Modelling Portfolio Capital Flows in a Global Framework: Multilateral Implications of Capital Controls

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Abstract

In the aftermath of the global financial crisis, many emerging market countries resorted to capital controls to tackle the excessive surge of capital inflows. A number of recent research papers have suggested that the imposition of controls may have imposed negative externalities on other countries by deflecting flows. Our aim in the research reported in this paper is to assess the efficacy of capital controls and potential deflection effects on other countries by constructing a comprehensive global econometric model which captures the dynamic interactions of capital flows with domestic and global fundamentals. The results suggest that capital controls are effective for some countries in the short run, but have no lasting effects. Moreover, there is only limited evidence of deflection effects for a small number of emerging market countries.

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1 Introduction

Since the mid-1980s, emerging markets have experienced a rapid increase in financial investment from the rest of the world. While there are many gains from global financial integration (see e.g. Kose et al., 2009), the experience of the last few decades suggests that opening up domestic markets to free capital flows does introduce various risks for recipient countries. Concerns have been raised, for example, during and in the wake of the recent global financial crisis, with many countries facing a sudden collapse followed by a surge in capital flows.[1]

[1]The possible impact of surges in capital flows on the macroeconomy may not only be confined to developing countries. For example, Laibson & Mollerstrom (2010) argue that the global financial crisis itself may have been caused and certainly exacerbated by international financial flows chasing high asset

These events have brought about a renewed interest in the application of capital controls and in their effectiveness as a policy tool to manage capital flows. As noted by Forbes et al. (2012), even erstwhile advocates of capital market liberalization such as the International Monetary Fund (IMF) have in recent years become supportive of the judicious use of capital controls. This debate has been boosted by a series of policy and research papers, most notably from the IMF, providing guidance for countries and recommendations on how to design appropriate policy responses to changes in capital flows. In a recent IMF Staff Discussion Note, Ostry et al. (2012) recognize the use of capital controls as legitimate under certain conditions and argue that multilateral considerations must be taken into account in assessing the merits of capital controls at the individual country level, including taking into account the possible externalities for other countries in the form of deflection of flows.

However, empirically documenting and studying these effects is complex, as one must disentangle various domestic and international dependencies that drive capital flows, and this requires a comprehensive global perspective. It is well known that omitting relevant information in empirical models can easily lead to incorrect conclusions. Hence, our ambitious objective in the research reported in this paper is to construct an empirical model of the global economy that is sufficiently sophisticated as to be capable of capturing these interdependencies, yet sufficiently manageable as to be empirically informative in assessing whether the imposition of capital controls may trigger deflection effects. In order to do this, we employ an approach developed in the wake of the 1997-98 East Asian Crisis for modelling and simulating the dynamic interaction of very large systems such as the global macroeconomy, namely Global Vector Autoregressive (GVAR) modelling originally proposed in Pesaran et al. (2004). The GVAR approach provides a relatively simple yet highly effective way of modelling interactions in a complex high-dimensional system preserving theoretical coherence and statistical consistency. Alternative approaches to handling very large models are often incomplete in that they do not model a closed system, which is often essential for simulation analysis (Granger & Jeon, 2007). For further research on GVARs see, amongst others, Dées et al. (2007b), Chudik & Pesaran (2014) and Chudik & Fratzscher (2011). See also the recent applications by Georgiadis (2016), Chen et al. (2016) and Anaya et al. (2017).

The early literature on modelling portfolio capital flows (PCFs) focussed on foreign and recipient country factors, known as push and pull factors, respectively.[2] However, there may be other observed and/or unobserved factors that may result in spatial dependencies in PCFs to emerging market countries. Several recent papers, including Forbes & Warnock (2012), Fratzscher (2012), Ghosh et al. (2012) and Ahmed & Zlate (2014), document evidence of such dependencies. Incorporating relevant channels of transmission of shocks across countries is crucial for understanding the international transmission of policy shocks. The advantage of a global model is its ability to model international linkages and transmission channels simultaneously in a flexible framework where all variables of all countries are potentially endogenous.

There are several channels through which co-movements or interdependencies in PCFs can be generated. Changes in global push factors may result in a change in the total supply

returns in markets characterized by bubbles, in contrast to the global savings glut explanation of the global crisis advocated by Bernanke (2005) and others.

[2]See, for instance, Calvo et al. (1993), Taylor & Sarno (1997), Edison & Warnock (2008), Mody et al. (2001) and Chuhan et al. (1998).

of capital to be invested in emerging markets. Besides push factors, the literature clearly identifies interdependencies among countries with strong financial or real linkages; see, for example, Dées et al. (2007b) and Chudik & Fratzscher (2011). Hence, developments in one country may affect the expected returns on foreign investment not only in that country, but also in other countries which have linkages with it. These developments need not be macro-financial, but may be based on different considerations that could influence future expected returns on investment, such as geo-political risks. Changes in investor sentiment, combined with herding, may result in surges or sudden stops in capital flows to different countries simultaneously. Such sudden stops and interdependencies may not necessarily result from irrational behaviour. Claessens et al. (2000), for example, argue that the transmission of shocks to capital flows, asset prices or exchange rates among recipient countries can be explained by liquidity and incentive problems faced by rational investors. Overall, these mechanisms would naturally result in spatial dependencies in foreign investment and co-movements in capital flows. In the light of these international dependencies, isolating the impact of capital controls on capital flows necessitates a truly global model that incorporates both developed and developing countries. In our GVAR model we include 25 emerging market countries and 17 developed countries, resulting in more than 200 endogenous variables and about 46 cointegrating relationships within and across countries.

The effectiveness of capital controls and the presence of deflection effects are important considerations for both optimal policy design from the perspective of the individual recipient countries and the efficiency of the allocation of international capital flows across countries. To the degree that surges in PCFs are synchronized, the macroeconomic and financial stability risks that emerging market economies face will be similarly synchronized. In this case, the presence of deflection effects may lead to an inefficient equilibrium where countries impose controls that are too high compared to a setting without deflection effects, or to a setting with coordinated policies. Our results provide mixed evidence on the effectiveness of capital controls in limiting the level of capital flows in the country imposing the controls. Moreover, our findings reveal evidence of intra-regional deflection effects for a small number of countries, primarily in Latin America, while for most other countries in our sample there is no pervasive evidence of capital flow deflection. These results have important policy implications as they suggest that deflection effects should not pose a constraint to the use of capital controls as a policy tool to manage capital flows.

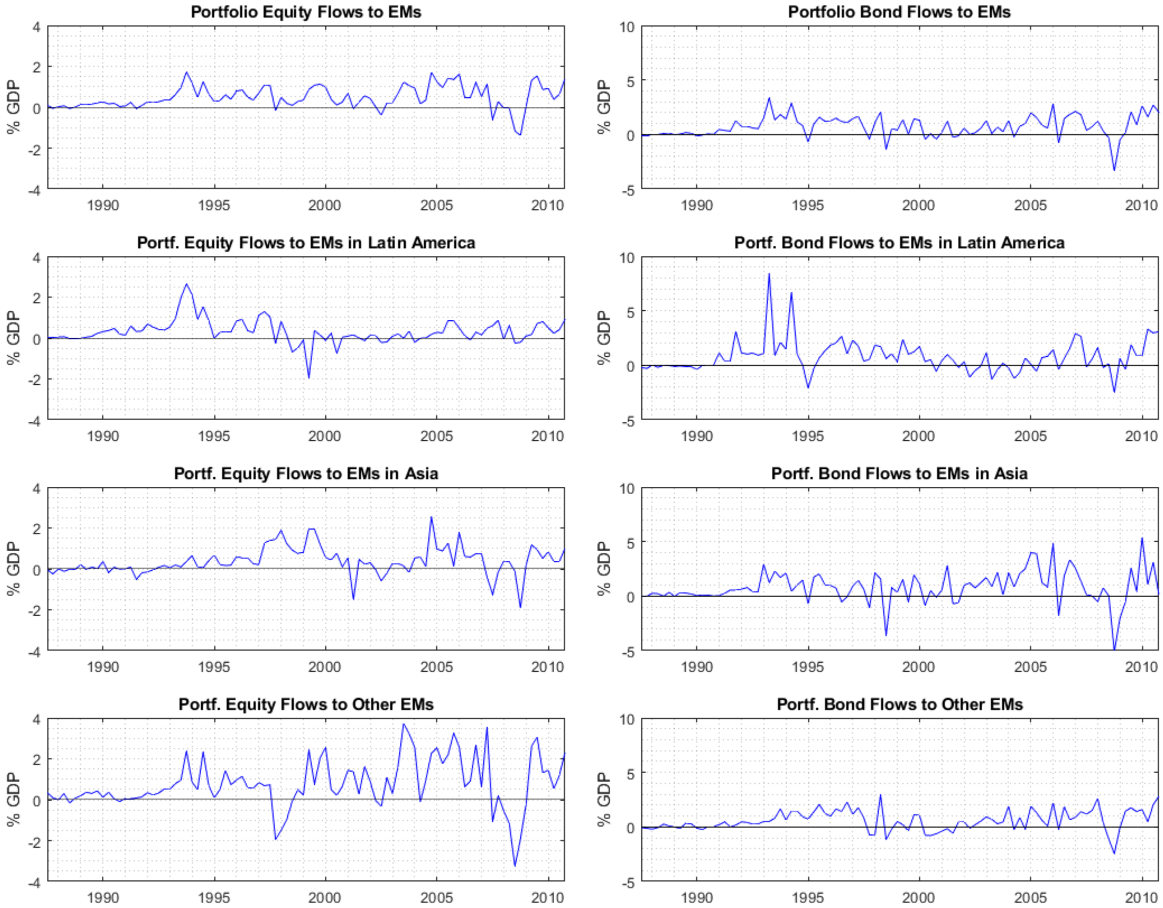
The organization of the remainder of the paper is as follows. Section 2 provides a descriptive analysis of the evolution of capital flows to EMEs over the last two decades, and presents the three measures of capital controls used in our models. Section 3 outlines the empirical methodology and presents the data. Section 4 reports the main empirical results and some robustness analysis. Section 5 concludes.

