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Emerging Economies?

Marco Hernández Vega
Banco de México

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How Relevant are Capital Flows for House Prices in Emerging Economies?

Marco Hernández Vega[†]
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Abstract: This work studies the impact of Foreign Direct Investment (FDI) and portfolio flows on house prices of emerging market economies using a static factors panel VARX model. The results show that an increase in both FDI and portfolio flows leads to higher house prices, but that portfolio flows have a more persistent effect. This work also finds that mortgage credit, as proxy of housing demand, is an important variable in house price dynamics in the sense that it has a higher positive impact on house prices than any of the other endogenous variables included. The results are robust to different specifications of the model, such as adding additional lags or changing the order in which the endogenous variables enter the model.

Keywords: Emerging Markets, Capital Flows, House Prices

JEL Classification: C32, E44, F32, G21

Resumen: Este trabajo estudia el impacto de la Inversión Extranjera Directa (IED) y los flujos de cartera en los precios de la vivienda de las economías de mercados emergentes utilizando un modelo VARX de datos panel con factores estáticos. Los resultados muestran que un aumento en los flujos de IED y de cartera conduce a precios de vivienda más altos, si bien los flujos de cartera tienen un efecto más persistente. Este trabajo también encuentra que el crédito hipotecario, como proxy de la demanda por casas, es una variable importante en la dinámica de los precios de la vivienda en el sentido de que tiene un impacto positivo mayor en los precios que cualquiera de las otras variables endógenas incluidas. Los resultados son robustos a diferentes especificaciones del modelo, como agregar rezagos adicionales o cambiar el ordenamiento de las variables endógenas.

Palabras Clave: Mercados Emergentes, Flujos de Capital, Precios de Casas

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1 Introduction

After the financial crisis, the global economy entered a new environment. In one hand, advanced economies reduced interest rates to historically low levels and implemented unconventional monetary policy measures in order to reactivate their economies. On the other hand, emerging market economies (EMEs) were more resilient to the crisis and were able to recover faster. In this context, capital flows to EMEs increased drastically.

The literature that analyzes capital flows states that these can contribute to economic growth, and help in the development of the financial markets of the recipient economy. Nevertheless, the empirical evidence also points to some undesired effects. The inflow of foreign capital tends to augment the demand for domestic-currency-denominated assets (such as stocks or housing) triggering a rapid increase in their prices. This could raise the risks of asset bubbles which, if burst, would deteriorate asset prices leading the recipient economy into a recession. For example, Bernanke (2010) explains how capital flows played an important role in the real state bubble in the US that preceded the 2008 financial crisis.

The above drove researchers to study the link between capital flows and house prices. In particular, recent works focus on the case of EMEs, where the empirical evidence suggests a strong association between asset prices appreciation and capital inflows (see Kim and Yang (2014) and Olaberria (2012) among others).

One of the most important challenges when studying house prices in EMEs is that the time series dimension is not long enough for many countries. The most common solution researchers have opted for is either use panel data techniques, or analyze individual countries for which the dimension of the data allows to estimate individual regressions.

As an example of the first, using a dynamic panel data model, Aizenman and Jinjark (2014) find that prices in the real estate sector are positively correlated with current account deficits. Sa et al. (2011) estimate a panel VAR for OECD countries and conclude that capital flows and monetary policy shocks are important factors determining housing prices. Following a similar technique for five Asian economies, Kim and Yang (2011) finds that capital flows have a positive effect on land prices. Finally, Tillmann (2013) concludes, using a similar model, that capital flows have an effect on house prices, but that the size of the impact depends greatly on the monetary policy response of each economy.

Within those works directed to analyze house prices and capital flows for individual economies, Feng et al. (2017) find that portfolio flows increase stock and house prices in China and that this shock lasts for two months. In turn, the impact of an FDI shock on house prices takes place with a lag and has no effect on stock prices. Similarly, Taguchi and Tian (2017) study the case of China

with a VAR and introduce the interaction between capital flows, money supply, and house prices. Lastly, in contrast with the results of Feng et al. (2017), Taguchi and Tian (2017) suggest that money supply is the main driver of property prices.

Chow and Xie (2016) studies the case of Singapore and their results suggest a strong positive impact from the lag of FDI on house prices' growth rate. Cheung et al. (2017) study the case of Hong Kong and concludes that, depending on the type of flows, the effects are different. For instance, official flows have a positive impact on house prices whereas illegal flows have a negative effect.

