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 construct a comprehensive global econometric model which captures the dynamic interactions of capital flows with domestic and global fundamentals, and to assess the efficacy of capital controls and potential deflection effects on other countries. 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, moreover. 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 returns in markets characterized by bubbles, in contrast to the global savings glut explanation of the global crisis advocated by Bernanke (2005) and others.

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 (Pesaran et al., 2004). The GVAR approach provides a relatively simple yet highly effective way of modelling interactions in a complex high-dimensional system in a theoretically coherent and econometrically consistent manner. 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. We provide a brief overview and introduction to GVAR modelling in Section 2.[2]

The early literature on modelling portfolio capital flows (PCFs) focussed on foreign and recipient country factors, known as push and pull factors, respectively.[3] 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) and Ghosh et al. (2012), 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

[2]See Granger & Jeon (2007), Dées et al. (2007b) and Chudik & Pesaran (2014) for for an overview of global modelling methodologies and surveys of GVAR modelling and its applications. Chudik & Fratzscher (2011) provide an interesting recent example of the GVAR methodology applied to modelling and simulating the global transmission mechanism in the context of the global financial crisis.

[3]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.[4] 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.

A truly global model would call for the inclusion of both developed and developing countries. In our GVAR model we include 25 emerging market countries and 17 developed countries. However, there are technical difficulties associated with constructing such a model since, in addition to problems ensuing from the sheer size of the system and the number of endogeneous variables, the capital flows data appear as stationary, whereas fundamentals often appear to be non-stationary. This leads us to adopt an empirical methodology by which stationary flow variables and non-stationary fundamentals are modelled in a global error-correction framework simultaneously. The ability of the model to test for and incorporate possible cointegration or long-run relationships between the underlying fundamentals is a valuable feature. The resulting GVAR model has more than 200 endogenous variables and 46 cointegrating relationships.

Regarding the drivers of PCFs, we find that push factors dominate the role of pull factors and flows to other countries have notably high explanatory power on flows to individual 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 some evidence of intra-regional deflection effects for a small number of countries, while they appear to be absent for the majority of country pairs in our sample. This has important policy implications as it suggests 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 sets out the theoretical framework and the econometric methodology. Section 3 presents the data and

[4]Following Forbes & Warnock (2012) and Fratzscher (2012), we define "surges" and "stops" as significant increases and decreases in non-resident capital flows

explains how we specify the country-specific models and combine them into the Global VAR framework. Section 4 reports the empirical results and Section 5 concludes.

2 Theory and Econometric Methodology

2.1 Theoretical Framework

A useful analytical framework can be developed by extending the theoretical model of capital flows of Fernandez-Arias & Montiel (1996) by introducing unobserved global-push factors, f, in a no-arbitrage condition that says that the product of the expected return on an asset and the creditworthiness of the country (a risk-adjustment factor) must, in equilibrium, be just equal to the opportunity cost of investing in that asset. In particular, suppose that capital flows can occur in the form of transactions in n types of assets, indexed by s, where $s = 1, ...n$. Then the no-arbitrage condition for asset s may be written:

$$G_s(g, F) \cdot C(c, S_{-1} + F) = V_s(v, f, S_{-1} + F), \tag{1}$$

where G_s represents the expected return on asset s, which is a positive function of its underlying fundamentals, g, and a negative function of the vector of net flows to all projects, F (based on a diminishing marginal productivity argument); C represents the creditworthiness of the country, which is a positive function of its fundamentals, c, and a negative function of the total amount of outstanding liabilities, $S = S_{-1} + F$, where S_{-1} denotes the initial stocks of liabilities; and V_s represents the opportunity cost of investing in asset s, which is a function of observed global factors v, of unobserved global push factors f, and of the stock of total liabilities $S = S_{-1} + F$, to reflect the portfolio diversification considerations of investors. Here, capital flows serve as part of the adjustment mechanism for the condition to hold. The simple intuition is that risk-adjusted expected returns on projects should equal the opportunity cost of investing in those projects.

The required level of flows, F, can be solved from (1) as:

$$F = F(g, c, v, f, S_{-1}). \tag{2}$$

As in Mody et al. (2001), by totally differentiating (2), denoting the i-th partial derivative of F by F_i, and approximating total derivatives by first differences, we can derive an approximation to (2):[5]

$$\begin{aligned} \Delta F &= F_1\Delta g + F_2\Delta c + F_3\Delta v + F_4\Delta f + F_5\Delta S_{-1} \\ F &= F_1\Delta g + F_2\Delta c + F_3\Delta v + F_4\Delta f + \phi F_{-1} \end{aligned} \tag{3}$$

where $\phi = (1 + F_5)$.

