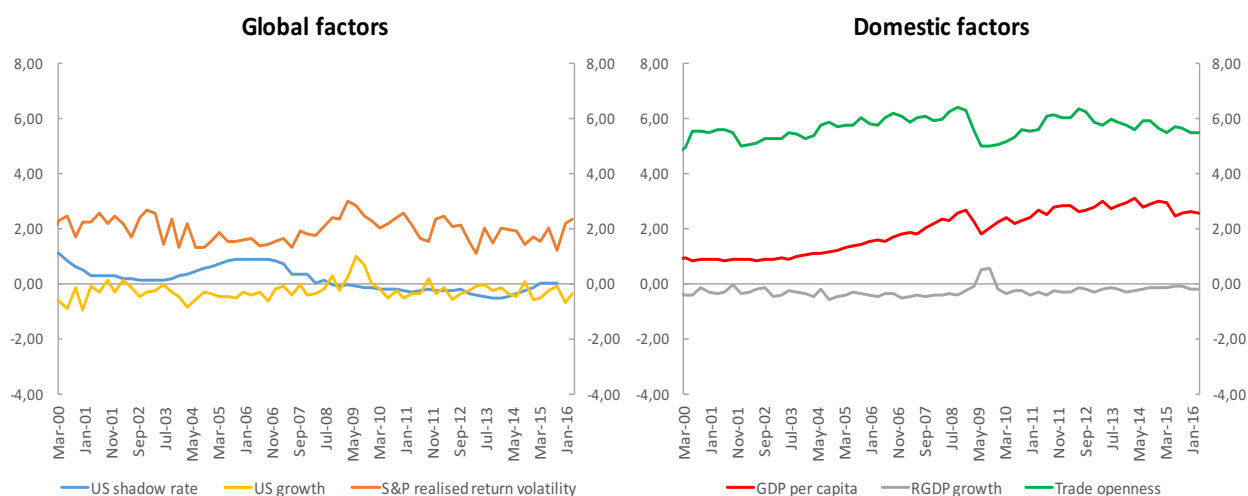


Figure 21: Factor contributions to the volatility of total gross inflows in EMDEs. *Notes:* Contributions are computed as an average of each factor's contributions across countries. Source: IMF, *International Financial Statistics*, authors' computations.

Box 2: The volatility of bank flows versus oil price

The results provided by the panel regressions allow us to study a bit more in-depth the relationship between capital flows volatility and some factors that are deemed influential by the literature. In particular, here we focus on the effect of a change in the price of oil over the volatility of bank inflows. This is relevant in light of some empirical work that underlines the crucial link existing between banks' profitability and, hence, the soundness of the banking system and oil price, a link that operates mainly through macroeconomic channels and is particularly strong in oil-exporting emerging economies³⁶.

³⁶ See, for instance, Hesse and Poghosyan (2009).

As we used the log of oil price in the right-hand side of the regression, it is possible to estimate the elasticity of volatility to oil price.

Figure 2.1 displays the evolution of elasticity over time, by disentangling between oil exporting and oil importing economies. The elasticity has gradually decreased over time, until the aftermath of the GFC. In the pre-crisis period, indeed, the overall average elasticity is 1.35% (i.e. a 1% increase in the oil price leads to a 1.35% increase in bank inflows volatility), while the same average decreases to 1.11% after the GFC. Moreover, as expected, there exists a stark difference between oil importing and oil exporting economies, with the latter displaying a substantially higher sensitivity of volatility to changes in oil price. In addition, it seems that elasticity in oil exporting economies has increased after the crisis, compared to earlier periods, a trend which is opposite to what observed for oil importers.

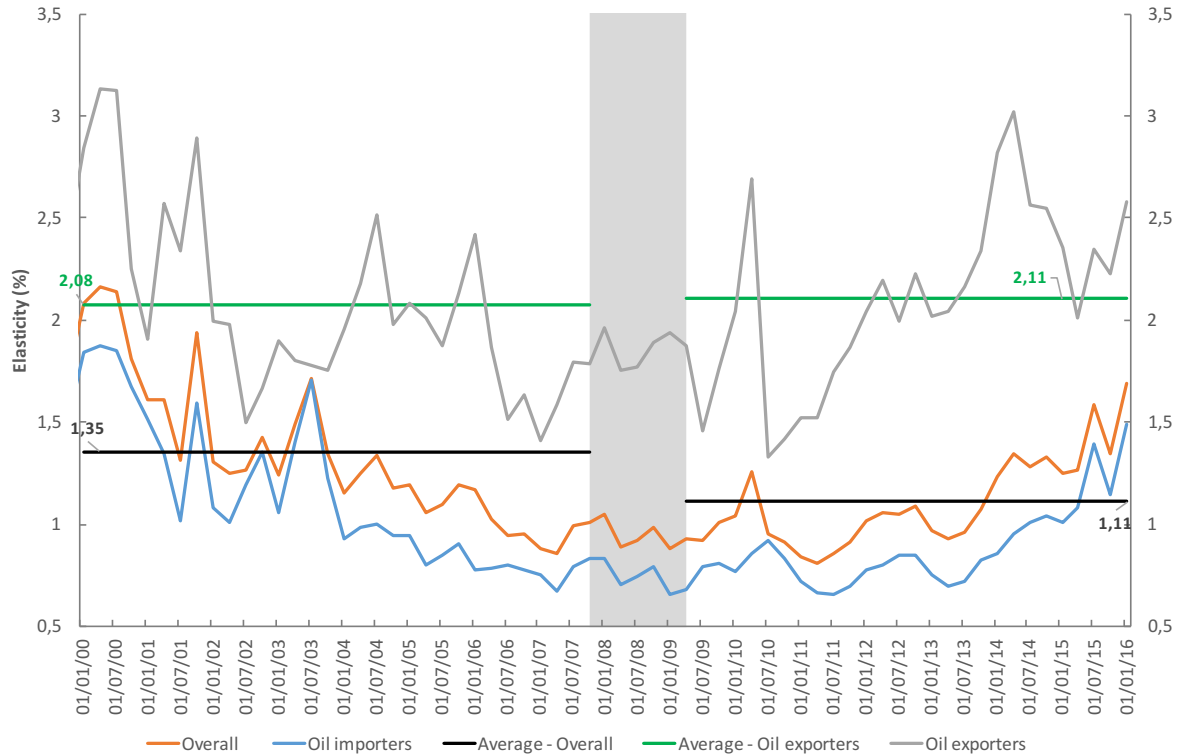


Figure 2.1: Average elasticity of gross bank inflows volatility to oil price in EMDEs. *Notes:* the shaded area indicates the GFC period. Oil exporters in the sample are: Brazil, Ecuador, Egypt, Indonesia, Kazakhstan, Mexico, Malaysia, Russia and Saudi Arabia. Source: IMF, *International Financial Statistics*, authors' computations.

Figure 2.2 depicts the evolution in the *median* elasticities for the overall sample, oil exporters and oil importers. The picture provided is more interesting, as it looks like that, during periods of financial distress (GFC), the median values all collapse to the same level, both for oil exporters and importers. This suggests that the distributions of oil price elasticities across groups tend to coincide when an aggregate shock hits, while in more "normal" times they are distinct and driven by idiosyncratic components.