One noticeable work is that of Cesa-Bianchi et al. (2015). These authors investigate the impact of global liquidity, as a proxy for capital flows, on house prices of advanced economies and EMEs. The main contribution of the authors is the design of a new house prices dataset gathering and combining information from different official sources, such as individual countries central banks and statistical agencies, the OECD and the BIS. This allows them to extend the data backward, mainly for EMEs, and widen the number of countries included. Their results show that capital flows are an important factor in house price booms in EMEs, but have a lesser role in advanced economies. In particular, after the crisis where excess liquidity generated significant capital flows to emerging economies.

In contrast, Favilukis et al. (2012) conclude that capital flows have had a minor effect in house prices and that the main factor behind an upsurge in house prices observed from 1994 to 2010 was a broaden financial liberalization. However, given that most of their countries in their sample are euro area members and advanced economies, it may be difficult to generalize their results to EMEs.

The objective of this work is to analyze the effects of capital flows on house prices in a sample of 12 EMEs. This is achieved by estimating a static factor panel VARX to obtain the response of house price inflation to gross FDI and portfolio flows shocks. The model also includes GDP growth and short-term interest rates as endogenous variables, and US GDP and interest rates as well as the Chicago VIX index as exogenous variables representing push factors.

Cesa-Bianchi et al. (2015) noted that in a dynamic model one would want to introduce a measure of housing demand such as residential investment. Alas, such data is not available for EMEs. Thus, in this work, we use mortgage credit balances as a percentage of GDP (obtained from the banking statistics reported by individual central banks) as a proxy variable for housing demand.

The results point to a significant and positive impact of FDI and portfolio flows shocks in EMEs' house price inflation, but with some minor differences between these responses. An FDI shock has a slightly higher initial effect on house prices, which persists for up to 4 quarters. In

turn, the effect of a portfolio flows shock persists for up to 7 quarters after the shock.

This work also finds that the inclusion of a proxy for residential investment, in this case mortgage credit as a percentage of GDP, is an important factor in house price dynamics. First, the response of house prices to capital flows does not change with the introduction of such variable. Second, an increase in mortgage credit has a higher positive impact on house prices than any of the other endogenous variables included.

It is important to highlight that, in all our results, house price inflation rises after a positive shock in short-run interest rates. One possible explanation for such a counter-intuitive result is given by Sutton et al. (2017), who analyze the relationship between interest rates and house prices in advanced and EMEs. They found that house prices responded positively to increases in short-run interest rates as a result of the sluggish adjustment of housing demand caused by the elevated costs of acquiring or selling a house faced by both purchasers and suppliers.

These findings are quite robust to different specifications of the model, such as using additional lags; introducing capital flows variables one a time; excluding the mortgage to GDP variable; or estimating the model with a different ordering of the endogenous variables. In turn, extending the model to allow for heterogeneous slopes (dynamic factor model) did not produce adequate results.

2 House Prices and Capital Flows Data

In contrast to what occurs for advanced economies, house price data for EMEs is available for a relatively short period and for a lower number of countries. This has led some researchers to look for alternative approaches to study the relationship between house prices and capital flows for these types of economies. For instance, Cesa-Bianchi et al. (2015) constructed a new dataset on house prices for a broad number of advanced and EMEs. Such dataset is a combination of several sources, like OECD; BIS; domestic central banks; statistical offices and other academic publications, which allowed them to extend backward the data on house prices and even increase the number of emerging economies covered.

Nevertheless, combining data from different sources may create comparability issues. This is particularly important when working with EMEs, given that there exist significant methodological differences in how the data is managed by each country.

As a result, this paper relies on BIS data. Specifically, we use residential property real price indices for a set of 12 EMEs: Brazil, Chile, Colombia, Czech Republic, Hong Kong, India, Korea, Malaysia, Mexico, Peru, Singapore and Thailand.¹ BIS data are the closest measure to a

¹These countries were selected on the availability of house price and macroeconomic data.

nationwide coverage and are obtained following a similar methodology, which allows for a better cross-country comparison. The period of analysis comprehends the period after the financial crisis, from the third quarter of 2009 to the fourth quarter of 2017.²

BIS data shows that in general, EMEs' house prices have had a positive trend in the years after the financial crisis (see Figure 1 and 2). However, in some countries, house price dynamics have been somewhat different in some periods. One of these cases is the Czech Republic, which observed very slow growth in house prices up to the last quarter of 2011 and even falls somewhat in the next two years. However, since 2014 house prices have been rising at an accelerated pace (see Figure 1 second row and second column). Brazil and Singapore are other cases with some differences in house price dynamics. In these economies, house prices rose quite fast after the financial crisis, particularly in Singapore, but in the last three years, prices have grown at a more moderated pace.