Equation (3) states that the observed flows are functions of changes in underlying fundamentals, pull factors, and observed and unobserved push factors.

[5]Formally, equation (3) can be derived from (1) by applying the implicit function theorem. However, the idea that the total change in F can be approximated by the change in each of its driving variables each multiplied by the local rate of change of F for changes in that variable seems intuitive enough.

2.2 Global Vector Autoregressive Modelling

The purpose of this research is empirically 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 dynamic interactions of capital flows with domestic and global fundamentals. 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. In this section, we therefore give a brief description of this approach, as well as of its evolution.

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, SVAR and VECM methodologies have proved useful in modelling and simulating the macroeconomy, they nevertheless suffer from the 'curse of dimensionality' in that, given 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] [9]

[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.

[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).

[9] As noted by Bernanke et al. (2005), the use of small VAR systems, as well as limiting the number of variables whose dynamic interaction the researcher is able to analyze, may also lead te incorrect inferences being drawn because of omitted variables bias, which may be remedied by the FAVAR approach. In particular, Bernanke et al. (2005) give an example of how this omitted variables bias may be given an economic interpretation in the case of VAR modelling of the monetary transmission mechanism, in that it may contaminate the measurement of policy innovations because central banks and the private sector may have information not reflected in the variables included in the VAR system. Further, these authors argue that this bias drives the so-called 'price puzzle' of monetary economics–i.e. the conventional finding in the VAR literature that a contractionary monetary policy shock is followed by a slight *increase* in the price level, rather than a decrease as standard economic theory would predict–and show that it disappears in a FAVAR analysis involving a standard VAR model of the monetary transmission mechanism augmented by factors summarizing large macro-financial datasets.

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 massive 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, however, and is the methodology applied 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; these country-specific models are referred to as VARX* systems, or sometimes VECMX* if they involve cointegrating relationships. In the second step, the estimated individual country-specific VARX* or VECMX* 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, in our research we apply the GVAR methodology to model and simulate the full dynamic interaction of over 200 endogenous variables.

We now show how the theoretical model set out in section 2.1 may be transposed into the GVAR framework.

2.3 Country-Specific VARX* Models

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

$$y_{it} = \delta_{0i} + \delta_{1i}t + \sum_{l=1}^{p} \Gamma_{ily} y_{it-l} + \sum_{l=0}^{q} \Gamma_{ily^\star} y^\star_{it-l} + \sum_{l=0}^{q} \Gamma_{ild} d_{t-l} + \varepsilon_{it}, \tag{4}$$

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 domestic variables $y^\star_{it} = (F'^\star_{it}, X'^\star_{it})'$. δ_{0i} and δ_{1i} are coefficient vectors, and Γ_{ily}, $\Gamma_{ily^\star}$ and Γ_{ild} are coefficient matrices.

A key point to note about the model (4) is that it incorporates both I(1) (i.e. first-difference stationary) and I(0) (stationary) variables. The theoretical predictions from the model described in Section 2.1 imply that the levels of flows are related to the first differences in the underlying fundamentals.[10] To account for that, the coefficients of the I(1) variables in the flows equations have been restricted such that flows depend on the differences in I(1) fundamentals.[11]

Since most of the fundamentals are non-stationary and are likely to be cointegrated, we have to model cointegration between fundamentals together with stationary flows in an error correction framework. To do so, we follow the two-step procedure described above.

[10] Furthermore, as we see below, unit root tests indicate that flows data are stationary, while most of the fundamentals are non-stationary.

[11] The restrictions imposed are as follows: $\Gamma^*_{i1FX} X_{it-1} + \Gamma^*_{i2FX} X_{it-2} = \Gamma_{i1FX} \Delta X_{it-1}$ with $\Gamma^*_{i1FX} = \Gamma_{i1FX}$, and $\Gamma^*_{i2FX} = -\Gamma_{i1FX}$.

First, we specify a conditional Vector Error Correction Model (VECMX*) for the I(1) variables to test for cointegration and to obtain estimates of the long-run cointegrating vectors and the error correction terms. Following the suggestion of Rahbek & Mosconi (1999), we include cumulated I(0) variables as I(1) weakly exogenous variables in the conditional model, and once the error correction terms have been obtained, the short-run parameters are estimated by Seemingly Unrelated Regressions (SUR) methods.