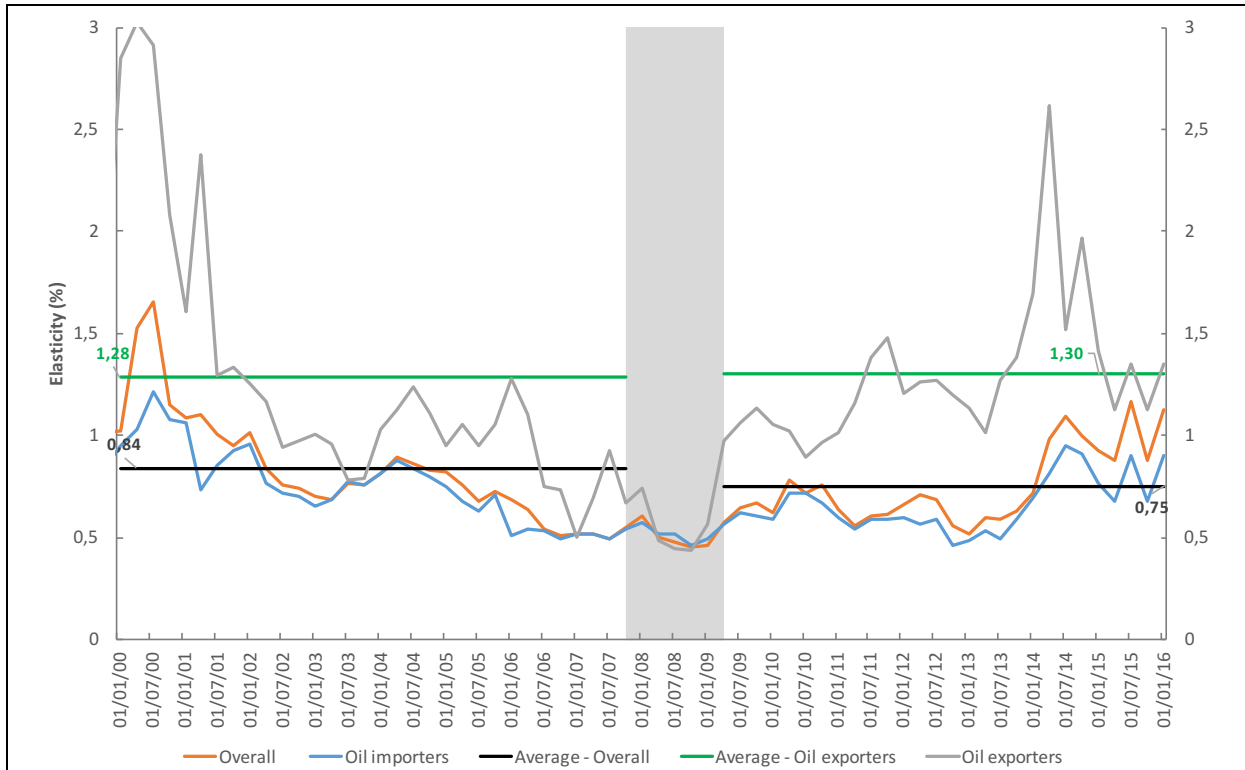
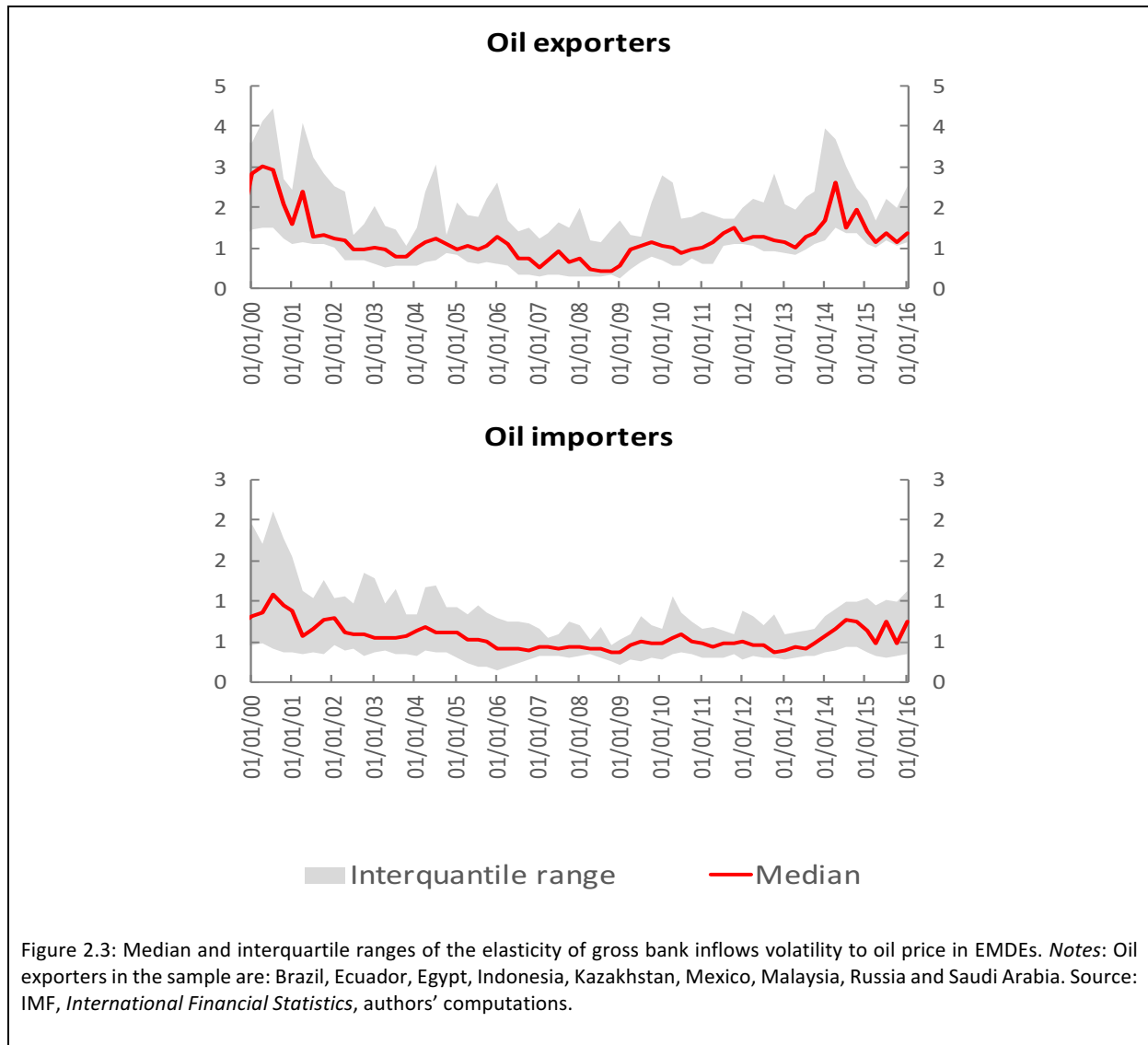


Figure 2.2: Median elasticity of gross bank inflows volatility to oil price in EMDEs. *Notes:* the shaded area indicates the GFC period. Oil exporters in the sample are: Brazil, Ecuador, Egypt, Indonesia, Kazakhstan, Mexico, Malaysia, Russia and Saudi Arabia. Source: IMF, *International Financial Statistics*, authors' computations.

Figure 2.3 displays the evolution of the median and the interquartile range of the estimates over time, for oil exporting and oil importing economies. This gives us a better sense of whether the changes observed above are driven by shifts in the overall distribution or by movements at the ends of the distribution (outliers). While for oil importers (bottom panel), we do not observe much variation in the median over time, on the other hand the interquartile range has considerably narrowed during the GFC. This points at a change towards a distribution of elasticity which is more concentrated around the mean (lower variance). For oil exporters (upper panel), conversely, it looks like there have been shifts in the entire distribution of elasticity. Notably, the median elasticity has decreased in the mid-2000s and, later, during the GFC, whereas it has started to increase again soon after the crisis, with a spike in the period 2014-2015.



VI. CONCLUDING THOUGHTS

We know that capital flows volatility is a major policy concern, but we don't know what volatility is....