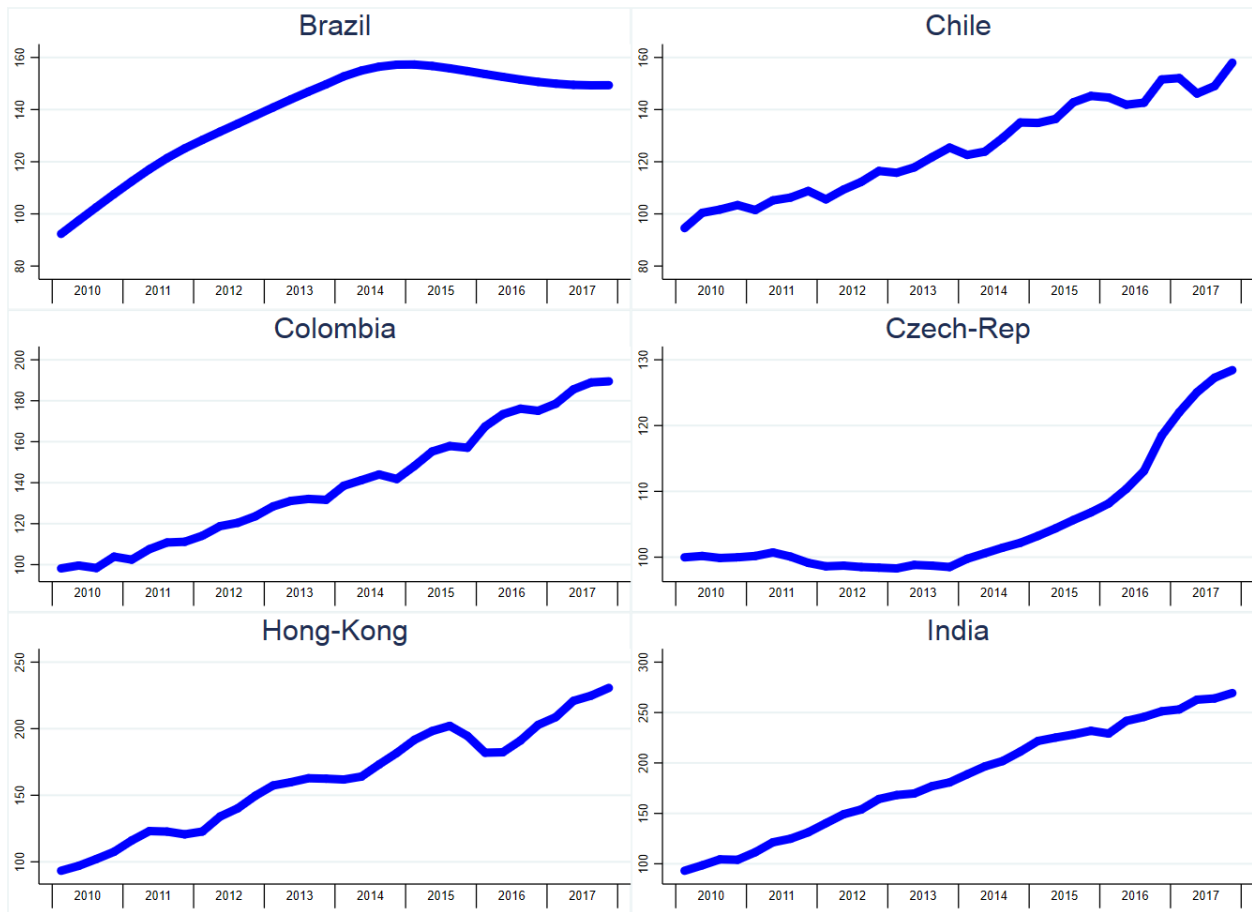
Regarding the capital flows data, this work uses quarterly gross FDI and gross portfolio investment to EMEs (inflows) obtained from the IMF's Balance of Payments Statistics. Gross inflows are preferred given that net flows (the difference between foreign inflows and domestic outflows) are not as close as before. Hernandez-Vega (2019) shows how up to 2003 net flows were very close to gross inflows due to the small amount of EMEs' investment abroad (outflows). However, after the financial crisis not only foreign capital to EMEs increased, but also EMEs investment abroad expanded.