2 Capital Flows and Capital Controls

2.1 Portfolio Equity and Debt Flows

Before proceeding with the analysis, it is worthwhile to discuss the dynamics of portfolio capital flows to EMs over time. Figure 1 plots average portfolio equity and debt flows

Figure 1: Portfolio Capital Flows to EMs



Latin America includes Argentina, Brazil, Chile, Colombia and Peru; Asia includes India, Indonesia, South Korea, Malaysia, Pakistan, Philippines, Taiwan and Thailand; Other EMs include Egypt, Hungary, Morocco, Poland, Romania, Turkey and South Africa.

to EMs in % of GDP.[3] The capital flows variables used in this paper are non-resident or liability inflows, consisting of non-residents' purchases of domestic assets net of sales. So, these are 'gross inflows' data as opposed to 'net flows', the latter being the sum of gross inflows (mainly driven by foreigners) and gross outflows (mainly driven by domestics). Our measure of 'gross inflows' excludes the actions of domestic investors, that is flows driven by residents (in the form of retrenchment). The reason for using 'gross inflows' (i.e. non-residents' flows only) comes from the findings of Forbes & Warnock (2012) which show that the dynamics of non-resident investment in domestic markets are significantly different from the resident investment in foreign markets, as these can be motivated by different factors and respond differently to various policies and shocks. For example, because of informational advantages, it is plausible that domestic investors would respond more sensitively to changes in local conditions, while foreign investors may be more responsive to changes in global conditions. As our study focuses on the effects of capital controls on portfolio capital inflows to EMEs, we believe that this measure of non-resident inflows is more directly relevant for our analysis.[4] Moreover, in order to consider the heterogeneity

[3]The series depicted in Figure 1 are calculated as *averages* across EMs.

[4]Of course it would be of interest also to consider a parallel analysis of gross outflows of domestic investors, but this is left to future research.

of portfolio flows, in our analysis we further divide capital flows into equity and debt flows, as these are important distinct components of all foreign investments in EMEs.

Table 1: Descriptive Statistics for Portfolio Equity Inflows

	Mean	Std Deviation	Max	Min
Argentina	0.07%	1.87%	5.74%	-15.09%
Brazil	0.63%	1.16%	3.98%	-4.08%
Chile	0.56%	1.01%	3.98%	-1.72%
Colombia	0.11%	0.29%	1.21%	-0.67%
Egypt	0.03%	0.87%	2.26%	-5.34%
Hungary	0.23%	1.78%	5.73%	-8.04%
India	0.76%	1.12%	4.46%	-2%
Indonesia	-0.08%	2.34%	2.85%	-15.92%
South Korea	0.68%	2.01%	5.52%	-6.82%
Mexico	0.43%	0.93%	5.44%	-1.38%
Morocco	0.11%	0.51%	4.38%	-0.61%
Pakistan	0.29%	0.94%	7.89%	-0.69%
Peru	0.14%	0.55%	2.81%	-2.44%
Poland	0.16%	0.64%	3.3%	-1.18%
Romania	0.1%	0.21%	1.24%	-0.15%
South Africa	1.7%	3.1%	11.85%	-11.69%
Taiwan	2.02%	4.07%	15.04%	-11.36%
Thailand	0.95%	1.52%	5.84%	-3.17%
Turkey	0.25%	0.53%	2.11%	-0.97%
Average	0.48%	1.34%	5.03%	-4.91%

Figure 1 illustrates that, across all EMEs, the magnitude of equity and debt flows increased substantially since the beginning of 1990s and both flows have shown periods of high volatility. For instance, both increased heavily in the years before the global financial crisis, turning suddenly negative during the crisis, followed by a sharp surge in the post-crisis period. However, portfolio capital flows to specific regions shows some differences in their dynamics. For instance, capital flows to Latin America accelerated in the beginning of the '90s, ending with the Mexican debt crisis of 1995, while in Asia the accelaration of portfolio equity flows did not begin until a few years later. Also, the 1997-98 Russian and East Asian Crises led to a significant fall in portfolio capital flows to Asia.

To further highlight the differences across capital flows to different emerging market countries, Table 1 and 2 present descriptive statistics for portfolio equity and debt flows to individual EMs, respectively. One can see that for several countries, including Argentina, Brazil, Mexico, Peru, Hungary and Poland, the maximum and minimum values of debt inflows are much more extreme than the corresponding values for equity inflows. Additionally, on average equity inflows have been more stable and smaller in magnitute compared to debt flows, as clearly indicated by the average mean and standard deviations across all EMEs.

Table 2: Descriptive Statistics for Portfolio Debt Inflows

	Mean	Std Deviation	Max	Min
Argentina	0.71%	5.79%	41.47%	-10.23%
Brazil	0.98%	4.24%	38.8%	-5.02%
Chile	0.82%	1.88%	7.66%	-2.72%
Colombia	0.59%	1.47%	7.6%	-2.53%
Egypt	0.19%	1.48%	5.12%	-4.19%
Hungary	2.01%	5.33%	17.27%	-13.38%
Indonesia	0.67%	1.75%	12.61%	-3.28%
South Korea	1.1%	1.96%	8.98%	-5.77%
Mexico	0.89%	2.5%	8.72%	-10.1%
Pakistan	0.04%	0.64%	2.46%	-1.75%
Peru	0.79%	2.13%	9.51%	-4.06%
Philippines	1.27%	3.06%	11.9%	-6.1%
Poland	0.98%	2.35%	10.37%	-3.19%
Romania	0.2%	1.53%	6.44%	-8.24%
South Africa	0.78%	2.66%	8.18%	-6.8%
Taiwan	0.19%	1.08%	6.3%	-5.13%
Thailand	0.26%	1.32%	4.82%	-3.11%
Turkey	0.73%	2.07%	4.51%	-8.8%
Average	0.73%	2.4%	11.82%	-5.8%

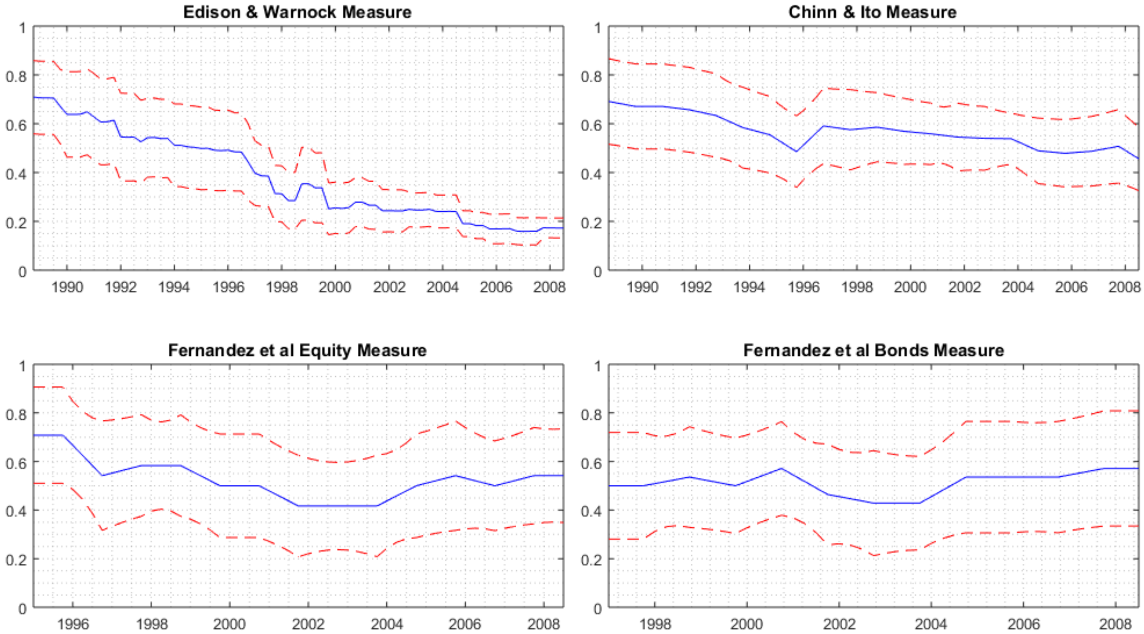
2.2 Capital Control Indicators

A common difficulty in studying the effects of capital controls on capital flows arises immediately in the availability of an appropriate measure of capital controls or financial openness. The existing literature has used various different measures of capital controls, which may be classified into two categories, $dejure$ (i.e. official) and $defacto$ (i.e unofficial or 'in actual fact') measures. Each has advantages and disadvantages. $dejure$ measures are mostly constructed using the IMF Annual Reports on Exchange Arrangements and Exchange Restrictions (AREAER). As Kose et al. (2009) argue, a common problem with these measures is that they do not necessarily reflect actual capital account openness and whether the controls are enforced effectively.

In this paper we employ three measures of capital controls: the $defacto$ measure from Edison & Warnock (2003), and two $dejure$ measures: Chinn & Ito (2008) and Fernández et al. (2015).

The Edison & Warnock (2003) measure has the advantage of being available at a monthly frequency for a large number of emerging market countries, albeit for a limited period of time. In order to be able to use this index in our GVAR model which is built on quarterly data, we have reconstructed and extended the original dataset at a quarterly frequency for the period 1990Q3-2008Q3, using data obtained from Datastream. This measure is calculated using the Standard and Poor's (S&P) International Finance Corporation Global (IFCG) and Investable (IFCI) indices. The Global index represents the overall market portfolio, while the Investable index represents that portion of the market available to foreign investors. Therefore, the ratio of the market capitalizations of equities in the IFCI and IFCG indices naturally yields a measure of equity market openness, and

Figure 2: Capital Controls Measures



Blue and red lines represent the mean and half standard error bands across EMs respectively. Lower values indicate lower levels of capital controls and high values indicate stronger controls. Chinn & Ito measure has been reversed and normalized to be between zero and one for ease of comparison. The Fernandez measures are on capital inflows.

hence, one minus this ratio provides a measure of the intensity of capital controls for a given country. The measure varies from zero to one, with a value of zero representing no restrictions (a completely open market), and a value of one indicating a completely closed market.[5] The major shortcoming of the Edison & Warnock (2003) measure is the fact that it focuses only on direct investment restrictions on foreign ownership of domestic equities. It does not capture other types of controls, including taxes or controls imposed on other securities or derivatives.