This paper is an attempt to deepen our understanding of capital flows volatility, which is nowadays a major policy concern. To start off, we quantify volatility using three measures: rolling standard deviation, GARCH, and ARIMA estimates. We show that there is sufficient heterogeneity, both across countries and across instruments, to warrant examining these entities separately. In addition, following recent literature arguing that the pattern of net flows can be different from gross inflows and gross outflows, we look at both net and gross flows. One of the major contributions of this paper thus consists of the development of a comprehensive set of volatility estimates of capital flows, encompassing gross and net flows as well as different instruments across thirty-seven individual EMDEs and twenty-eight individual AEs.

Constructing volatility estimates for both the aggregate EMDEs and the individual countries, we document the evolution of volatility over time and compare the levels of volatility across instruments. The results of aggregate EMDEs show that portfolio debt and bank flows tend to be more volatile than FDI flows. We also find that the volatility of all instruments are prone to bouts during episodes of global financial turmoil. The results for the individual countries suggest that there can be significant variation amongst countries. The patterns witnessed in volatility of aggregate EMDE, both in terms of evolution over time and relative magnitude across instruments, do not necessarily hold across countries. These variations underscore the importance of also monitoring volatility of individual countries.

In addition, the measures we use are a way to extrapolate information about uncertainty in international capital markets. While the GFC has represented an episode of generalized higher uncertainty, the pre and post crisis periods display volatility patterns that are very similar to each other. That said, only a reduced part of such uncertainty is imputable to domestic macroeconomic and structural factors, as well as to relevant global factors.

Our estimates for individual countries can be useful for future studies on this issue, particularly as far as cross-country analysis is concerned, since there exists a high degree of heterogeneity across countries. As an example, we use these measures to perform panel regressions with the aim of detecting the determinants of volatility. Interestingly, our results show that push factors can be relatively more important than pull factors, thus suggesting that some of the characteristics of capital flows volatility can be different from those of capital flows levels.

Future studies could aim at further informing about different aspects of capital flows volatility. In this regard, we also briefly touch upon some issues to provide motivation for further analysis on some topics. For instance, we show through simple scatterplots that the relationship between financial depth and capital flows volatility is significant only for certain instruments, whereas a higher degree of financial development increases a country's international exposure on the international financial markets. This analysis could be extended by building a fully-fledged analytical framework to study the linkages between financial depth and volatility. We also show that commodity prices can influence the volatility of bank flows, an analysis which is definitively worth extending, given the recent developments in that sphere.

VARIABLES	(1) Total	(2) FDI	(3) portfolio portfolio	(4) portfolio Debt	(5) portfolio Equity	(6) Other	(7) Banks	(8) Official	(9) Non-banks	(10) Total private
US shadow rate _(t-1)	0.174** [0.0948] (0.0714)	0.170** [0.0772] (0.0665)	0.0854** [0.0813] (0.0358)	0.0192 [0.0694] (0.0426)	0.0909*** [0.0385] (0.0233)	0.114* [0.0780] (0.0663)	0.145** [0.0739] (0.0555)	0.0436 [0.0568] (0.0461)	0.0551 [0.0429] (0.0350)	0.116*** [0.0552] (0.0435)
S&P 500 returns volatility _(t-1)	0.849*** [0.383] (0.191)	0.526*** [0.359] (0.141)	0.225** [0.148] (0.101)	0.222** [0.125] (0.0939)	0.00865 [0.0586] (0.0481)	0.331* [0.148] (0.192)	0.282 [0.142] (0.171)	0.235 [0.132] (0.173)	0.198*** [0.0901] (0.0572)	0.375*** [0.134] (0.136)
US growth _(t-1)	-0.492*** [0.305] (0.136)	-0.444*** [0.287] (0.105)	0.0272 [0.116] (0.0546)	0.0484 [0.0948] (0.0459)	-0.0538 [0.0389] (0.0443)	-0.444*** [0.131] (0.121)	-0.216*** [0.140] (0.0787)	-0.169 [0.0953] (0.107)	-0.108* [0.0577] (0.0548)	-0.264*** [0.109] (0.0904)
US inflation _(t-1)	-0.320** [0.151] (0.126)	-0.0465 [0.0691] (0.0841)	0.0688 [0.0960] (0.0593)	-0.00891 [0.0638] (0.0357)	0.0254 [0.0418] (0.0384)	-0.244* [0.107] (0.125)	-0.132** [0.0780] (0.0502)	0.0642 [0.0708] (0.0527)	-0.0261 [0.0512] (0.0434)	-0.197*** [0.101] (0.0720)
Oil price (log) _(t-1)	1.224 [1.732] (1.112)	-0.484 [1.306] (1.059)	-1.329** [0.844] (0.643)	-0.934 [0.792] (0.591)	-0.896** [0.651] (0.348)	0.0114 [0.979] (0.887)	1.335** [0.602] (0.607)	-2.848*** [1.097] (0.543)	0.130 [1.010] (0.403)	0.988 [0.898] (0.606)
RGDP growth _(t-1)	-0.230*** [0.100] (0.0450)	-0.0689** [0.0621] (0.0342)	-0.0387** [0.0216] (0.0192)	-0.0387 [0.0229] (0.0251)	0.00100 [0.0110] (0.0140)	-0.125*** [0.0693] (0.0424)	-0.0186 [0.0388] (0.0289)	-0.0687** [0.0536] (0.0263)	-0.0345** [0.0190] (0.0153)	-0.0772** [0.0419] (0.0325)
GDP per capita _(t-1)	0.00130** [0.00121] (0.000524)	0.00148*** [0.00140] (0.000502)	0.000568*** [0.000333] (0.000201)	0.000363** [0.000314] (0.000165)	0.000144* [0.000143] (7.52e-05)	0.000747** [0.000680] (0.000305)	0.000732 [0.000428] (0.000440)	0.00101*** [0.000712] (0.000255)	-0.000168 [0.000350] (0.000141)	6.07e-06 [0.000390] (0.000320)
Policy rate _(t-1)	0.0177 [0.0216] (0.0197)	-0.00488 [0.0301] (0.0245)	0.00362 [0.0121] (0.0116)	-0.00504 [0.0110] (0.00974)	0.00126 [0.00608] (0.00432)	0.0240* [0.0204] (0.0142)	0.0273*** [0.0128] (0.00989)	0.00154 [0.0278] (0.00980)	0.00381 [0.0169] (0.00854)	0.000520 [0.0109] (0.00881)
Chinn-Ito index _(t-1)	-2.029* [1.494] (1.020)	-1.105 [2.341] (0.986)	0.338 [0.564] (0.526)	0.205 [0.560] (0.482)	0.601*** [0.307] (0.160)	-0.578 [0.977] (0.590)	1.453** [1.066] (0.608)	-1.376** [1.362] (0.611)	-0.651** [0.640] (0.303)	-0.183 [0.560] (0.424)
Trade openness _(t-1)	0.0845*** [0.0361] (0.0192)	0.0684*** [0.0469] (0.0219)	0.0320*** [0.0113] (0.00709)	0.0273*** [0.0124] (0.00524)	0.0180*** [0.00721] (0.00406)	0.0227 [0.0124] (0.0152)	0.0127 [0.0125] (0.0100)	0.0300*** [0.0126] (0.0101)	0.0212*** [0.00930] (0.00566)	0.0195** [0.00979] (0.00820)
Reserves/GDP _(t-1)	0.00708 [0.0119] (0.0124)	0.0157 [0.0112] (0.0101)	0.00500* [0.00365] (0.00265)	0.00593** [0.00445] (0.00297)	0.00703*** [0.00346] (0.00208)	0.00406 [0.00742] (0.00478)	0.0310*** [0.01000] (0.00561)	-0.000519 [0.0109] (0.00890)	-0.00701* [0.00870] (0.00410)	0.00920*** [0.00729] (0.00319)
Crisis	1.467** [0.726] (0.664)	0.346 [0.653] (0.531)	-0.0601 [0.382] (0.209)	-0.0655 [0.478] (0.240)	0.382** [0.315] (0.166)	0.624 [0.483] (0.538)	-0.356 [0.311] (0.391)	0.938*** [0.470] (0.314)	0.515** [0.504] (0.244)	0.146 [0.361] (0.384)