Looking at the behavior of FDI flows one can see that, in contrast to house price dynamics, these flows have had a more homogeneous and stable behavior across countries (see Figures 3 to 4 top right panel). Hernandez-Vega (2019) shows that these flows tend to be less volatile, particularly when compared with gross portfolio flows. This may help explain why gross FDI flows exhibit a strong positive trend across all countries in our sample.

In turn, as has been documented in the literature, portfolio flows tend to fluctuate more and exhibit a diverse behavior amongst EMEs. For instance, portfolio flows in Brazil, Korea, and Malaysia recovered faster after the financial crisis, but in the last five to four years they either stabilized or even decline (Figures 5 and 6).

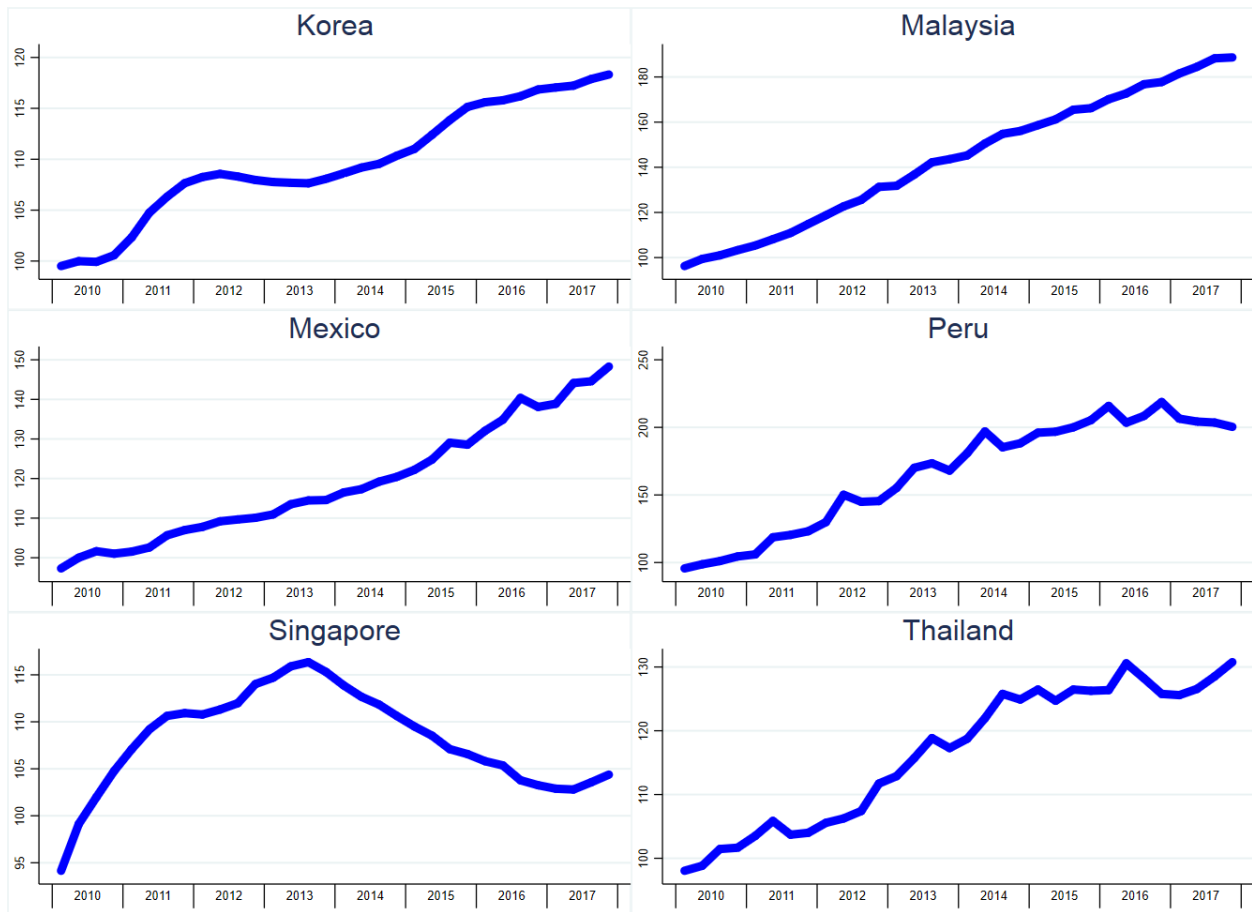
²According to the NBER the financial crisis ended in June 2009.