2.4 Solving the Global VAR Model

Once the estimation of country-specific models is completed, the GVAR model is obtained by stacking country models as in Smith & Galesi (2011). Consider the following VARX*(2,2) specification:

$$\begin{aligned} y_{it} &= \delta_{0i} + \delta_{1i}t + \Gamma_{i1y}y_{it-1} + \Gamma_{i2y}y_{it-2} + \Gamma_{i0y^\star}y^\star_{it} + \Gamma_{i1y^\star}y^\star_{it-1} \\ &\quad + \Gamma_{i2y^\star}y^\star_{it-2} + \Gamma_{i0d}d_t + \Gamma_{i1d}d_{t-1} + \Gamma_{i2d}d_{t-2} + \varepsilon_{it}. \end{aligned} \tag{5}$$

Equation (5) can be rewritten as

$$A_{i0}\kappa_{it} = \delta_{0i} + \delta_{1i}t + A_{i1}\kappa_{it-1} + A_{i2}\kappa_{it-2} + \varepsilon_{it}, \tag{6}$$

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

$$\kappa_{it} = W_i y_t. \tag{7}$$

Substituting (7) in (6), for $i \in \{1, 2, \cdots, N\}$ gives:

$$A_{i0}W_i y_t = \delta_{0i} + \delta_{1i}t + A_{i1}W_i y_{t-1} + A_{i2}W_i y_{t-2} + \varepsilon_{it}. \tag{8}$$

Stacking all country-specific models given by (8) yields:

$$G_0 y_t = \delta_0 + \delta_1 t + G_1 y_{t-1} + G_2 y_{t-2} + \varepsilon_t, \tag{9}$$

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 (9) by G_0^{-1}, which gives:

$$y_t = a_0 + a_1 t + B_1 y_{t-1} + B_2 y_{t-2} + \upsilon_t, \tag{10}$$

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 $\upsilon_t = G_0^{-1}\varepsilon_t$.

3 Dataset and Model Specification

We implemented empirical methodology described in section 2 for 42 countries, consisting of 25 emerging market countries and 17 developed countries. The frequency of the data is quarterly, the sample period starts in 1987Q3 and extends to 2010Q4 or 2008Q3, depending on data availability.[12] The end point of the sample was dictated by data availability

[12]Matlab codes by Smith & Galesi (2011) have been modified by the authors to carry out the estimation.

for the variables needed to construct our capital controls indicator. The emerging markets under study include Argentina, Brazil, China, Chile, Colombia, Egypt, Hong Kong, Hungary, India, Indonesia, Korea, Lebanon, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Romania, South Africa, Singapore, Taiwan, Thailand and Turkey. The developed countries include Australia, Austria, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, New Zealand, Saudi Arabia, Spain, Sweden, Switzerland, the United Kingdom and the United States. The choice of sample period, countries and variables has been guided by data availability, with the aim of obtaining an econometric model that can reasonably 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.

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 the two categories, including the following real and financial variables: 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 ($REER$), Capital Controls (CC) and VIX Index (VIX). These variables are commonly highlighted in the literature on the drivers of capital flows. Specifically, the variables are defined as follows:

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

where 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;[13] 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; finally, $mc_{i,t}^{IFCI}$ 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. A full list of original sources and a description of how the data have been constructed is provided in Appendix A.[14]

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. As described

[13] 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.

[14] Another factor that might be included as a determinant of capital flows is whether the country in question has an approved and viable IMF programme in place, because of the potential signalling effects involved, although Mody & Saravia (2006) show that IMF programmes do not generate uniformly positive signalling effects and need to be considered on a case-by-case basis.

in Kose et al. (2009), 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. Following Kose et al. (2009), $dejure$ measures are mostly constructed using the IMF Annual Reports on Exchange Arrangements and Exchange Restrictions (AREAER). As Kose et al. (2009) argue, however, these measures do not necessarily reflect actual capital account openness and whether the controls are enforced effectively. In this paper we employ the $defacto$ measure from Edison & Warnock (2003), which is available at a monthly frequency for many emerging market countries, albeit for a limited period of time. We were able to reconstruct and extend the original dataset using data available from Datastream for the period 1990Q3-2008Q3. The Edison & Warnock (2003) 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 market, while the Investable index represents that portion of the market available to foreign investors. Therefore, the ratio of the market capitalizations of the IFCI and IFCG indices naturally yields a measure of equity market openness, and hence, one minus the 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. Following Edison & Warnock (2003), we also improve the measure by smoothing it to correct for asymmetric price fluctuations in the two indices, by dividing market capitalizations by the price indices. The major shortcoming of the Edison & Warnock (2003) method 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. Therefore, we conduct robustness checks using the alternative measure of Chinn & Ito (2008), based on the IMF AREAER. On the other hand, a drawback of the Chinn & Ito (2008) measure is that policy changes for different asset categories (equity-vs-debt) are aggregated. Also, Edison & Warnock (2003) focus only on ownership restrictions in the equity market. For these reasons, we also consider the disaggregated *de jure* capital controls measure of Fernández et al. (2015) and Schindler (2009).

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.[15]

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.

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-

[15]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.