Post-crisis	-0.979 [0.964] (0.786)	-0.888 [1.080] (0.669)	0.437 [0.383] (0.274)	0.170 [0.351] (0.328)	0.0329 [0.313] (0.208)	-0.168 [0.977] (0.731)	-1.024* [0.473] (0.562)	0.765 [0.585] (0.474)	0.135 [0.717] (0.319)	-0.149 [0.493] (0.424)
Constant	-4.135** [3.458] (1.653)	-4.594*** [4.139] (1.443)	1.153 [1.018] (0.722)	1.084 [1.131] (0.702)	0.0707 [0.595] (0.478)	0.850 [1.590] (1.019)	-4.654*** [1.801] (1.190)	3.844*** [1.835] (1.097)	1.033* [1.625] (0.606)	-0.804 [1.384] (0.886)
Observations	1,405	1,405	1,409	1,369	1,386	1,410	1,298	1,332	1,322	1,405
Number of groups	25	25	25	24	24	25	23	24	23	25
Within R ²	0.176	0.116	0.0732	0.0666	0.149	0.112	0.184	0.130	0.0882	0.0834

Table 4: Baseline regression for volatility of capital inflows. *Notes:* Clustered standard errors in brackets, Driscoll and Kraay (DK) standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1, using Driscoll and Kraay standard errors. Some countries have been excluded from the pool due to lack of an adequate number of observations.

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VIII. APPENDIX

A. Countries

<i>Advanced Economies</i>		
Australia	Iceland	
Belgium	Israel	
Canada	Italy	
Switzerland	Japan	
Cyprus	Korea	
Czech Republic	Luxembourg	
Germany	Norway	
Spain	New Zealand	
Estonia	Portugal	
France	Singapore	
United Kingdom	Slovakia	
Greece	Slovenia	
Hong Kong	Taiwan	
Ireland	United States	
<i>Emerging and Developing Economies</i>		
Albania	India	Russia
Bulgaria	Jordan	Saudi Arabia
Belarus	Kazakhstan	El Salvador
Brazil	Sri Lanka	Serbia
Chile	Lithuania	Thailand
China	Latvia	Turkey
Colombia	Mexico	Ukraine
Costa Rica	Makedonia	Uruguay
Ecuador	Malaysia	South Africa
Egypt	Peru	
Guatemala	Philippines	
Croatia	Poland	
Hungary	Paraguay	
Indonesia	Romania	

B. Variables

<i>Variable</i>	<i>Frequency</i>	<i>Time coverage</i>	<i>Countries</i>	<i>Source</i>
<i>Capital flows</i>				
Total flows	Quarterly	1970Q1:2016Q1	65	IMF-IFS
FDI	Quarterly	1970Q1:2016Q1	65	IMF-IFS
Portfolio	Quarterly	1970Q1:2016Q1	65	IMF-IFS
Portfolio Debt	Quarterly	1970Q1:2016Q1	65	IMF-IFS
Portfolio Equity	Quarterly	1970Q1:2016Q1	65	IMF-IFS
Other	Quarterly	1970Q1:2016Q1	65	IMF-IFS
<i>Macroeconomic Factors</i>				
Real GDP	Quarterly	1970Q1:2016Q1	37	IMF-WEO
Nominal GDP	Quarterly	1970Q1:2016Q1	37	IMF-IFS
CPI	Quarterly	1970Q1:2016Q1	37	IMF-IFS
Policy rate	Quarterly	1970Q1:2016Q1	37	IMF-IFS
Exchange rate vs USD	Quarterly	1970Q1:2016Q1	37	IMF-IFS
<i>Structural Factors</i>				
Public debt	Quarterly	1970Q1:2016Q1	37	IMF-IFS
International Reserves	Quarterly	1970Q1:2016Q1	37	IMF-IFS
Trade openness	Quarterly	1970Q1:2016Q1	37	IMF-DOTM
Financial Development Index	Annual	1979-2015	37	Sviryzdenka(2016)
Capital Account Openness	Annual	1996-2014	37	Chinn and Ito(2008)
Institutional Stability	Quarterly	1996Q4:2014Q4	37	WB-WGI
<i>Global Factors</i>				
US Wu-Xia Shadow Rate	Quarterly	1982Q1:2016Q2		Haver Analytics
S&P 500 volatility	Quarterly	1970Q1:2016Q2		Haver Analytics
US real GDP	Quarterly	1970Q1:2016Q1		IMF-WEO
US CPI	Quarterly	1970Q1:2016Q1		IMF-IFS
US Corporate Bond Spread	Quarterly	1991Q3:2016Q1		FRED
US Government Yield Spread	Quarterly	1970Q1:2016Q1		IMF-IFS
Global Liquidity	Quarterly	1970Q1:2016Q1		NCBs
Oil price	Quarterly	1970Q1:2016Q1		IMF-IFS

Table 2: List of variables with time coverage and sources. *Notes:* Trade Openness: sum of imports plus exports over GDP; Capital Account Openness = Chinn-Ito index; Institutional Stability = Rule of Law index; S&P 500 volatility = realized returns volatility for the S&P 500 Index; US Gov't Yield Spread = difference between the 10-year and the 3-year US government bond yields; Global Liquidity = sum of M2 aggregates across the G7 economies; Oil price = Brent spot price (USD per barrel). *Sources:* IMF-IFS = International Financial Statistics; IMF-DOTM = Direction of Trade Monthly; IMF-WEO = World Economic Outlook; WB-WGI = World Bank Worldwide Governance Indicators; FRED = Federal Reserve Economic Database; NCBs = National Central Banks.

C. Geweke's Separated Partial Means Test

The Geweke's separated partial means test is used to check the convergence of a parameter estimate over time. Define M as the sample length and p as a fixed positive integer equal to the number of means which you want to split the sample into.

Given a sequence of a $(k \times 1)$ vector of parameters of interest, $\{\theta\}_{m=1}^M$, and for each sample length M such that $M_p = M/2p$ is an integer, the p separated means are defined as:

$$\bar{h}_{j,p}^{(M)} = M_p^{-1} \sum_{m=1}^{M_p} \theta_i^{(m+M(2j-1)/2p)}, j = 1, \dots, p, i = 1, \dots, k$$

Let $\hat{\tau}_{j,p}^{2(M)}$ be the estimate for the variance³⁷, τ^2 , of $\bar{h}_{j,p}^{(M)}$, which is computed as follows:

$$\hat{\tau}_{j,p}^{2(M)} = \hat{S}(0) = \hat{c}_0^{(M)} + 2 \sum_{s=1}^{L-1} [(L-s)/L] \hat{c}_s^{(M)},$$

where $\hat{c}_j^{(M)} = M^{-1} \sum_{m=j+1}^M [\theta_i^{(m)} - \bar{\theta}_i^{(M)}] [\theta_i^{(m-j)} - \bar{\theta}_i^{(M)}]$, $j = 0, \pm 1, \pm 2, \dots$ is the sample autocovariance function and $L(M)$ is an integer-valued function such that $\lim_{M \rightarrow \infty} L(M) = \infty$ and $\lim_{M \rightarrow \infty} L(M)^2/M = 0$.