The second measure of capital controls used in this paper is the *de jure* measure of capital account openness of Chinn & Ito (2008), based on the IMF's AREAER. This is one of the few measures of capital controls available back to 1985 for a broad sample of countries.This is an aggregate measure of controls on both inflows and outflows that combines equity and debt restrictions. The measure focuses on regulatory aspects of capital account openness, incorporates the extent and intensity of capital controls, overcoming some of the shortcomings of the *de facto* measure of Edison and Warnock. This index is such that higher values indicate greater openness. Although this measure covers a wide range of countries, it is only available at an annual frequency. Therefore, in order to be able to use this index in our GVAR model, we have reconstructed the whole series at a quarterly frequency, by implementing different interpolation procedures as in Boot et al. (1967) and Chow & Lin (1971), described in detail in the Data Appendix. Moreover, in order to facilitate comparison with the other indices, we have normalised the index with values from zero to one, with zero representing no restrictions.

[5]Following Edison & Warnock (2003), we also improved the measure by smoothing it to correct for asymmetric price fluctuations in the two indices, by dividing market capitalizations by the price indices. See the Data Appendix for more details.

The two measures described above are available with broad time and country coverage, but they are both aggregate indices of capital account openness. On the other hand, other measures, such as Schindler (2009), available at a finer level of disaggregation, are more limited in terms of sample coverage. Recently, however, Fernández et al. (2015) have made available an updated and extended version of the dataset originally constructed by Schindler. This is a disaggregated *de jure* capital control measure, which differentiates both by type of capital flow (categories of assets: equity and debt) and by whether the capital controls are on inflows or outflows (directions of transactions). The dataset is based on annual information published by the IMF and is available over the period 1995-2013. We have reconstructed this measure at a quarterly frequency, and used it in our GVAR model as a further alternative measure of capital controls.

Table 3: Descriptive Statistics for Alternative Capital Control Measures

	EW	CI	F (Equity)	F (Bond)
Mean	0.25	0.57	0.50	0.51
Max	0.40	0.69	0.58	0.57
Min	0.16	0.46	0.42	0.43
Std Deviation	0.07	0.06	0.06	0.04

Latin America	EW	CI	F (Equity)	F (Bond)
Mean	0.18	0.39	0.49	0.39
Max	0.21	0.6	0.67	0.67
Min	0.15	0.2	0.33	0
Std Deviation	0.02	0.13	0.15	0.23

Asia	EW	CI	F (Equity)	F (Bond)
Mean	0.31	0.64	0.59	0.48
Max	0.56	1	0.83	0.67
Min	0.17	0.28	0.5	0.25
Std Deviation	0.12	0.15	0.11	0.15

Other	EW	CI	F (Equity)	F (Bond)
Mean	0.16	0.37	0.45	0.54
Max	0.23	0.57	0.5	0.7
Min	0.08	0.14	0.17	0.4
Std Deviation	0.05	0.1	0.1	0.1

Latin America includes Argentina, Brazil, Chile, Colombia and Peru; Asia includes India, Indonesia, South Korea, Malaysia, Pakistan, Philippines, Taiwan, Thailand; Other EMs include Egypt, Hungary, Morocco, Poland, Romania, Turkey and South Africa.

Table 3 presents the descriptive statistics for the three alternative capital control measures employed in this paper, across all EMEs and by major regions. We can see that all the three indices indicate a more open market on average for the Latin American EMEs than in the Asian EMEs. Higher variability is indicated within the Asian countries than the Latin American countries, by the standard deviation of the Edison & Warnock and Chinn & Ito indices. The Fernandez index shows similar level of capital controls on average for equity and bonds in Latin America, while in the Asian countries the level of capital controls on equity flows is higher on average than that on debt flows. Figure 2 shows that there are co-movements in the evolution of the two most aggregate measures of capital controls, the Edison & Warnock and the Chinn & Ito indices. Compared to the mid '90s, the two aggregate indicators show a gradual decrease in the level of controls over the sample period, although this is more accentuated in the Edison & Warnock index. On the other hand, the two Fernandez indices show a more stable evolution across time, on average over all countries, although from the descriptive statistics in Table 3 we have seen notable differences both across and between regions.

The three measures of capital controls described here will be used in turn, in our analysis below, aimed at detecting possible deflection effects of capital controls across EMs.

3 Empirical methodology and model specification

The purpose of this research is to assess, within a global setting, the efficacy of capital controls and potential deflection effects on other countries. In order to do this, we need to capture the complex dynamic interactions of capital flows with both domestic and global factors. In doing so, we face the daunting task of modelling the salient time-series characteristics of the whole global macroeconomy. The Global Vector Autoregressive Modelling or GVAR methodology which we employ in this research has been developed for precisely such purposes. Its main feature is to take into account the financial and real linkages connecting the world economies. In this section, we therefore give a brief description of this approach, as well as of its evolution, and present the model specification, the countries and the variables included in the model.

3.1 Global Vector Autoregressive Model

The well known Vector Autoregressive (VAR) modelling methodology pioneered by Sims (1980) was an attempt to capture the dynamic interactions and complexity of macroeconomic systems without recourse to the 'incredible identifying assumptions' employed by structural macroeconomic models. VAR models generalize univariate autoregressive (AR) models by allowing for more than one evolving variable. In a simple VAR all variables are treated symmetrically and each has an equation explaining its evolution based on its own lags and the lags of the other model variables.[6] An extension of this allows the VAR to be conditioned on lags of other variables, whose evolution is not modelled within the system, by simply including lags of those variables in each equation.[7]

While the VAR methodology and its extensions, such as the Structural VAR and Vector Error Correction Model (VECM) have proved useful in modelling and simulating the macroeconomy, they nevertheless suffer from the 'curse of dimensionality' in that, given

[6]While, in any particular application, a VAR system may accord intuitively with a system of variables suggested by economic theory, it may be more formally justified by a statistical theorem (Wold's representation theorem), which states that any jointly covariance stationary vector time series will have an infinite vector moving average representation, since the VAR can be interpreted as a finite approximation of the infinite moving average; see e.g. Canova (2007).

[7]It should be noted, however, that applied VAR analysis will often invoke a number of identifying restrictions concerning the temporal causality of innovations in the system, since this is typically required in order to identify the impulse-response functions. See, for example, the Structural VAR (SVAR) approach developed by Blanchard & Watson (1986), Blanchard & Quah (1993) and others.

the typical span of most time-series datasets, degrees of freedom are quickly exhausted as the number of endogenous variables in the system is expanded beyond a relatively small number, typically around six to eight.

One recent response to this has been to attempt to summarize large data sets into just a few series, or 'factors', and to augment VAR or VECM systems with those factors as exogenous or conditioning variables, resulting in Factor Augmented VAR (FAVAR) systems (see, e.g., Bernanke et al., 2005; Mumtaz & Surico, 2009; Kim & Taylor, 2012).[8] However, while FAVAR modelling may be useful for conditioning relatively small systems–a single macroeconomy or monetary system, for example–on exogenous factors summarizing potentially very big datasets, it is less useful for modelling and simulating the dynamic interaction of very large systems, such as the global macroeconomy. The GVAR approach, originally proposed by Pesaran et al. (2004), is designed to do exactly that, and is the methodology used in this paper.

The GVAR methodology is a two-step procedure. In the first step, relatively small-scale country-specific models are estimated conditional on the rest of the global economy. These country-specific models are represented as standard VAR models of domestic variables augmented by variables that are cross-section weighted averages of foreign variables, commonly referred to as foreign-star variables. The literature refers to these country-specific models as VARX* systems, that is VAR models that condition on a set of (assumed) exogenous variables, or VECMX* if they involve cointegrating relationships. In the second step, the estimated individual country-specific models are stacked and solved simultaneously as one large global VAR, i.e. GVAR, model. The resulting GVAR model can then be used for forecasting and simulation analysis exactly as with lower-dimensional VAR models. In contrast to the six or eight endogenous variables typically modelled in a VAR or FAVAR analysis, as described below, we apply the GVAR methodology to model and simulate the full dynamic interaction of over 200 endogenous variables and 46 cointegrating relationships.

Similar to Mody et al. (2001), to capture the dynamic interaction of capital flows (F) and their underlying domestic variables (X), global observed factors (d) and global unobserved fundamentals (f), we specify the following VARX* model for each country $i = 1, 2, ..., N$, and time periods $t = 1, 2, ..., T$:

$$y_{it} = \delta_{0i} + \delta_{1i}t + \sum_{l=1}^{p} \Gamma_{ily} y_{it-l} + \sum_{l=0}^{q} \Gamma_{ily^\star} y^\star_{it-l} + \sum_{l=0}^{q} \Gamma_{ild} d_{t-l} + \varepsilon_{it}, \tag{1}$$

where $y_{it} = (F'_{it}, X'_{it})'$, and following Dées et al. (2007b) and Pesaran (2006), we account for unobserved global push factors f by using cross-sectional averages of corresponding (weakly exogenous) foreign variables $y^\star_{it} = (F'^\star_{it}, X'^\star_{it})'$ (i.e. foreign variables relative to country i). d is the vector of global factors affecting every country, δ_{0i} and δ_{1i} are coefficient vectors, and Γ_{ily}, $\Gamma_{ily^\star}$ and Γ_{ild} are coefficient matrices of suitable dimension. The construction of country-specific foreign-star variables involves choosing appropriate weight or 'link' matrices to obtain weighted cross-sectional averages. These link matrices are typically constructed using data from bilateral foreign trade or capital flows.

[8] One simple way of constructing these factors is to construct principal components of the large datasets on which the researcher wishes to condition the analysis and to use the first few of these as conditioning variables in the VAR, see, e.g., Bernanke et al. (2005).

The GVAR model is obtained in the second step, by stacking all of the country models, one on top of the other, using the link matrices defined to construct country-specific foreign variables, as in Smith & Galesi (2011). So the final GVAR model is equivalent to a large scale reduced form VAR, with several within and cross-equations restrictions. More formal details of the structure of the GVAR representation are provided in Appendix A.