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), using the same specification, but including as foreign-star variables in the conditional country models $EF^{\star}_{it}$ and $DF^{\star}_{it}$, respectively. Furthermore, considering that the focus of attention is on emerging markets, a single model for the Developed Countries sample (named DC model), including also Saudi Arabia, is estimated using aggregated variables obtained as cross-section weighted averages with weights based on the PPP valuation of country GDPs. See Dées et al. (2007b) for a similar aggregation for the Euro-zone. In the DC model, only $Y^{\star}_{it}$ has been included as a weakly exogenous foreign variable.

The capital control variable (CC), which is available only up to 2008Q3, is introduced in the GVAR model later in the analysis, when we turn our attention to the study of the direct and deflection effects of capital controls.

The results obtained from the Augmented Dickey Fuller (ADF) test (Dickey & Fuller, 1979) and the Weighted-Symmetric ADF (WS-ADF) test (Park & Fuller, 1995) indicate that the flow variables are stationary, whereas most of the fundamentals are non-stationary. The results of these tests are available upon request.

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.[16] 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.[17]

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 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,

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

[17] 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.

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.

4 Results

4.1 Drivers of PCFs: Forecast Error Variance Decompositions

We start with an analysis of the relative importance of various domestic and global fundamentals for PCFs as an attempt to shed light on the nature of PCFs over the sample period 1987Q3-2010Q4. This analysis is conducted by means of generalized forecast error variance decompositions (GFEVDs). 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.[18]

For space considerations, we present detailed results only for the contributions to the forecast error variance decomposition of equity flows, while the corresponding results for debt flows are available on request, and only briefly summarised below.

In Figure 1 we present the *normalized* (to sum up to one) contributions of different fundamentals, *averaged* across countries, at the zero-quarter (0Q) horizon (contemporaneously), and at the four-quarter (4Q) horizon.[19] The contributions of domestic and developed countries (DC) variables are presented separately for each variable. The average normalized contributions in Figure 1 show that, amongst the domestic variables, real equity prices (SM), credit ratings (CR) and the real effective exchange rate (Reer) play an important role in explaining the forecast error variance of equity flows, both contemporaneously and at the four-quarter horizon, while the relative contributions of other variables, such as real GDP (Y) and the ratio of reserves to short-term debt (RSD) seem to increase, on average, after four quarters. Amongst the developed countries variables, real equity prices (SM) explain the greatest proportion of equity flows forecast error variance, on average, followed by real GDP (Y) and the VIX index.

[Figures 1-3 about here]

We now turn to Figure 2, which documents the heterogeneity across countries regarding the relative importance of different fundamentals in explaining the forecast error variance of equity flows. Specifically, each bar in the figure indicates the number of countries (vertical axis), out of a total of 19 countries, in which each variable (horizontal axis) was ranked first (blue bar), second (red bar) or third (green bar) in terms of their relative contributions.[20] For example, in the first panel of Figure 2 we see that, at the zero-quarter horizon, the main domestic factors that help explain the forecast error variance of equity flows are the short-term interest rates (SR) in two of the 19 countries, inflation (Dcpi) in three countries, real exchange rate (Reer) in four countries, real equity prices (SM)

[18]The main advantage of this procedure is that there is no need to specify a certain ordering for the variables or countries in the model. On the other hand, given the presence of correlations across model residuals, GFEVDs do not necessarily sum up to one.

[19]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.

[20]Note that SM is not available for six EMs out of 19.

in two countries, and so on. One interesting observation is that real GDP (Y) seems not to be a major domestic factor explaining the forecast error variance of equity flows contemporaneously (does not rank first in any country), but it becomes the main factor in two countries at the four-quarter horizon. Also, the ratio of reserves to short-term debt (RSD) appears to be the top domestic factor in six countries at the four-quarter horizon, while current account (CA) and real exchange rate (Reer) are ranked second in five countries. These findings suggest that there is substantial heterogeneity in the importance of different domestic fundamentals among countries. With regard to the relative importance of developed countries variables in explaining the forecast error variance of equity flows in emerging markets, there seems to be less heterogeneity across countries than what we have seen for the ranking of domestic variables. As shown in Figure 2, the greatest proportion of equity flows forecast error variance is explained by foreign equity prices (SM) in 14 out of the 19 countries at the zero-quarter horizon, and in 16 countries at the four-quarter horizon, real GDP (Y) is ranked as the second main contemporaneous factor in nine countries, and VIX as the third main factor in eight countries. 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.

The main differences in the underlying drivers of debt-vs-equity flows are briefly summarised below, while detailed results are available on request. Contemporaneously, real equity prices appear as the least important fundamental for debt flows, whereas the real effective exchange rate, inflation, the ratio of reserves to debt and real GDP appear as the main important domestic fundamentals. The relative importance of the developed countries variables is similar to our findings for equity flows. Unlike the findings of (Chudik & Fratzscher, 2012, p. 45-46), on average, the VIX index seems to contribute more towards the variability of debt flows than equity flows. The heterogeneity across countries with respect to the relative importance of different fundamentals is also present for debt flows.