In addition, define the $(p-1) \times 1$ vector $\bar{\mathbf{h}}_p^{(M)}$ with j th element $\bar{h}_{j+1,p}^{(M)} - \bar{h}_{j,p}^{(M)}$, and the $(p-1) \times (p-1)$ tridiagonal matrix $\hat{\mathbf{V}}_p^{(M)}$, in which $\hat{v}_{jj}^{(M)} = M_p^{-1} (\hat{\tau}_{j,p}^{2(M)} + \hat{\tau}_{j+1,p}^{2(M)})$ and $\hat{v}_{jj-1}^{(M)} = \hat{v}_{j-1j}^{(M)} = -M_p^{-1} \hat{\tau}_{j,p}^{2(M)}$. It follows that:

$$G = \bar{\mathbf{h}}_p^{(M)'} [\hat{\mathbf{V}}_p^{(M)}]^{-1} \bar{\mathbf{h}}_p^{(M)} \xrightarrow{d} \chi^2(p-1)$$

where G is the statistic used to test whether the separated means are equal (null hypothesis) or not (alternative)³⁸.

In our case, we want to check whether the mean value of volatility of capital flows in the pre-crisis period (2000Q1:2007Q2) is the same as the mean value in the post-GFC period (2009Q3:2016Q1). In order to do so, we perform the separated partial means test over our volatility estimates (θ), by setting $p=2$ and $L(M)=0.02 * M$ ³⁹.

³⁷ i.e. the numerical standard error (NSE).

³⁸ See Geweke (2005) for proofs.

³⁹ In other words, we taper the autocovariance function at 2%.

D. Volatility Adjusted for Levels

Net Flows

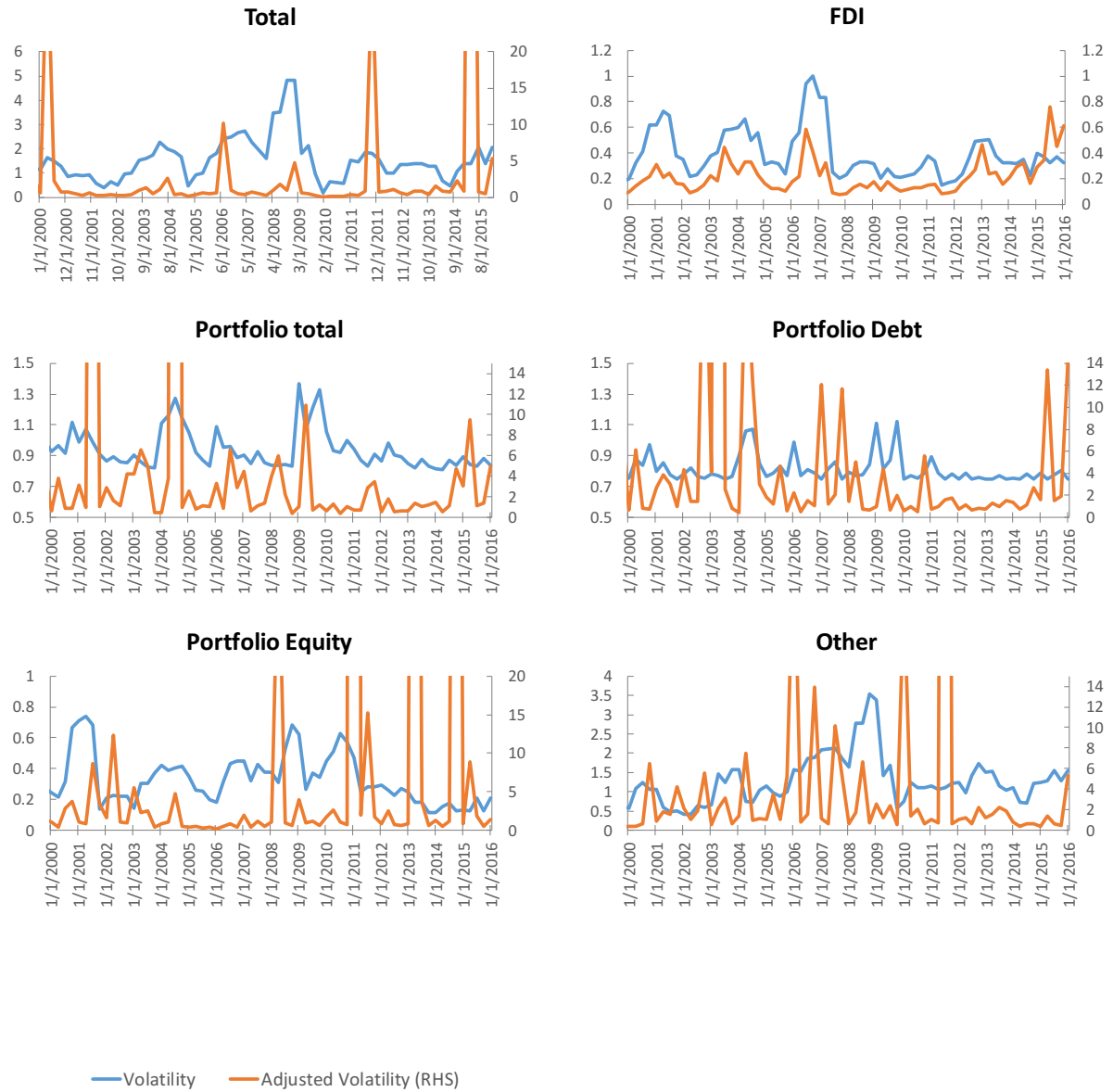


Figure D1: volatility and adjusted volatility (coefficient of variation) for net capital flows in EMDEs by instrument. Notes: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