Figure 1: Real House Price Indices, 2010=100



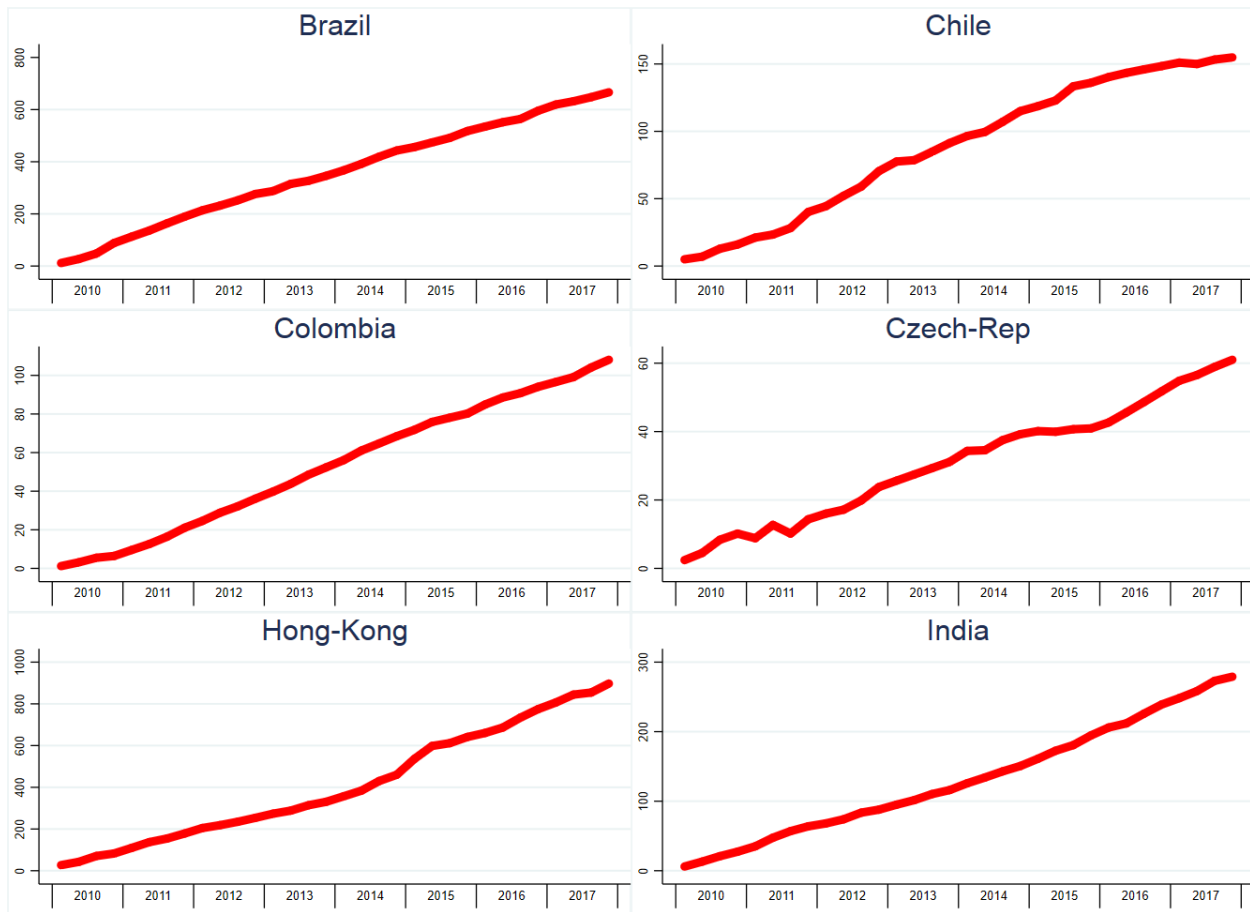
Sources: BIS residential property prices.