A key point to note about the model (1) is that most of the fundamentals are likely to be non-stationary and cointegrated, so in order to test for cointegration between fundamentals we first specify a country-specific conditional Vector Error Correction Model (VECMX*) to obtain estimates of the long-run cointegrating relationships and the disequilibrium terms.[9] Once the disequilibria from the estimated long-run relations (the error correction terms) have been obtained, the short-run parameters of the country models are estimated by Seemingly Unrelated Regressions (SUR) methods.

3.2 Dataset and Model Specification

We now turn to the description of the underlying data. We implemented the GVAR model by using quarterly data for an initial sample of 42 countries, over the period 1988Q4 - 2010Q4, covering several interesting episodes including the crises in Asia in the 1990s and in Latina America in the early 2000s, and the Global Financial Crisis of 2008-2009. Both the sample period and the selection of countries are constrained by data availability, especially determined by a large set of variables required for the construction of capital controls indicators and also by the fact that not all the countries report capital inflows disaggregated by equity and debt.

The sample for our GVAR model covers a broad range of countries, including 25 emerging market countries and 17 developed countries, all together aggregating to around 90 per cent of world GDP. While for each country in the EMEs group we estimate an individual VARX* model, as explained in the methodology section above, the developed countries will be grouped together to form a single 'Developed Country' model, using aggregated variables obtained as cross-section weighted averages, as explained in more detail below.

Specifically, our sample of EMEs include: China, Hong Kong, India, Indonesia, Korea, Malaysia, Pakistan, the Philippines, Singapore,Taiwan and Thailand; Argentina, Brazil, Chile, Colombia, Mexico and Peru; Hungary, Poland, Romania and Turkey; Egypt, Morocco and South Africa. While in the Developed Country Model we include: Australia, Austria, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, New Zealand, Spain, Sweden, Switzerland, the United Kingdom, the United States, and also Saudi Arabia.

Regarding the composition of EMEs versus developed countries, this varies across studies, particularly with respect to Hong Kong and Singapore, as given their importance as world financial hubs, their dynamics can be very different from that of emerging market countries. So, their classification depends very much on the focus of the analysis. Our main rationale for classifying Hong Kong and Singapore within the EMEs is that in doing

[9]Following the suggestion of Rahbek & Mosconi (1999), we include cumulated I(0) variables as I(1) weakly exogenous variables in the conditional model.

so, we will estimate unit-specific models also for these two important financial hubs, rather than modelling them as part of a single aggregate developed country model, therefore taking more directly into account the financial and real linkages connecting them to the other EMEs, particularly in the Asian region.[10] Several recent papers from the literature on international capital flows, capital controls and global spillovers, including Forbes & Warnock (2012), Georgiadis (2016) and Chen et al. (2016), have used samples based on a similar choice and classification of countries.

Beside inevitable data availability constraints, the coverage of countries has been guided by our aim of obtaining an econometric model that can reasonably and comprehensively represent the global economy, provide insights on the drivers of capital flows, and explicitly address the question of whether there is any empirical evidence of deflection effects induced by capital controls.[11]

In our analysis we break down capital flows into portfolio equity flows (EF) and debt flows (DF), and construct separate GVAR models for each of these two categories. The models include real and financial variables which are commonly highlighted in the literature on the drivers of capital flows. These include real GDP (Y), current account (CA), sovereign credit ratings (CR), ratio of reserves to short-term debt (RSD), short-term interest rates (SR), inflation ($Dcpi$), real equity prices (SM), real effective exchange rate ($REER$), a Capital Control index (CC) and the VIX Index (VIX). A detailed definition of the variables, a full list of original sources and a description of how the data have been constructed is provided in Appendix B.[12]

In the light of the literature, country-specific variables are chosen both on the basis of their importance for flows and to construct a comprehensive global model that allows for rich dynamics between flows and their underlying fundamentals. Capital flows are found to be pro-cyclical and related to the business cycle, therefore, as an indicator of the business cycle and overall economic activity we have included real GDP. Ghosh et al. (2012) argue that higher growth may increase both financing requirements and possible returns on foreign investment in the respective country. Real equity prices are related to the developments and returns in the local market which may be relevant for flows, based on evidence of return chasing behaviour of foreign investors. Inflation is another important macroeconomic indicator, as it may erode the real value of returns on unhedged investment and short-term interest rates are a proxy for domestic returns. As in Taylor & Sarno (1997) and Mody et al. (2001), sovereign credit ratings has been included as an indicator of creditworthiness. Calvo et al. (1993) and Ghosh et al. (2012) document that real effective exchange rate is closely related to flows. The current account represents

[10]We thank a referee for raising this point.

[11]For example, Belgium and Luxembourg are not included in our sample since some of the data for these countries are available only after 1999. These countries formed the Belgium Luxembourg Economic Union (BLEU) and some data, such as International trade statistics, were available for BLEU only as a combined entity until 1999, when European Community rules required split information. Moreover, other OECD countries could have been included, such as Denmark and Ireland. However, our sample of developed countries is highly representative for the type of analysis that we want to conduct, and given that in the implementation of the GVAR the developed countries enter as an aggregate single model, inclusion of other small open economies, constituting around 0.4 per cent of world GDP each, would not make a material difference to key results.

[12]As described in the Data Appendix, four different interpolation methods have been used in constructing our dataset, namely, the methods by Chow & Lin (1971), Dées et al. (2007b), Boot et al. (1967) and the 1D Interpolation. The Matlab library on temporal disaggregation and interpolation provided by Quilis (2009) has been used for Chow & Lin (1971) and Boot et al. (1967) methods.

external financing needs and the ratio of reserves to short-term debt has been included as an indicator of both occurrence and severity of crises across countries. Finally, the VIX has been included as an indicator for global risk appetite, since it has been depicted to be an important driver of capital flows, see, for example, Forbes & Warnock (2012) and Ghosh et al. (2012).

The construction of country-specific foreign-star variables involves choosing appropriate weight matrices to obtain weighted cross-sectional averages. Following the literature, all foreign-star variables, except flows, are constructed using trade data from the IMF direction of Trade Statistics, IMF (2012). The total volume of trade (average of exports-plus-imports during 1998-2001) is taken as a measure of interconnectedness between countries. For foreign flows variables, the weights between countries have been set equal to the pair-wise correlation coefficients of flows to the respective countries. Weights are then normalized such that the total weights sum up to one for each country. Foreign capital control weights are constructed as $AF_i/\sum_j AF_j$, where AF_x represents average inflows to country x during the sample period. These weights reflect the relative importance of foreign countries in attracting foreign capital.

Depending on data availability, a typical emerging market country model includes as domestic fundamentals $Y_{it}, SR_{it}, Dcpi_{it}, Reer_{it}, SM_{it}, CR_{it}, CA_{it}$, RSD_{it}, as foreign-star variables $Y^{\star}_{it}, SR^{\star}_{it}, Dcpi^{\star}_{it}, SM^{\star}_{it}, CR^{\star}_{it}, CA^{\star}_{it}, RSD^{\star}_{it}$ and as global variable VIX_t. As mentioned above, separate GVAR models have been constructed for portfolio equity flows (GVAR-EF) and debt flows (GVAR-DF), including as foreign-star variables in the conditional country models $EF^{\star}_{it}$ and $DF^{\star}_{it}$, respectively. Furthermore, the single Developed Country model (named DC model), is estimated using aggregated variables obtained as cross-section weighted averages, with weights based on the PPP valuation of country GDPs.[13] In this model, only $Y^{\star}_{it}$ has been included as a weakly exogenous foreign variable.[14] Finally, three alternative capital control measures, described in section 2.2, are introduced in the GVAR model when we turn our attention to the study of the direct and deflection effects of capital controls.

Details of model specification, including tests for non-stationarity, lag order determination, cointegration rank, weak exogeneity, diagnostic tests and tests for model adequacy are reported in Appendix C.

4 Empirical results

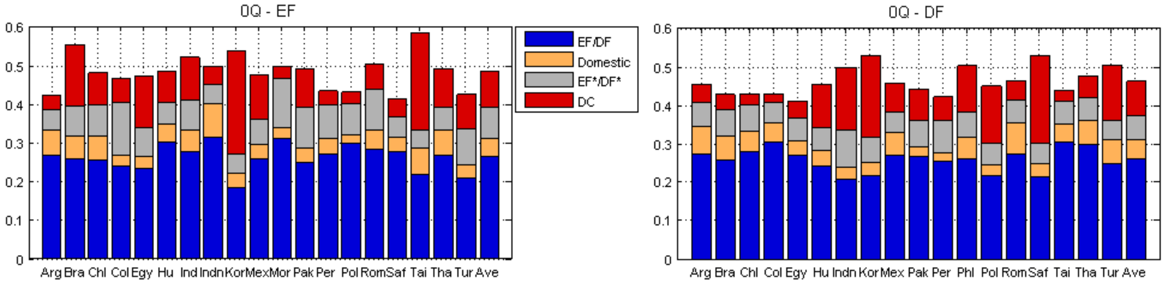
4.1 The benchmark model

Before we present the results of our investigation of the direct and multilateral effects of capital controls, we summarise the main findings from an exercise which shows how our benchmark GVAR model captures the complex dynamic interactions of capital flows with domestic and global variables. The exercise sheds light on the relative importance of various domestic and global fundamentals for PCFs over the sample period 1987Q3-2010Q4, and was conducted by means of generalized forecast error variance decomposi-

[13]See Dées et al. (2007b) for a similar aggregation for the Euro-zone.

[14]Matlab codes by Smith & Galesi (2011) have been modified by the authors to carry out all of the GVAR estimations.

Figure 3: GFEVD: Total Contribution of Pull vs Push factors



tions (GFEVDs).[15] These results are discussed only briefly in this section, while a more detailed discussion can be found in Appendix D.