Gross Inflows

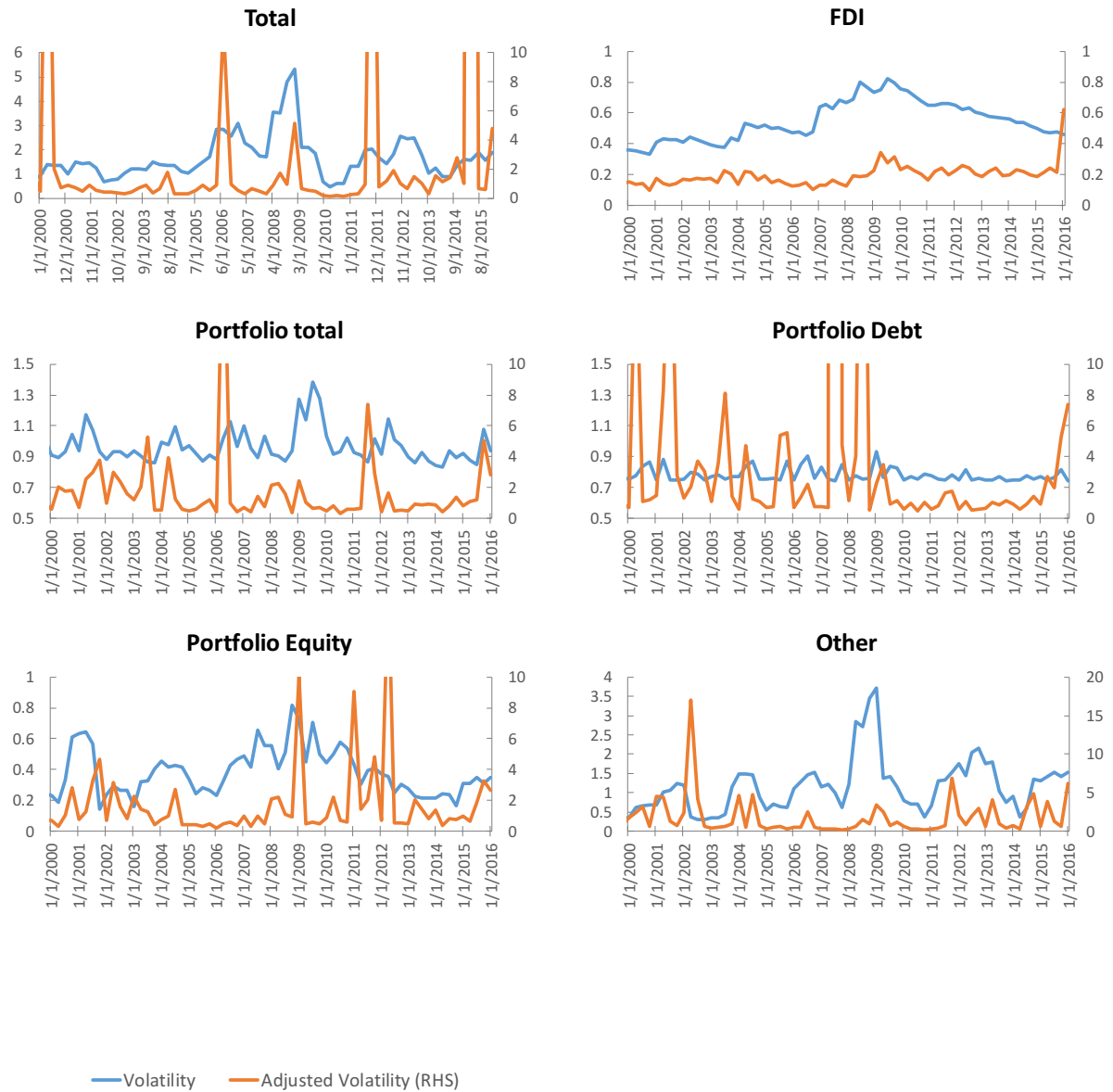


Figure D2: volatility and adjusted volatility (coefficient of variation) for gross capital inflows in EMDEs *by instrument*. Notes: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

E. Volatility of Capital Flows excluding China

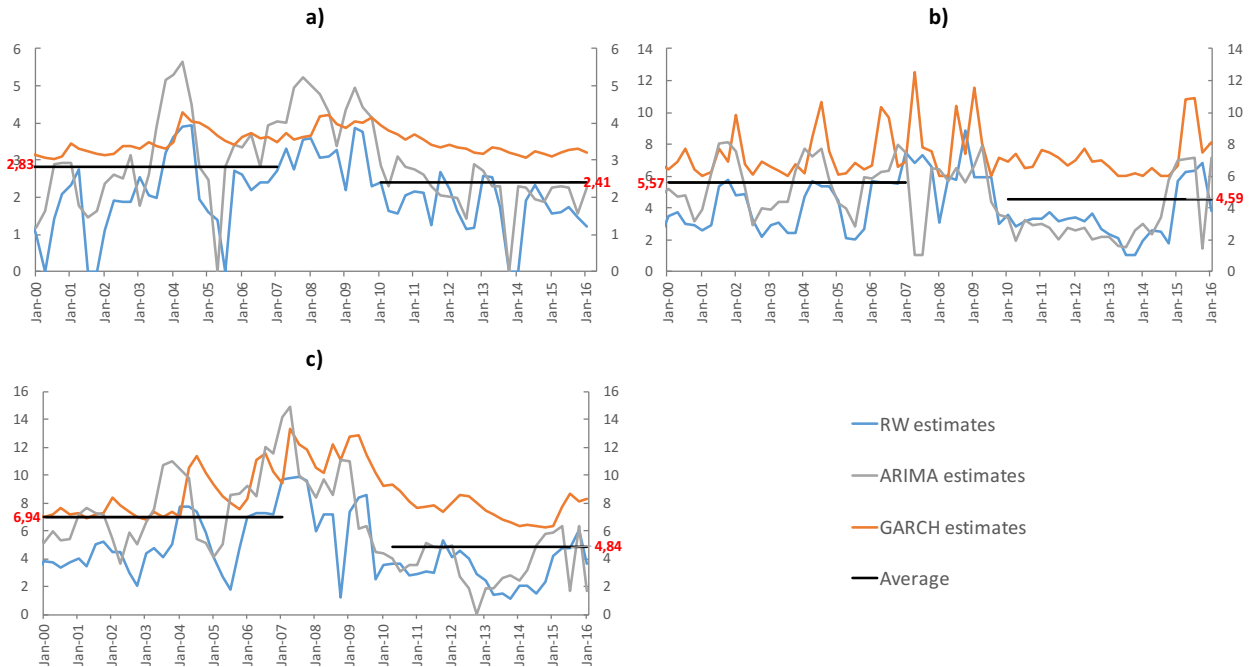


Figure E1: Volatility of capital flows for the World aggregate, excluding China. *Notes:* a) Net Inflows; b) Gross Inflows; c) Gross Outflows. Measures are expressed as % of total GDP. Source: IMF, *International Financial Statistics*, authors' computations.

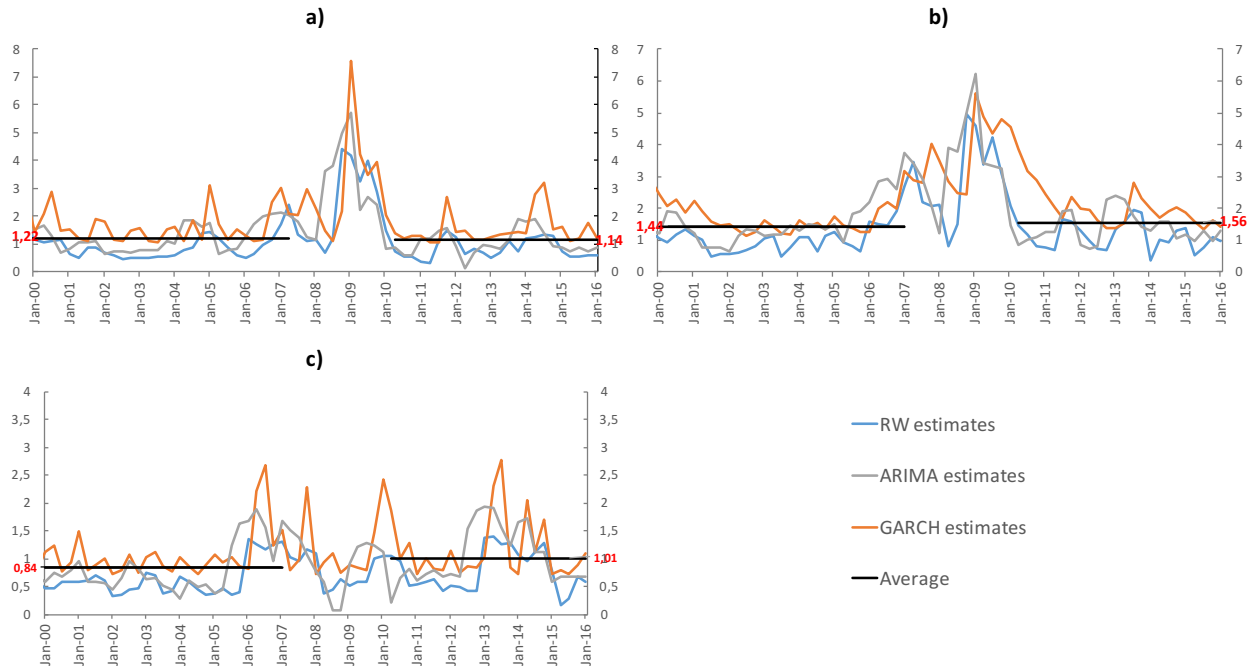


Figure E2: Volatility of capital flows in EMDEs, excluding China. *Notes:* a) Net Inflows; b) Gross Inflows; c) Gross Outflows. Measures are expressed as % of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