Figure 2: Real House Price Indices, 2010=100



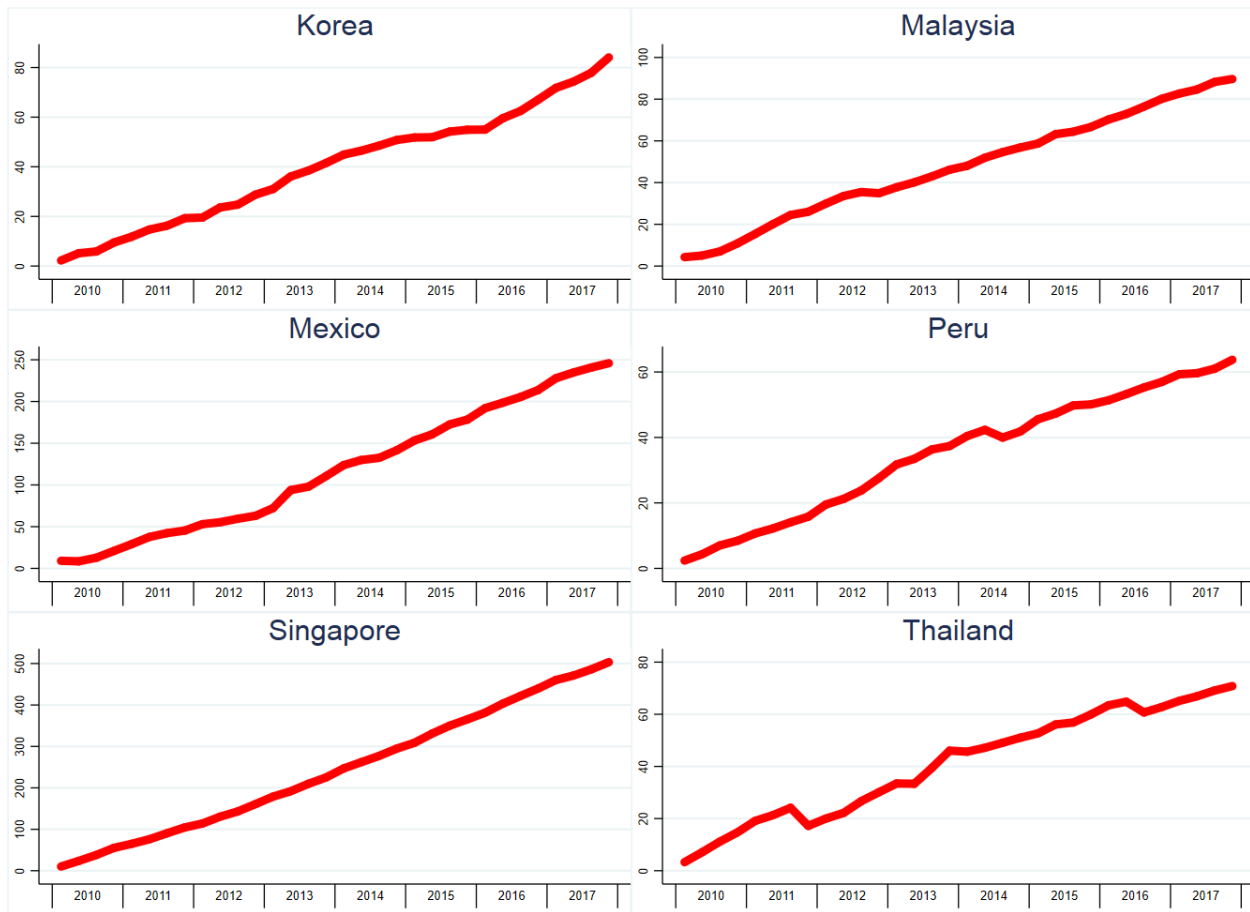
Sources: BIS residential property prices.