Finally, in Figure 3 we present, for each country, the normalized percentage contributions of domestic variables, domestic and foreign capital flows and developed countries (DC) variables in explaining PCFs. Regarding the long-debated issue of the relative importance of pull (domestic) and push (foreign) factors in driving capital flows, the results summarized in Figure 3 indicate that the latter dominates the former. 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 $EF^{\star}$ and $DF^{\star}$, 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 the sample countries in the importance of these factors. Furthermore, 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. Flows to countries that are smaller in terms of GDP seem to depend more on flows to other countries, especially with regard to equity flows. The correlation between the economic size of the country and the ratio of the normalized contributions of $EF^{\star}$ ($DF^{\star}$) to DC-push factors are -41% (-14%) and -49% (-21%) at the 0Q and 4Q horizons, respectively.[21] These findings imply that PCFs to countries smaller in economic size are more subject to spatial dependencies and/or contagion.

Compared to the existing literature, there are several points to highlight. In a related GVAR application to net foreign asset positions (NFA) for three Latin American countries, Boschi (2007) finds that domestic factors play a greater role for NFA than external factors, which is in contrast with our findings for PCFs. Evidence from Ghosh et al. (2012) suggests that foreign interest rates are important drivers of flows, whereas our results suggest that foreign interest rates are not one of the key drivers of flows. This finding is in line with the evidence presented in Forbes & Warnock (2012), which suggests that foreign interest rates are not related to capital inflows surges/stops. On the other hand, Forbes & Warnock (2012) find that global growth is a key factor for surges and stops, which is also consistent with the evidence obtained in this paper. Regarding the domestic fundamentals, Ghosh et al. (2012) suggest the importance of the real effective exchange rate and real GDP, whereas Forbes & Warnock (2012) provide some evidence for the role of real GDP. Although their findings are broadly consistent with the results obtained in this paper, overall, there is a notable degree of heterogeneity across countries regarding the importance of different fundamentals. Comparing the importance of push versus pull factors, by employing a high-frequency dataset, Fratzscher (2012) finds that push factors had been the dominant drivers before and during the global financial crisis, but pull factors have become the key drivers in the aftermath. Our results, obtained from a sample period of more than two decades indicate that, overall push factors have been the dominant drivers.

4.2 Capital Controls: The Benchmark Model

We now turn our attention to an investigation of the direct and multilateral effects of capital controls. For this analysis, we have included in the GVAR models for equity and debt flows the measure of capital controls described in Section 3, which we have reconstructed with data available from 1990Q3 up to 2008Q3. The results of this analysis are therefore based on the GVAR-EF and GVAR-DF models, re-estimated over this restricted period. Following the standard approach in the GVAR literature, to examine the dynamic effect of shocks to capital controls we employ Generalized Impulse Response Functions (GIRFs), introduced by Koop et al. (1996) and developed by Pesaran & Shin (1998) and Dées et al. (2007b). The responses of equity flows (EF) and debt flows (DF) to a one standard error country-specific positive shock to capital controls are reported in Tables 1 and 2, respectively. To the degree that equity market restrictions are introduced as part of a broader capital controls package, the capital controls variable captures 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. See Forbes et al. (2012) for a discussion of the signalling channel.

Tables 1 and 2 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. Full results are available upon request.

[21]GDP-PPP (averages of 2006-2008) values have been used for this exercise.

[Tables 1, 2 about here]

4.2.1 Direct effects of capital controls

Starting with the results for equity flows, as we can see from Table 1, there is mixed evidence on the effectiveness of controls in limiting the level of portfolio equity flows domestically. For most countries, the direct response of equity flows to tightened capital controls are insignificant, 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 do 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 an increase in capital controls is Taiwan, where the level of equity flows is significantly reduced after one quarter.

A contemporaneous and temporary reduction in debt flows is observed only for Brazil (Table 2), consistent with the analysis of Forbes et al. (2012). There are cases like Turkey, where the direct response of both equity and debt flows to an increase in capital controls 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 in Taiwan, after one quarter. 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 ineffective for a large number of countries may reflect compositional effects.[22]

Overall, however, the results obtained here are 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, reaching the conclusion that controls have no significant effects on either type of flows across countries.

4.2.2 Deflection effects of capital controls

In this section we 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 1 and 2 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, with regard to equity flows deflections, the only 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 are observed for debt flows. These include significant responses in Turkey (at quarter zero) and Peru (at quarter one) following an increase

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

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 (Forbes et al., 2012).