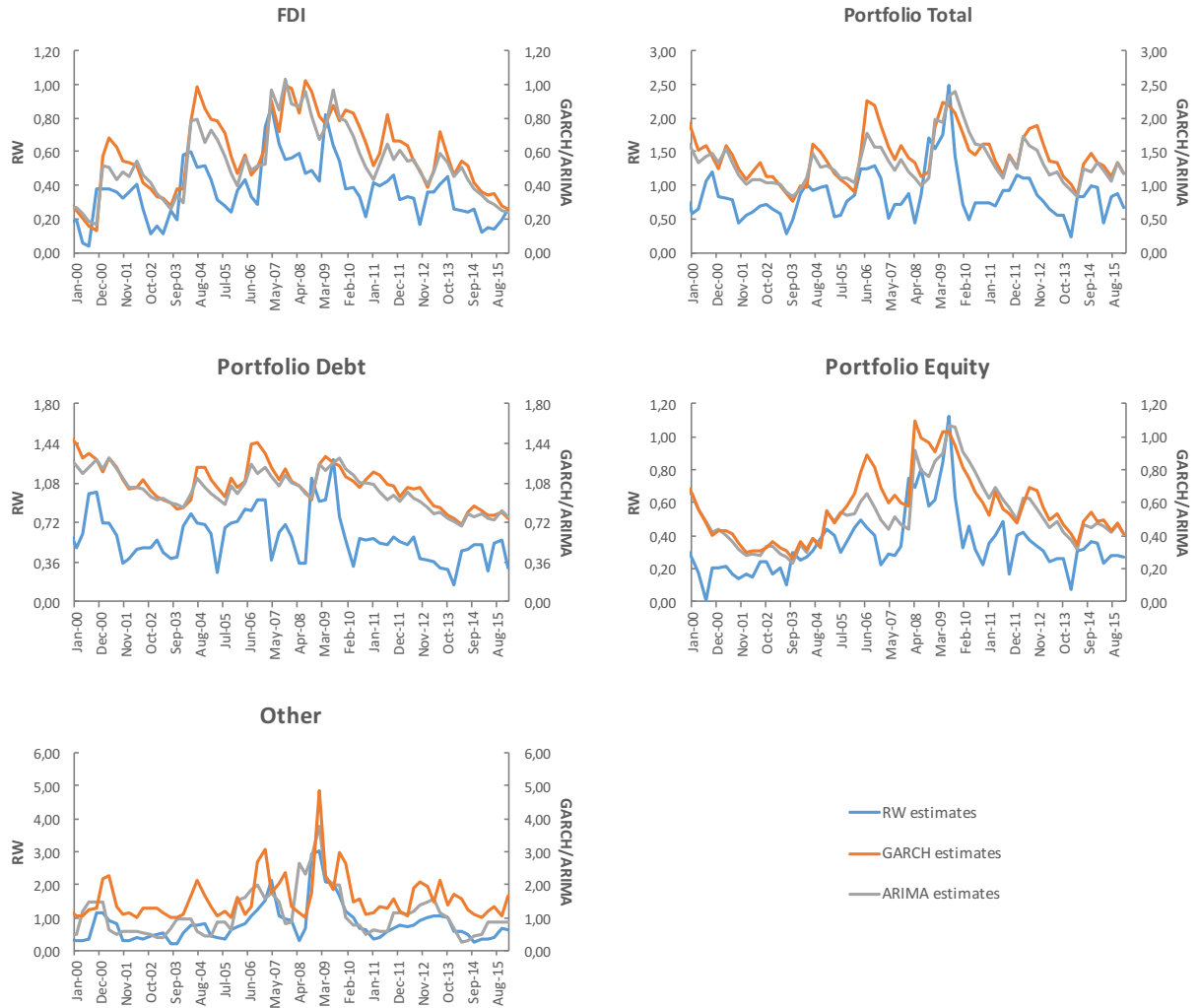


Figure E3: Volatility of gross capital inflows for EMDEs excluding China *by components*. Note: volatility is expressed as % of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

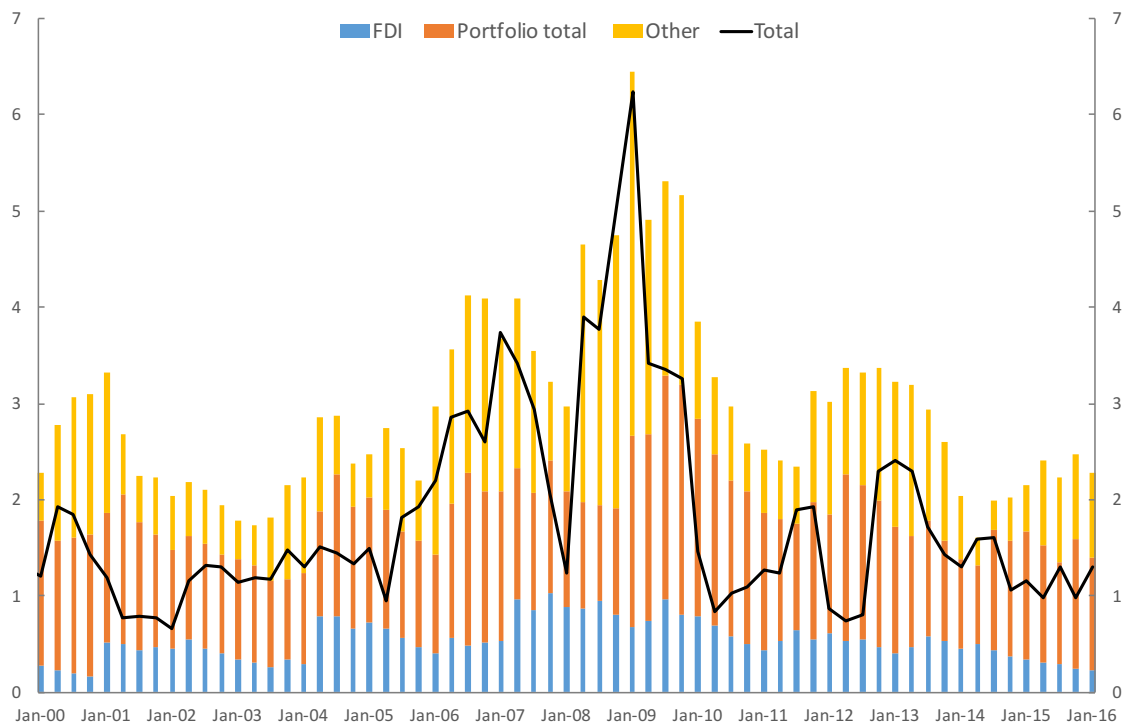


Figure E4: ARIMA volatility estimates of aggregate gross capital inflows and their components in EMDEs, excluding China. *Notes:* Measures are expressed as % of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