Figure 3: Accumulated FDI Gross Flows in Billions of USD



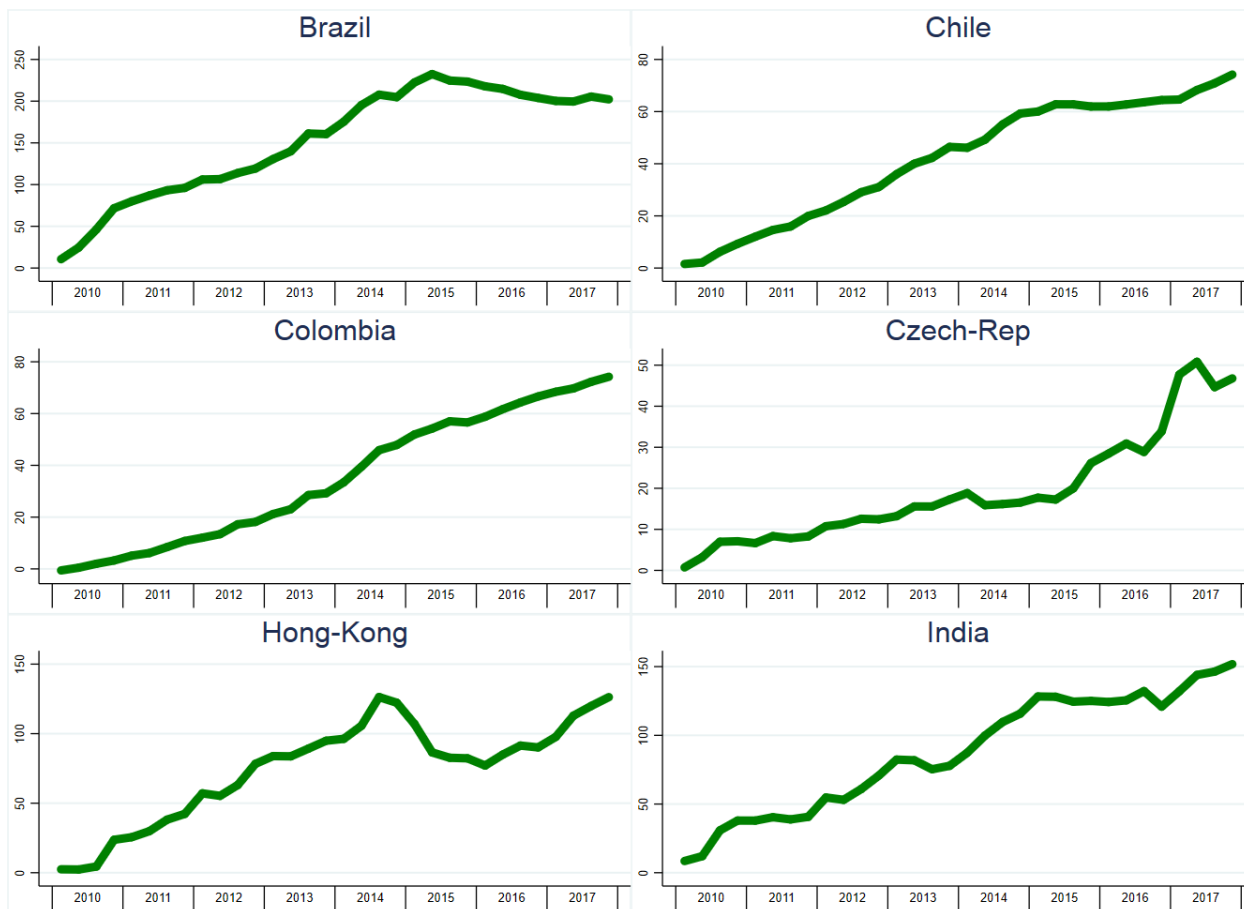
Sources: IMF Balance of Payments Statistics.