Regarding the long-debated issue of the relative importance of pull (domestic) and push (foreign) factors in driving capital flows, our results indicate that the latter dominate the former. Figure 3 presents, for each country, the normalized percentage contributions of domestic variables, domestic and foreign capital flows and developed countries (DC) variables in explaining PCFs. On average, the DC variables seem to have contributed towards the variability in PCFs by more than the domestic factors for both types of flows, both contemporaneously and at the four-quarter horizon. The partial importance of domestic factors, excluding portfolio capital flows' own innovations from domestic contributions, seems to increase at the four-quarter horizon, even though they are still outweighed by the DC factors. Concerning the foreign-star variables $EF^\star$ and $DF^\star$, that is equity and debt flows in other countries, which directly proxy for possible inter-linkages of flows across countries, the results suggest that these variables contribute to the variability of their domestic counterparts by more than the domestic fundamentals, and almost as much as the DC variables, on average across countries. However, there are notable differences across countries regarding the relative importance of these factors. For example, there seems to be an interesting pattern in terms of the relative importance of the $EF^\star$ and $DF^\star$ variables with respect to the DC-push factors, whereby flows to countries that are smaller in terms of GDP appear to depend more on flows to other countries. These findings seem to indicate that PCFs to countries smaller in economic size are more subject to spatial dependencies and/or contagion.

At an aggregate level, by averaging the contributions of each fundamental across all EMEs, we find that, amongst the domestic variables, real equity prices (SM), credit ratings (CR) and the real effective exchange rate (Reer) have a relatively higher contribution than the other domestic variables in explaining the forecast error variance of equity flows, contemporaneously. Similar results are obtained for debt flows, with the exception of equity prices which appear to be the least important factor in the forecast error variance decomposition of debt flows. Equity prices in developed countries are also found to be important in the forecast error variance decomposition of equity and debt flows, followed by real GDP. Finally, the VIX index appear to contribute more towards the variability of debt flows than equity flows. See Appendix D for more detailed results and figures.

[15] As developed by Koop et al. (1996) and Pesaran & Shin (1998), this technique serves as a useful method of finding out the proportion of a variable's forecast error variance that is attributable to itself or other model variables at different horizons.

Finally, in general we find substantial heterogeneity in the importance of different domestic fundamentals amongst countries, while there seems to be less heterogeneity regarding the relative importance of foreign star variables and variables from the developed countries block. Ghosh et al. (2012) argue that foreign factors act as "gate-keepers" for capital flows, meaning that they have a significant role in the occurrence of surges. Our results seem to be in line with this argument, indicating a higher degree of similarity across countries regarding the importance of foreign variables in explaining equity flows.

4.2 The Effects of Capital Controls

We now turn our attention to our major task which is to empirically assess the direct and multilateral effects of capital controls. We start this analysis by including in our benchmark GVAR model the *de facto* measure of capital controls by Edison & Warnock (2003). We then repeat the analysis with the other two alternative indices described in Section 2. The Edison and Warnock index is one of the most popular measures of aggregate capital controls that has been used in empirical research. This measure, as described in Section 2, was initially available only for a limited period, at a monthly frequency. Using data from Datastream we were able to reconstruct and extend the index at a quarterly frequency for the period 1990Q3 to 2008Q3. The index ranges between zero and one, with higher values indicating higher levels of controls.

Following the standard approach in the GVAR literature, we employ Generalized Impulse Response Functions (GIRFs), introduced by Koop et al. (1996) and developed by Pesaran & Shin (1998) and Dées et al. (2007b), in order to examine the impact of shocks to capital controls on the dynamics of portfolio equity and debt flows. The shock is specified as a one standard error country-specific positive shock to the capital control measure, simulating a tightening of the controls.[16] As discussed in Section 2, one limitation of this measure is that it focuses only on direct investment restrictions on foreign ownership of domestic equities. However, to the degree that equity market restrictions are introduced as part of a broader capital controls package, this measure should still provide a good proxy for the overall tightening of controls. In fact, Edison & Warnock (2003) find that their measure is highly correlated with general measures of capital account openness. Moreover, even if the restriction is only in the equity market, investors may form expectations of tougher restrictions in the given country overall.[17] The responses of equity flows (EF) and debt flows (DF) to this shock are reported for some selected countries in Tables 4 and 5, respectively. The tables report, in matrix form, the significance level and the sign of the EF and DF responses, at the zero-quarter and one-quarter horizons. The blank cells in the tables indicate no significant response. Responses at longer horizons were in general not significant.

[16] A look at the effects of a relaxation, rather than a tightening, of the controls would also be an interesting analysis, considering that most EMEs relaxed many of the controls over our sample period. However, this would take us away from our main aim which is to assess the direct and multilateral effects of controls.

[17] For a discussion of the signalling channel see, for example, the study by Forbes et al. (2012) on the effects of changes in Brazil's tax on capital inflows in 2006-2011, which found that an increase in tax on foreign investment in bonds causes investors to significantly decrease their portfolio allocations to Brazil in both bonds and equities.

Table 4: GVAR-EF Benchmark Specification: EF Responses to Capital Control Shocks

	0Q - EF Response				1Q - EF Response							
Shock	Arg	Chl	Col	Per	Arg	Col	Hu	Kor	Safr	Taiw	Thai	Turk
Arg								+*				
Bra			+*		+*							
Chl		-**										
Egy												
India												
Indn												
Kor									-*			
Mex		+*		+*								
Taiw	+*				+**	+**	-*		-*	-**	-*	
Thai												
Turk												+*

⋆, ⋆⋆ denote significance using 10-90 and 5-95 quantiles of bootstrap GIRFs respectively.

Table 5: GVAR-DF Benchmark Specification: DF Responses to Capital Control Shocks

	0Q - DF Response							1Q - DF Response				
Shock	Bra	Chl	Indn	Per	Rom	Safr	Turk	Egy	Per	Phlp	Taiw	Turk
Arg												
Bra	-**		-*	+*								
Chl												
Egy												
Indn		-*				+*						
Kor							+*		+**	+*		
Mex					+*							
Phlp								+*				
Taiw											+**	
Thai												
Turk												+**

⋆, ⋆⋆ denote significance using 10-90 and 5-95 quantiles of bootstrap GIRFs respectively.

4.2.1 Direct portfolio effects of capital controls

Starting with the results for equity flows, as we can see from Table 4, for most countries, the direct response of equity flows to tightened capital controls do not appear to be significant, with the exception of a small number of countries for which an increase in capital controls temporarily reduces the level of flows. In particular, the results suggest that only in Chile capital controls seem to be effective in changing instantaneously the level of equity flows domestically, since the contemporaneous response is negative and significant. The other country for which we observe a significant negative response to a shock in the capital control measure is Taiwan, where the level of equity flows is significantly reduced after one quarter.

Regarding the results from the GVAR model for debt flows (Table 5), a contemporaneous and temporary reduction in debt inflows is observed only for Brazil, a results which is consistent with the analysis of Forbes et al. (2012). The table also reports cases like Turkey, where the direct response of equity and debt flows to a shock in the capital controls measure is significantly positive after one quarter, which could be taken as an indication that the controls in that country are not binding. Debt flows respond significantly and positively also for Taiwan, after one quarter, which is an interesting finding, having just observed in Table 4 that the same shock resulted in a significant reduction in equity flows, and might suggest some portfolio rebalancing effects.

Several studies find that controls do not successfully alter the volume of capital flows, but they do affect the composition of capital flows. Our finding that controls are largely ineffective may well reflect compositional effects.[18] Overall, our findings so far seem to be broadly consistent with those of Binici et al. (2010), who analyse the effectiveness of controls in changing the level of equity and debt inflows, using panel data techniques, and reach the conclusion that controls have no significant effects on either type of flows across countries.

4.2.2 Deflection effects of capital controls

We now investigate the impact of capital controls on equity and debt flows to other countries. As in the case of direct effects, we also find mixed evidence on the extent of deflection effects to third countries. Tables 4 and 5 indicate that only in a small number of cases do we observe an increase in capital flows to third markets as a result of the tightening of capital controls in the recipient country.

In particular, it is of interest to note some intra-regional substitution effects for capital flows, especially in Latin America, with significant deflection effects to third countries, primarily following increases in capital controls in Brazil and Mexico.

With regard to equity flows deflections (Table 4), significant instantaneous (at quarter zero) responses are observed for Colombia following a tightening of capital controls in Brazil, and for Chile and Peru following capital flow restrictions in Mexico. At the 1-quarter horizon, significant responses are observed for Colombia and Argentina following a positive shock to capital controls in Taiwan, and for Argentina following an increase in capital controls in Brazil. The finding of significant externalities generated by Brazilian capital controls is again in line with the research of Forbes et al. (2012).

Fewer cases of deflection effects have been detected also for debt flows (Table 5). These include significant responses in Turkey (at quarter zero) and Peru (at quarter one) following an increase in capital controls in Korea, a significant response in Egypt (at quarter one) following a shock to capital controls in the Philippines, and in Peru (at quarter zero) following a tightening of controls in Brazil. However, a part from the substitution effect from Brazil to Peru, in none of the other cases there seems to be a plausible explanation for flows to spillover from one country to another.

In the next sections we examine whether the results obtained in the benchmark GVAR specification are robust with respect to changes in model specification, including the use of different capital controls measures, identification strategies and ways of constructing foreign star variables.

[18]See Ostry et al. (2011) for a discussion of previous findings in the literature.

4.2.3 Robustness Checks: Alternative GVAR specifications

In order to check whether the results are sensitive to the particular way the empirical setup has been implemented, following standard practice in GVAR models, we consider a variety of alternative model specifications, including different capital controls measures, identification schemes for the impulse response functions, cointegration rank and foreign controls variables. For this analysis we have considered in total 22 alternative GVAR specifications, described in detail in the Appendix.

The first alternative measure of capital controls used as a robustness check is the Chinn & Ito (2008) index, which we have reconstructed at a quarterly frequency and described in Section 2.

The major outcome from our robustness analysis is that there is no pervasive evidence for the presence of either systematic deflection effects, or domestic effectiveness of capital controls. However, there is some consistent evidence across the 22 specifications for both deflection effects and domestic capital controls effectiveness for some of the countries in the sample. Table 6 summarizes these results.