Overall, the results reported in Tables 1 and 2 indicate that capital controls in some countries can have significant effects on equity flows and/or debt flows to other countries, although most responses are insignificant; furthermore, they are not always robust across model specifications, as we will see in the robustness analysis presented below.

[Tables 3,4,5 about here]

4.3 Robustness Checks

4.3.1 Alternative GVAR specifications

In the absence of a strong prior belief about the most appropriate capital controls measure, choice of model variables, specification and identification strategy, it is important to consider alternative models and check whether the results are sensitive to the particular way the empirical setup has been established. For this reason, following standard practice in GVAR models, and similar to Cardoso & Goldfajn (1998) and Fratzscher & Straub (2009), we consider a variety of alternative model setups, with different capital controls measures, identification schemes, variables, cointegration rank and foreign controls variables, as described in Table 4. The different specifications used for the robustness analysis are summarized in Table 5.

The first alternative measure of capital controls used as a robustness check is the Chinn & Ito (2008) index, while in Section 4.3.3 we present the results obtained with another alternative measure of capital controls, recently constructed by Fernández et al. (2015).[23] 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.

Similar to Edwards (1998) and Cardoso & Goldfajn (1998), we consider alternative identification schemes, namely, 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). Also, we have considered two different specifications for the structure of the variance covariance matrix of the GVAR, namely, block diagonal (country-by-country) and unrestricted.

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

[23] We report the results for the Fernández et al. (2015) controls measure separately since the sample size, country level data availability and other model specifications are significantly different than the benchmark and alternative models reported in Tables 4 and 5.

GVAR specification.[24] The signs for the supply, demand and monetary policy shocks were obtained from Rafiq & Mallick (2008), Peersman & Straub (2009) and Cassola & Morana (2004). 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 3 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 re-computed 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 4-5.

4.3.2 Results

We examined whether the results obtained in the benchmark specification are robust with respect to changes in model specification, capital controls measure and identification strategies. The major outcome of the sensitivity 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 specifications for both deflection effects and domestic capital controls effectiveness for some countries.

There are literally hundreds of possible country pairs among which there may be deflection effects. To gauge the extent to which there are significant responses to foreign controls among all country pairs, we first calculated the percentage of the total number of country pairs for which significant responses have been detected in each of the 22 different model specifications considered. The results confirm the key findings obtained with the benchmark model. There is evidence of deflection effects only in a very small fraction of country pairs. The majority of the significant responses observed in the benchmark case are not robust. The results for equity flows indicate that the fraction of country pairs with significant contemporaneous and one quarter ahead deflection effects is less than 7% on average across specifications. Similar results are obtained for debt flows responses, with less than 4% significant responses.

[Table 6 about here]

Although there is little evidence of systematic deflection effects among the sample countries considered, our results suggest that for a few country pairs responses are consistently significant and have the expected sign across specifications. Table 6 presents

[24] This analysis is based on the procedure described in Rubio-Ramirez et al. (2010) and Blake & Mumtaz (2012).

the results for these particular pairs in each of the 22 specifications considered.[25] 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 is positive as expected in all of these cases. 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 of the 18 specifications.

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

As discussed in Section 3, 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, in this section we repeat 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).

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 and 1997 for equity and debt restrictions respectively. Therefore, due to the limited sample size, 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.

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.

[Figure 4 about here]

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. To examine whether there is any supportive evidence for the earlier results for Brazilian and Mexican controls, Figure 4 plots the IRFs for several country pairs.[26] Across the alternative specifications considered, only Brazilian capital controls

[25] Complete set of results are available upon request.

[26] Complete set of results are available upon request.

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, 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. Fratzscher (2012) finds that real or financial openness of a country is not relevant in the transmission of shocks via portfolio capital flows, which is in line with our results. 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. 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 25 emerging and 17 developed countries, with the developed countries being treated as an aggregate single model, in order to investigate the international dependencies of portfolio capital flows, their major drivers, and the direct and multilateral effects of capital controls. We contribute to the literature on international capital flows in various ways.

First, we have introduced a GVAR model for modelling portfolio equity and debt flows which incorporates stationary flow variables and non-stationary cointegrating fundamentals.

Second, we have examined the drivers of portfolio capital flows and provide evidence of notable dependencies across capital flows to different emerging market economies, which is in line with recent findings in the literature, including that of Ghosh et al. (2012) and Forbes & Warnock (2012). The evidence from our paper reinforces previous suggestions by Pesaran (2006) that existing panel data applications conducted on capital flows have possibly been subject to the problem of cross-sectional dependence. We also find that push factors dominate the role of pull factors, on average across countries, in driving portfolio capital flows.