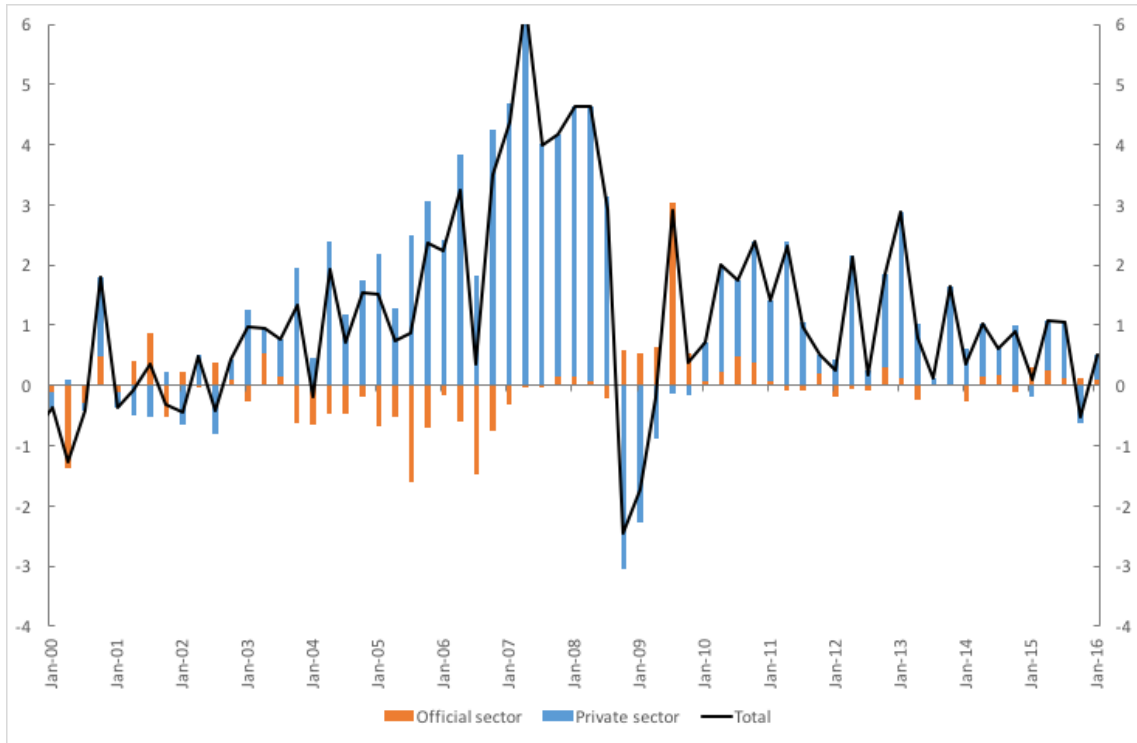


Figure E5: Other gross capital inflows in EMDEs excluding China *by sector*. *Notes*: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

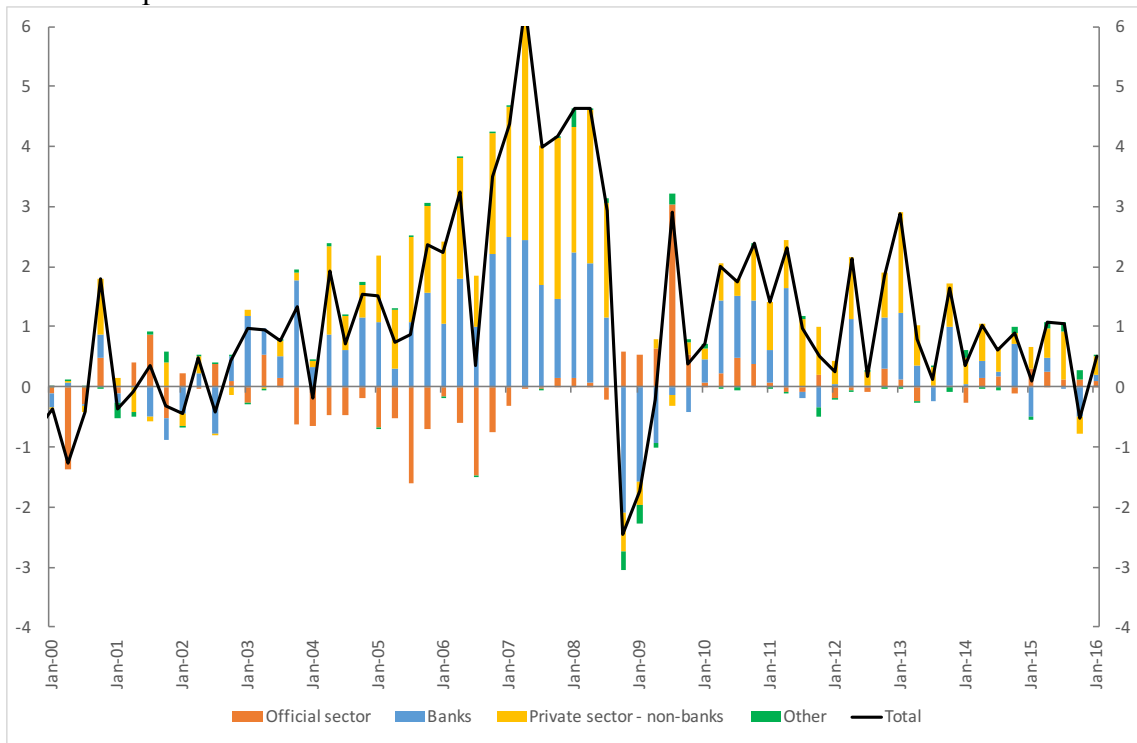


Figure E6: Other gross private inflows in EMDEs excluding China *by sector*. *Notes*: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.

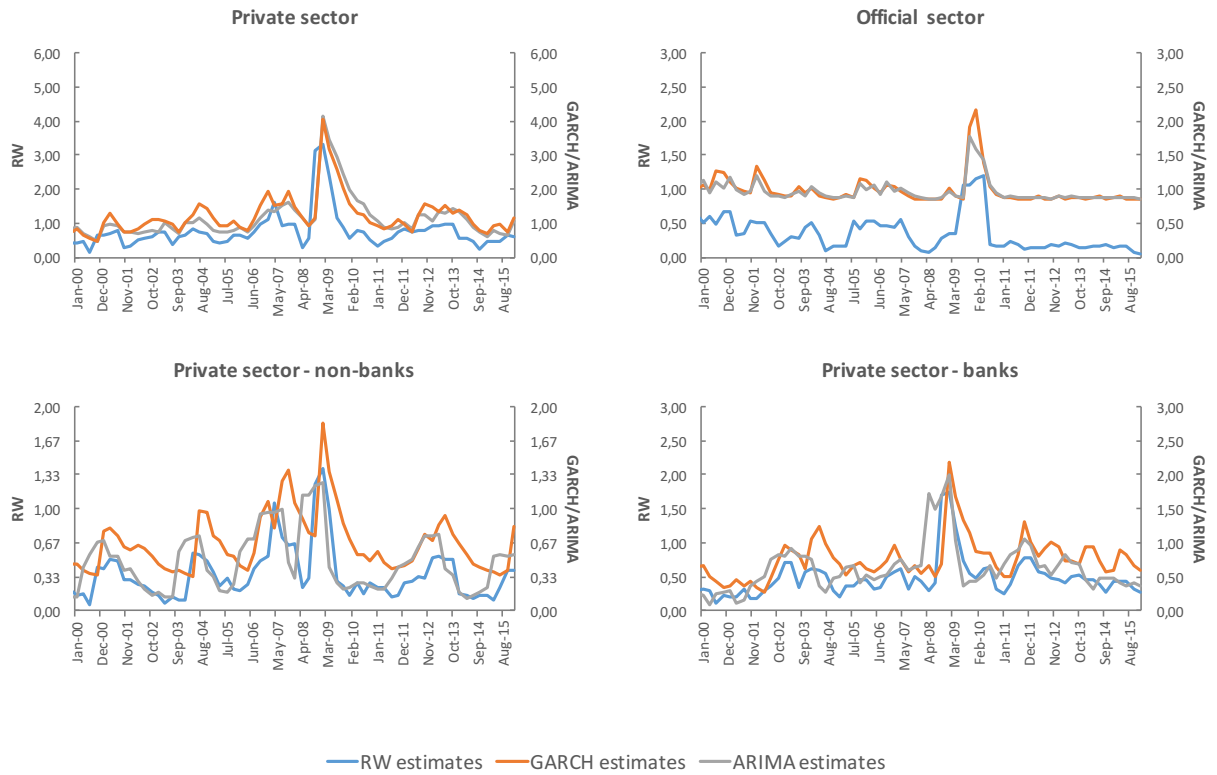


Figure E7: Volatility estimates for other gross capital inflows in EMDEs excluding China *by components*. Notes: measures are expressed as % share of group GDP. Source: IMF, *International Financial Statistics*, authors' computations.