Table 6: Robustness Analysis: effects of shocks on capital controls

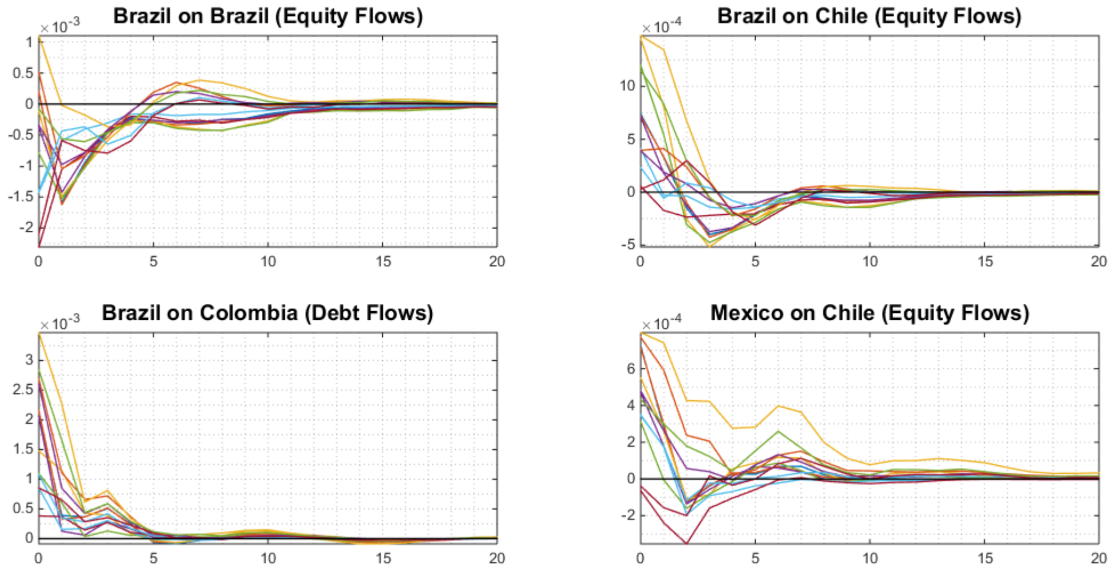
	Equity Flows					Debt Flows
Spec	Bra→Col	Bra→Arg	Mex→Chl	Mex→Per	Taiw→Taiw	Bra→Bra
(1)	+*	+*	+*	+*	-**	-**
(2)	+**	+*		+*	-**	-**
(3)	+**	+**	+*			-*
(4)					na	-*
(5)			+*	+**	na	-*
(6)	+**	+*	+*	+*	-**	-**
(7)	+**	+**	+*	+*	-*	
(8)	+**	+**			-**	-*
(9)	+**	+**		+**	-**	
(10)					na	na
(11)			-**		na	na
(12)	+**	+*	+**	+**	-**	-**
(13)	+**	+**	+**	+**	-**	-**
(14)	+**	+**	+**	+*		-*
(15)		+**			na	-**
(16)		+**	+*	+**	na	-*
(17)	+**	+**	+**	+**	-**	-*
(18)	+**	+**	+**	+**		
(19)	+**	+**	+*	+**	-**	-**
(20)	+**	+**	+*	+**	-*	
(21)					na	na
(22)					na	na

Details of alternative model specifications from (1) to (22) are discussed in the Appendix.

⋆, ⋆⋆ denote significance using 10-90 and 5-95 quantiles of bootstrap IRFs respectively.

Starting with the first pair, Brazilian capital controls have a significant impact on Colombian equity flows contemporaneously in 14 out of 22 specifications, and the sign

Figure 4: IRFs: Disaggregated Capital Controls Shocks for Selected Country Pairs



Lines in different colours represent IRFs under alternative specifications for given country pair.

is positive as expected. Similarly, the response of equity flows in Argentina to capital controls in Brazil is significant in 16 out of 22 specifications with the expected positive sign one quarter ahead. Also, Mexican controls result in positive contemporaneous deflection effects to equity flows in Chile and Peru in 14 out of 22 cases for both pairs, and positive in almost all cases. Regarding the domestic impact, capital controls are effective in Brazil and Taiwan in lowering the level of debt (contemporaneously) and equity flows (one quarter ahead) respectively in 14 and 11 specifications.

4.2.4 Disaggregated Capital Controls Measure: Fernández et al. (2015)

As discussed in Section 2, one major challenge facing empirical studies in this area concerns the availability of indicators of capital controls. In our benchmark model we have used the *de facto* measure of Edison & Warnock (2003), while in the robustness analysis above we have introduced the *de jure* measure of Chinn & Ito (2008). Both measures have their own limitations. The Edison & Warnock (2003) measure captures only foreign equity ownership restrictions, whereas the Chinn & Ito (2008) index is an aggregate measure of controls on both inflows and outflows that combines equity and debt restrictions.

As a further robustness check, we have repeated our analysis by using a third measure of capital controls, namely, the newly constructed index of Fernández et al. (2015), based on the methodology in Schindler (2009), which we have reconstructed at a quarterly frequency. This is a *de jure* measure that differentiates by type of capital flow (categories of assets) and by whether the capital controls are on inflows or outflows (directions of transactions). Such a disaggregated capital controls measure should allow a more accurate analysis of the effects of controls imposed for a specific category of flows (equity or debt). This measure is available only after 1995 for equity restrictions and only after 1997 for restrictions on debt flows. Therefore, due to the limited sample size, although we were able to extend the period until 2013, the GVAR models estimated with this controls measure are more parsimonious than our original benchmark model. Specifically, the variables RSD, CA, Reer and CR have been excluded, and the cointegration rank has been reduced to one for all models except those whose rank was originally greater than two, for which we set a rank of two.

As we did for the other two measures, we have estimated several alternative specifications, including different identification strategies involving different variable ordering, structure of the variance-covariance matrix and sign restrictions, over the period 1995-2013.

Similar to our previous results, we observe significant positive deflection effects in less than 3% of all possible country pairs in the benchmark specification for both equity and debt flows. Figure 4 plots the IRFs for the country pairs for which we found evidence of deflection effects. Across all of the alternative specifications considered, only Brazilian capital controls results in deflection effects to Colombia through debt flows. This is in line with our previous findings for this pair. In 36% of alternative specifications, we also find evidence that Brazilian controls have a significant impact on the volume of domestic flows after one quarter, all with the expected negative sign. Also, in a smaller number of specifications, Brazilian and Mexican controls result in a significant contemporaneous deflection of equity flows in Chile, with consistent positive signs.

Overall, the robustness analysis broadly confirms the general results obtained with the benchmark model. With few exceptions, the direct responses to capital controls are in general insignificant and in some cases of ambiguous sign. Also, there is very limited evidence of deflection effects with the exception of a small number of country pairs. However, a geographical pattern emerges for these countries indicating intra-regional substitution effects for capital flows, particularly in Latin America, with significant deflection effects to third countries, primarily following increases in capital controls in Brazil and Mexico, which are the largest equity and debt markets in Latin America. This is in line with the finding of Ghosh et al. (2012), who detect substitution effects within countries in the same regions. In a relevant paper, Pasricha et al. (2015) assess possible spillover effects of capital controls via capital flows. They find that spillover effects are significantly stronger in Latin America than in Asia, which is again in line with our results. Moreover, previous studies have found similar results regarding the effects of capital controls imposed in Brazil; see for example Forbes et al. (2012). For most other country pairs in our sample, deflection effects are found to be insignificant, or not robust across all alternative specifications.

5 Conclusion

This paper reports the results of research in which we constructed a Global VAR model for a broad range of countries, in order to investigate the international dependencies of portfolio capital flows and the direct and potential multilateral effects of capital controls. First, we have provided evidence of notable dependencies across capital flows to different emerging market economies. We have also found that push factors dominate the role of pull factors, on average across countries, in driving portfolio capital flows.

Then we have turned to our main goal of assessing the effectiveness of capital controls domestically and potential deflection effects on third-party countries. This analysis has been conducted using both *de facto* and *de jure* measures of capital controls. Our results suggest that, at a general level, the effects of capital controls may be at best temporary and that, with the exception of a geographical pattern relating to Latin America, there is little evidence of the effects of the imposition of capital controls on third-party countries. This is not to deny that capital controls may still be extremely important in shielding an emerging market economy, at least in the short run, from the worst effects of capital surges and sudden stops, nor that externalities are never generated by capital controls. Our research does suggest, however, that on the one hand capital controls are not a general and permanent panacea for insulating an economy from the international financial system and, on the other hand, that the externalities associated with them should not be overstated. Hence, as long as capital controls are not imposed to gain competitive advantage or to avoid external adjustment, there is a case for emerging market countries having greater discretion in employing capital controls to deal with macroeconomic and financial stability concerns.

Our finding that, for the most part, capital controls appear to have at best a temporary effect on portfolio capital inflows, confirming previous research findings, is worthy of further investigation. If the reasons behind the limited effectiveness of capital controls in influencing capital inflows were better understood, forms of capital controls could be designed and used more effectively, although this in itself might lead to stronger and more significant capital flow deflection effects. These are pressing issues which call for future research.

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A GVAR model

Consider for easy of exposition the following VARX* specification with two lags on each variable:

$$\begin{aligned} y_{it} &= \delta_{0i} + \delta_{1i}t + \Gamma_{i1y}y_{it-1} + \Gamma_{i2y}y_{it-2} + \Gamma_{i0y^\star}y^\star_{it} + \Gamma_{i1y^\star}y^\star_{it-1} \\ &\quad + \Gamma_{i2y^\star}y^\star_{it-2} + \Gamma_{i0d}d_t + \Gamma_{i1d}d_{t-1} + \Gamma_{i2d}d_{t-2} + \varepsilon_{it}. \end{aligned} \tag{2}$$

Equation (2) can be rewritten as

$$A_{i0}\kappa_{it} = \delta_{0i} + \delta_{1i}t + A_{i1}\kappa_{it-1} + A_{i2}\kappa_{it-2} + \varepsilon_{it}, \tag{3}$$

where $\kappa_{it} = (y'_{it}, y'^\star_{it}, d'_t)'$, $A_{i0} = (I_{k_i}, -\Gamma_{i0y^\star}, -\Gamma_{i0d})$, $A_{i1} = (\Gamma_{i1y}, \Gamma_{i1y^\star}, \Gamma_{i1d})$ and $A_{i2} = (\Gamma_{i2y}, \Gamma_{i2y^\star}, \Gamma_{i2d})$.