Third, we have conducted an investigation of the effects of capital controls on equity and debt flows in recipient countries (direct effects), and to third countries (deflection effects). This analysis has been conducted first with a benchmark GVAR model, and then repeated for a large number of alternative specifications, including the use of different measures of capital controls.

We find mixed evidence on the effectiveness of controls in limiting the level of capital flows domestically, with the exception of a minority of countries for which an increase in capital controls temporarily reduces the level of capital flows. Regarding the presence of deflection effects, we also find that these effects are in general insignificant, with the exception of a very few countries, suggesting that there seems to be a geographical pattern indicating intra-regional substitution effects for flows primarily in Latin America. For most other country pairs in our sample, there is no pervasive empirical evidence of capital flow deflection.

These findings have important policy implications since, at a general level, they suggest that 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 Data

A.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)).

A.2 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.

A.3 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.

A.4 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.

A.5 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.

A.6 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.

A.7 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.

A.8 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.

B Tables

Table 1: 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 2: 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.

Table 3: CC Shocks Robustness - Sign Restrictions

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

Table 4: 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 5: 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

Table 6: Robustness Analysis: Selected Country Pairs across Specifications

	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

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

Figure 1: GFEVDs: Average Normalized Contributions Across EMs - Equity Flows

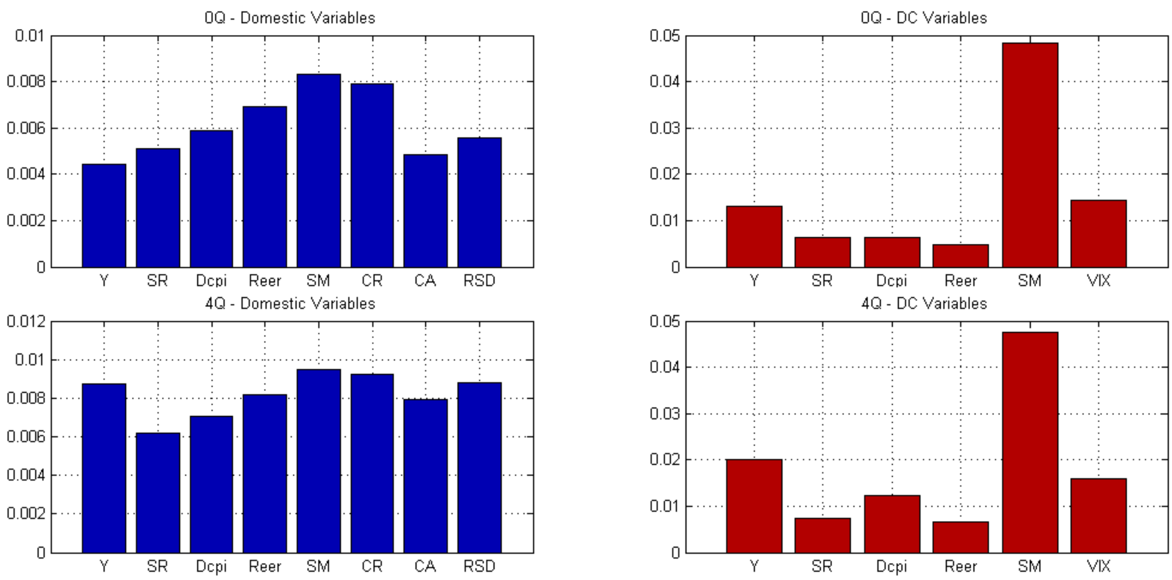


Figure 2: GFEVDs: Fundamentals Contributions towards Equity Flows

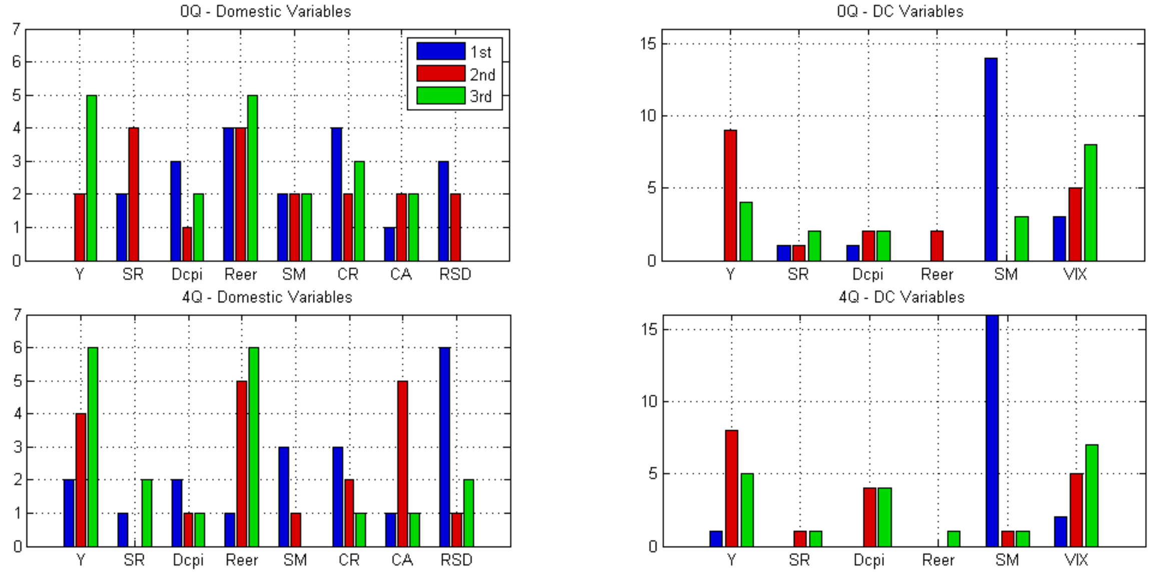


Figure 3: GFEVDs: Total Contributions of Pull vs Push Factors

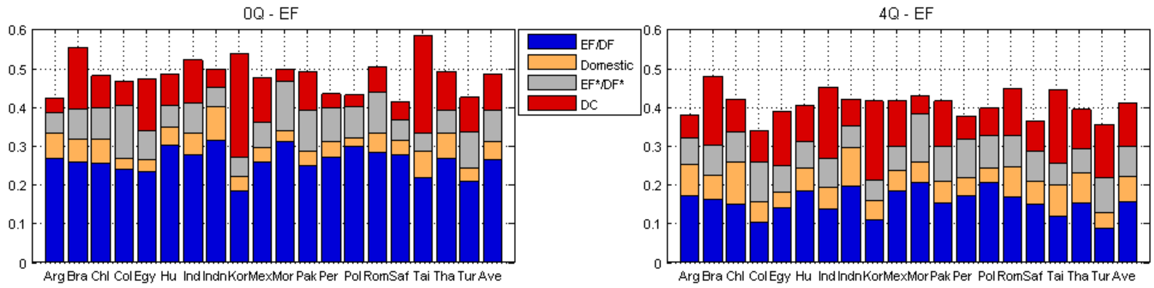
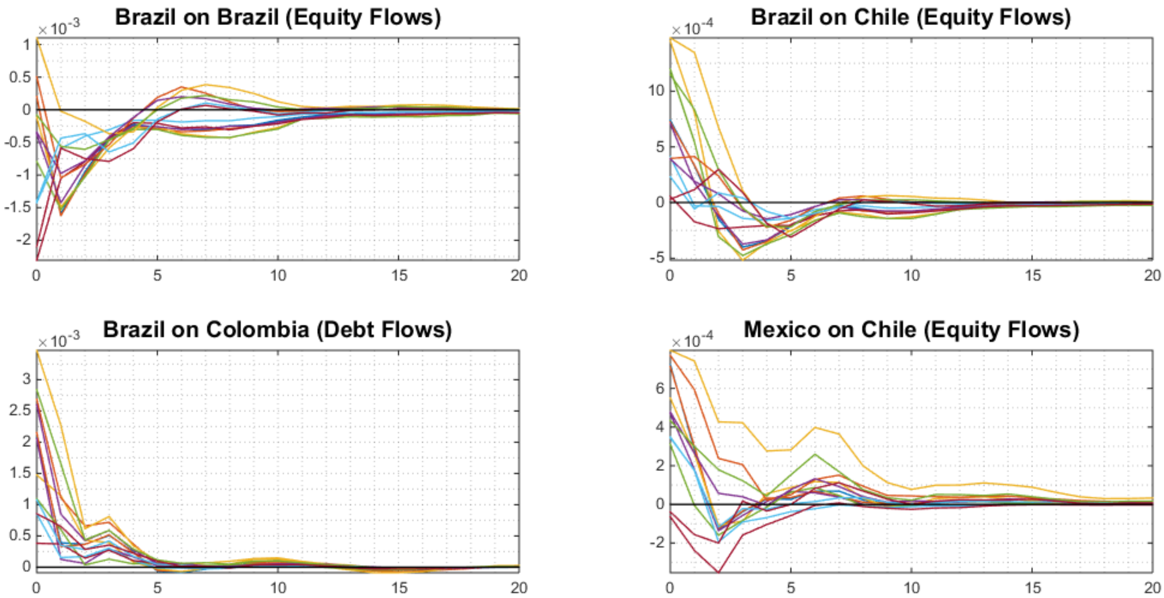


Figure 4: IRFs: Disaggregated Capital Controls Shocks for Selected Country Pairs



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