Using the link matrices, W_i, it is possible to express country-specific variables κ_{it} as

$$\kappa_{it} = W_i y_t. \tag{4}$$

Substituting (4) in (3), for $i \in \{1, 2, \cdots, N\}$ gives:

$$A_{i0}W_i y_t = \delta_{0i} + \delta_{1i}t + A_{i1}W_i y_{t-1} + A_{i2}W_i y_{t-2} + \varepsilon_{it}. \tag{5}$$

Stacking all country-specific models given by (5) yields:

$$G_0 y_t = \delta_0 + \delta_1 t + G_1 y_{t-1} + G_2 y_{t-2} + \varepsilon_t, \tag{6}$$

where $G_0 = (A_{10}W_1; A_{20}W_2; \cdots; A_{N0}W_N)$, $G_1 = (A_{11}W_1; A_{21}W_2; \cdots; A_{N1}W_N)$ and $G_2 = (A_{12}W_1; A_{22}W_2; \cdots; A_{N2}W_N)$. The final step to obtain the Global VAR representation is to multiply both sides of equation (6) by G_0^{-1}, which gives:

$$y_t = a_0 + a_1 t + B_1 y_{t-1} + B_2 y_{t-2} + \upsilon_t, \tag{7}$$

where $a_0 = G_0^{-1}\delta_0$, $a_1 = G_0^{-1}\delta_1$,$B_1 = G_0^{-1}G_1$, $B_2 = G_0^{-1}G_2$ and $\upsilon_t = G_0^{-1}\varepsilon_t$.

B Data

B.1 Variables definition

$$\begin{aligned} EF_{it} &= geif_{it}/ngdp_{it} & SR_{it} &= 0.25 \times ln(1 + r_{it}/100) \\ DF_{it} &= gdif_{it}/ngdp_{it} & Dcpi_{it} &= ln(cpi_{it}) - ln(cpi_{it-1}) \\ Y_{it} &= ln(ngdp_{it}/cpi_{it}) & SM_{it} &= ln(1 + nsm_{it}/cpi_{it}) \\ CA_{it} &= ca_{it}/ngdp_{it} & REER_{it} &= ln(reer_{it}) \\ CR_{it} &= ln(cr_{it}) & VIX_t &= vxo_t \\ RSD_{it} &= res_{it}/std_{it} & CC_{it} &= Capital\ Control\ measure \end{aligned}$$

subscripts i and t denote the t-th observation for country i. $ngdp_{it}$ is nominal gross domestic product; $geif_{it}$ and $gdif_{it}$ are *non-resident/liability* portfolio inflows, defined as non-residents' net purchases of domestic equity and debt respectively. The reason behind using non-resident flows comes from the findings of Forbes & Warnock (2012). The authors show that the dynamics of non-resident investment in domestic market are significantly different from the resident investment in foreign markets. cpi_{it} is the consumer price index; ca_{it} denotes current account balance in US dollars; cr_{it} is the credit rating of country i; res_{it} is central bank reserves in US dollars; std_{it} denotes the short-term external debt of country i; r_{it} is the short-term interest rate; nsm_{it} denotes the nominal aggregate equity price index for country i; $reer_{it}$ is the real effective exchange rate; vxo_t is the CBOE (Chicago Board Options Exchange) S&P 100 Volatility Index at time t.

B.2 Data construction and data sources

B.2.1 Portfolio Capital Flows

For all countries, IMF International Financial Statistics (IMF-IFS) has been used as the main source for PCFs data, except Taiwan, for which flows data has been obtained from Datastream. To obtain missing flows data, the Chow & Lin (1971) procedure has been employed using indicator series from the US Treasury International Capital System (TIC). Additional data bases have been used for interpolation purposes, for the following countries: China (World Bank), Chile, Colombia (IMF International Investment Position), Egypt, Hungary, Morocco and Peru (Lane & Milesi-Ferretti (2007)).

B.2.2 Capital Controls or Financial Openness measures

The Edison and Warnock index is constructed as: $CC_{it} = 1-(mc_{i,t}^{IFCI}/p_{i,t}^{IFCI})/(mc_{i,t}^{IFCG}/p_{i,t}^{IFCG})$ where $mc_{i,t}^{IFCI}$ and $mc_{i,t}^{IFCG}$ denote the market capitalization at time t of country i's International Finance Corporation Investable (IFCI) and Global (IFCG) indices, and $p_{i,t}^{IFCI}$ and $p_{i,t}^{IFCG}$ denote the corresponding price indices.

The Chinn and Ito measure was available originally at a yearly frequency, hence we have implemented different interpolation procedures in order to obtain quarterly data, as in Boot et al. (1967) and Chow & Lin (1971). In the latter case, the quarterly measure of Edison & Warnock (2003) has been used as an indicator variable. Similarly, the annual disaggregated controls measure of Fernández et al. (2015) has been interpolated with the Boot et al. (1967) procedure.

B.2.3 Real and Nominal GDP

IMF-IFS has been used for most countries for RGDP, except Argentina, Lebanon and Taiwan for which Datastream has been used. The Chow & Lin (1971) procedure has been implemented, in several cases, to obtain missing data by using Industrial Production (IP) as an indicator series. The sources for the IP series for the individual countries are as follows: Brazil (OECD), China (Data Service & Information (DSI) - WB), Colombia (DSI-WB), Hungary (IMF), Indonesia (OECD), Malaysia (IMF), Pakistan (DSI-WB), Poland (OECD), Romania (IMF), Saudi Arabia (DSI-WB). The interpolation procedure of Dées et al. (2007b) has also been used for other countries, or for some of the countries listed above, but for different time periods. These countries are: Argentina, China, Colombia, Egypt, India, Morocco, Pakistan, Saudi Arabia, Singapore and Thailand. Seasonally unadjusted series have been seasonally adjusted in Eviews by the US Census Bureau' s X12 seasonal adjustment program.

IMF-IFS is the source of Nominal GDP for all countries except Canada, Korea, Mexico, Norway, South Africa and USA, for wich OECD data have been used; for Lebanon and

Pakistan we used Datastream, and for Taiwan we used Bloomberg. The Dées et al. (2007b) interpolation method has been used with WB data for the following countries: Argentina, Brazil, China, Chile, Colombia, Egypt, Hungary, India, Indonesia, Malaysia, Morocco, New Zealand, Pakistan, Peru, Poland, Romania, Saudi Arabia, Singapore, Thailand. Seasonally unadjusted series have been seasonally adjusted in Eviews by the US Census Bureau' s X12 seasonal adjustment program. Nominal GDP in local currency has been converted to US Dollars using nominal exchange rate data from IMF-IFS for all countries, except Romania for which we used Bloomberg. GDP-PPP (international US Dollars) data has been obtained from WB, except for Taiwan where Datastream has been used.

B.2.4 Short-term Interest Rates

IMF-IFS database is the main source for the short-term interest rate variable, except for the following countries: Hong Kong (interbank rate from Datastream), Morocco (short rate from Datastream, using the interpolation procedure of Boot et al. (1967)), Norway (short rate from Datastream), Saudi Arabia (deposit rate from Datastrem, interpolated with Boot et al. (1967)), Poland and Romania (short rate from Datastream), Taiwan (commercial paper rate from Datastream). Money market rate has been used for Argentina, Australia, Austria, Brazil, Canada, Finland, France, Germany, Hong Kong, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Morocco, Netherlands, Norway, New Zealand, Pakistan, Philippines, South Africa, Singapore, Spain, Sweden, Switzerland, Thailand, Turkey, UK and US. Deposit Rate has been used for China, Chile, Colombia, Egypt, Hungary. Discount rate has been used for India and Peru. Treasury bill rate has been used for Lebanon. Similar to Dées et al. (2007b), Euro Overnight Index Average (EONIA) from the European Central Bank has been used for Austria, Finland, France, Germany, Italy, Netherlands and Spain for 1999Q1-2010Q4.

B.2.5 Consumer Price Index

The consumer price index is from IMF-IFS, except Romania, Lebanon, China, Taiwan, and the UK for which Datastream has also been used. Seasonally unadjusted series have been seasonally adjusted in Eviews by the US Census Bureau' s X12 seasonal adjustment program.

B.2.6 Real Effective Exchange Rates

IMF-IFS data have been used for the following countries: Australia, Austria, Brazil, Canada, China, Chile, Colombia, Finland, France, Germany, Hong Kong, Hungary, Italy, Japan, Korea, Malaysia, Morocco, Netherlands, Norway, New Zealand, Pakistan, Philippines, Poland, Romania, South Africa, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, the UK and the US. Datastream has been used for Argentina, Egypt, Peru, Taiwan and Thailand, whereas the source for India, Indonesia, Mexico and Turkey is OECD. Finally, data for Egypt has been 1D interpolated using yearly Datastream data.

B.2.7 Real Equity Prices

The main source for nominal equity prices data is IMF-IFS, except Argentina, Brazil, Chile, Hong Kong, Indonesia, Philippines, Taiwan and Thailand for which Datastream has also been used. For Switzerland and Turkey OECD have been used. Once nominal series have been obtained, real equity prices have been calculated using the consumer price index.

B.2.8 Current Account

IMF-IFS is the source of current account data for all countries except Singapore and Taiwan foe which Datastream has been used. The interpolation procedure of Boot et al. (1967) has been employed for China, Chile, Colombia, Egypt, Hong Kong (also with Datastream), Hungary, Lebanon (also with Datastream), Malaysia, Morocco, Norway, Peru, Poland, Romania, Saudi Arabia, Switzerland. Seasonally unadjusted series have been seasonally adjusted in Eviews by the US Census Bureau' s X12 seasonal adjustment program.

B.2.9 Credit Ratings, Reserves, Short Term Debt and VXO Index

The source of the credit ratings data for all countries is the Institutional Investor Magazine's semi-annual Credit Ratings. Reserves data is obtained from IMF-IFS, except Hong Kong and Taiwan for which Datastream has been used. For all countries, except Hong Kong, international bank claims consolidated up to one year from the Bank for International Settlements (BIS) have been used. The CBOE (Chicago Board Options Exchange) S&P 100 Volatility Index has been obtained from Datastream.

C GVAR model specification

In this appendix we report the details of some of the procedures that we have implemented for the specification of the model, including tests for the non-stationarity of the variables, the determination of the lag order, tests for cointegration rank, weak exogeneity, some diagnostic tests and tests for model adequacy.

The results obtained from the Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979) and the Weighted-Symmetric ADF (WS-ADF) test (Park & Fuller, 1995) have indicated that the flow variables are stationary, whereas most of the fundamentals are non-stationary.[19] Considering the limited number of available time series observations, and based on the GVAR literature, the lag orders for the domestic and foreign variables are set to 2 and 1, respectively.[20] In addition, dummy variables are included in the country models by examining the outliers in the residuals. Following Pesaran et al. (2000) and Johansen (1992), the Trace test for cointegration rank in the presence of I(1) weakly exogenous variables was conducted for models with equity flows and debt flows, respectively. The final choice of the cointegration rank is based on the stability properties exhibited by the resulting GVAR models and the persistence profiles of the resulting cointegrating relationships.[21]

Finally, we conducted a number of diagnostic test and tests for model adequacy. Likelihood Ratio tests for the exclusion of cumulated stationary variables in the cointegrating vectors indicated that, in most cases, the null hypothesis is not rejected. We tested the validity of the weak exogeneity assumption, following Dées et al. (2007b), and taking guidance from Johansen (1992) and Harbo et al. (1998). The results of these tests indicated that most of the foreign variables can be considered as weakly exogenous in the

[19] The results of these tests are available upon request.

[20] These are the minimum lags that can be chosen to be able to implement the model.

[21] The sieve bootstrap methodology described in Smith & Galesi (2011), Dées et al. (2007a) and references therein, has been employed to bootstrap the Global VAR models and hence to obtain the empirical distribution of test statistics and impulse responses, with a small modification to account for the presence of dummy variables.

individual country models. In addition to these formal tests, following common practice, we also examined the average pair-wise cross-section correlations for the endogenous variables and then the corresponding cross-section correlations in individual country VECMX* residuals. While there were substantial cross-section correlations between the endogenous variables, the cross-section correlations of the associated residuals were much smaller, implying that the inclusion of foreign variables in the models helped to capture the cross-section correlations and common effects across countries. We also examined the contemporaneous impact coefficients of foreign-star variables on corresponding domestic variables. Finally, we verified the stability of the GVAR model by examining the Persistence Profiles (PPs), as in Lee & Pesaran (1993) and Pesaran & Shin (1996). Details of this analysis are available upon request.

D Results from the Forecast Error Variance Decomposition

In Figure A1 we present the *normalized* (to sum up to one) contributions of different fundamentals, in explaining the forecast error variance of equity flows, contemporaneously. The figure reports *averaged* contributions across all EMEs countries. Note that variables' own contributions and foreign star flows variables have not been reported to preserve the clarity of the figures, but they are available upon request. Amongst the domestic variables, real equity prices (SM), credit ratings (CR) and the real effective exchange rate (Reer) have a relatively higher contribution than the other domestic variables in explaining the forecast error variance of equity flows, contemporaneously. Similarly, amongst the developed countries variables, real equity prices (SM) explain the greatest proportion of equity flows forecast error variance, on average, across all EMEs countries, followed by real GDP (Y) and the VIX index. Results for debt flows in Figure A2 offer a similar picture.

E Robustness Analysis: Alternative GVAR specifications

Amongst the alternative identification schemes, we consider the Cholesky decomposition and identification based on sign restrictions. For the Cholesky decomposition, we have implemented two alternative orderings of the model variables, with capital controls variables ordered in the first (as the most exogenous) and last (as the most endogenous) position, respectively. The other variables are ordered as $SR - SM - Dcpi - Reer - CA - RSD - CR - Y - EF$ (or DF).

Sign identification involves imposing constraints on the signs of the impulse responses of variables to structural shocks. Guided by the literature, restrictions were imposed to identify structural supply, demand, monetary policy, inflow and capital control shocks, while the current account, credit rating and reserves-to-debt ratio are excluded from this GVAR specification. Following Cardarelli et al. (2010), capital inflow surges were associated with overheating pressures, hence the inflows shock has been informally assumed to generate such effects on domestic variables contemporaneously. Finally, the controls shock was assumed to be effective in lowering the volume of inflows and resulting in a fall in real equity prices, following Henry (2000). Table A1 summarizes the contemporaneous sign restrictions employed.

We also considered a more parsimonious model without credit ratings and ratio of reserves to debt. Moreover, in a further alternative specification, the cointegration rank for all countries has been reduced by one.

In the benchmark case, cross-sectional averages of capital controls variables were introduced in each conditional country model. As an alternative, this homogeneity assumption on the transmission of controls shocks was relaxed to allow for different coefficients on the policy variables of different countries. In order to do so, the GVAR model was recomputed for each country that imposes the controls. In each case, under the assumption that individual countries impose controls independently of flows to and controls in other countries, the capital controls variable of the given country was included as a conditioning global variable in other recipient country models instead of cross-sectional averages of capital controls. This GVAR specification is called "Pairwise" in Tables A2-A3.

F Figures & Tables

Figure A1: GFEVDs: Average Normalized Contributions Across EMs - Equity Flows

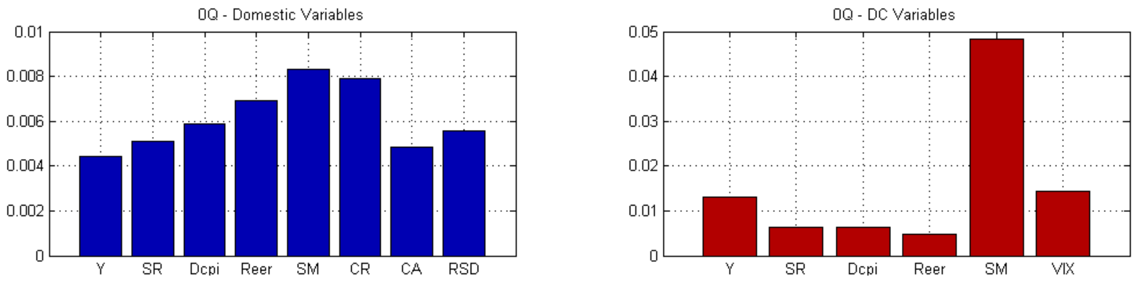

Figure A2: GFEVDs: Average Normalized Contributions Across EMs - Debt Flows

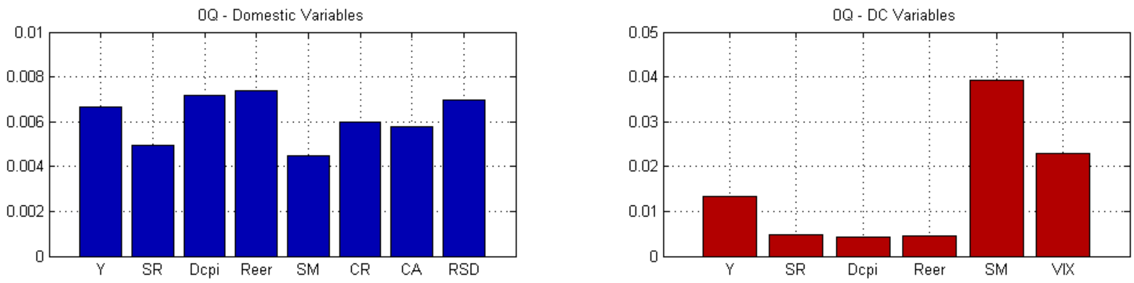

Table A1: CC Shocks Robustness - Sign Restrictions

	Response						
Shock	Y	SR	Dcpi	Reer	SM	F	CC
Supply	>		<				
Demand	>		>				
Monetary Policy	<	>	<	>	<		
Inflows	>		>	>	>	>	
Capital Controls					<	<	>

Table A2: Model Specification and Identification Strategies

CC Measure	Identification	Variables	CI Rank	Foreign Controls
EW	GIRFs	Bench.	Bench.	Cross-sec. Ave.
CI, BFL	Chol, CC-first	Small	Altern.	Pairwise
CI, CL	Chol, CC-last			
	Chol, CC-first, Diag VC			
	Chol, CC-last, Diag VC			
	Sign, CC-last			
	Sign, CC-last, Diag VC			

EW: Edison & Warwock, CI: Chinn & Ito, BFL: Boot et al. (1967), CL: Chow & Lin (1971), Chol: Cholesky, CC-last/first: Ordering of CC variable, (Diag) VC : (Diagonal) GVAR Variance-Covariance Matrix.

Table A3: Model Specifications Considered

Spec	CC Measure	Identification	Variables	CI Rank	Foreign Controls
(1)	EW	GIRFs	Bench.	Bench.	Cross-sec. Ave.
(2)	EW	GIRFs	Bench.	Altern.	Cross-sec. Ave.
(3)	EW	GIRFs	Small	Bench	Cross-sec. Ave.
(4)	CI, BFL	GIRFs	Bench	Bench	Cross-sec. Ave.
(5)	CI, CL	GIRFs	Bench	Bench	Cross-sec. Ave.
(6)	EW	Chol, CC-first	Bench	Bench	Cross-sec. Ave.
(7)	EW	Chol, CC-last	Bench	Bench	Cross-sec. Ave.
(8)	EW	Chol, CC-first, Diag VC	Bench	Bench	Cross-sec. Ave.
(9)	EW	Chol, CC-last, Diag VC	Bench	Bench	Cross-sec. Ave.
(10)	EW	Sign	Bench	Bench	Cross-sec. Ave.
(11)	EW	Sign, Diag VC	Bench	Bench	Cross-sec. Ave.
(12)	EW	GIRFs	Bench.	Bench.	Pairwise
(13)	EW	GIRFs	Bench.	Altern.	Pairwise
(14)	EW	GIRFs	Small	Bench	Pairwise
(15)	CI, BFL	GIRFs	Bench	Bench	Pairwise
(16)	CI, CL	Chol, CC-first	Bench	Bench	Pairwise
(17)	EW	Chol, CC-first	Bench	Bench	Pairwise
(18)	EW	Chol, CC-last	Bench	Bench	Pairwise
(19)	EW	Chol, CC-first, Diag VC	Bench	Bench	Pairwise
(20)	EW	Chol, CC-last, Diag VC	Bench	Bench	Pairwise
(21)	EW	Sign	Bench	Bench	Pairwise
(22)	EW	Sign, Diag VC	Bench	Bench	Pairwise