Figure 4: Accumulated FDI Gross Flows in Billions of USD



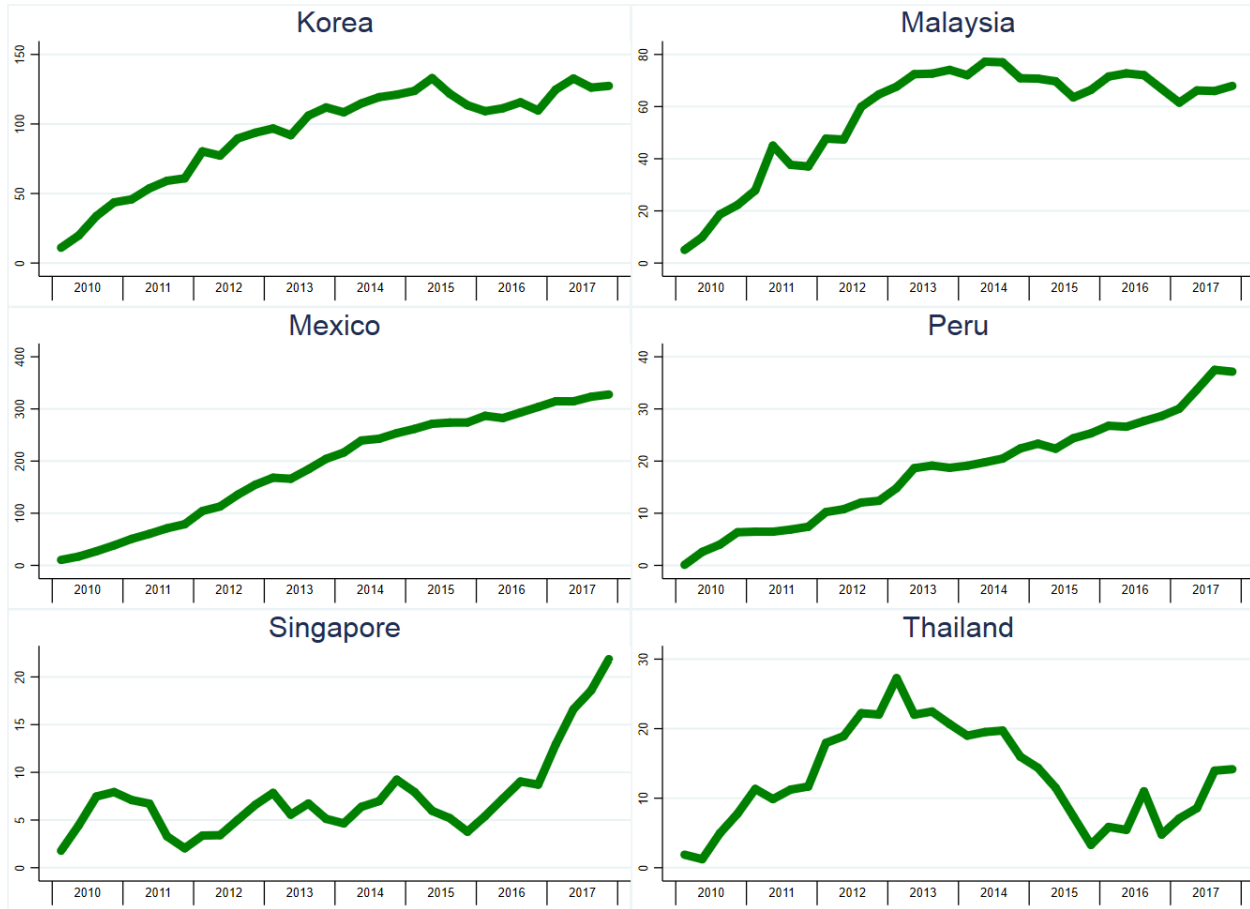
Sources: IMF Balance of Payments Statistics.

Figure 5: Accumulated Portfolio Gross Flows in Billions of USD



Sources: IMF Balance of Payments Statistics.

Figure 6: Accumulated Portfolio Gross Flows in Billions of USD



Sources: IMF Balance of Payments Statistics.

The case of Hong Kong is also somewhat different. Portfolio flows to this economy grew faster up to the third quarter of 2014, then they fall rapidly for the next four quarters but have recovered strongly since then (Figure 5). Singapore, the other Asian financial center, suffered for a highly volatile dynamic of portfolio flows up to the last quarter of 2015. However, these flows have steadily recovered (Figure 6). Finally, portfolio flows to Thailand have shown a very different behavior from the rest of the EMEs included in this work. In the years after the crisis, portfolio flows recovered steadily but then began to fall in the second quarter of 2013 (coinciding with the taper tantrum episode) and kept decreasing for eight consecutive quarters (see Figure 6).

2.1 Additional Variables

Besides the capital flows variables, the study also includes other variables commonly used in the related literature, such as the national GDP as an indicator of economic activity and lending rates

as a proxy of short-term interest rates. The use of these rates serves the purpose to account for debt service, which plays a relevant role in the housing market as noted by Sutton et al. (2017).

Other variables used in the literature consist of external factors that may have some influence on EMEs internal markets like US GDP and short term interest rates as proxies for global economic activity and costs of external funding respectively, and the Chicago VIX index as a proxy of international financial conditions.³

3 Methodology

In order to account for the possible interactions amongst capital flows and macroeconomic variables across countries, we estimate a panel VARX. One advantage of these models consist on allowing for the transmission of idiosyncratic shocks across the countries in the sample; i.e., the model allows for country i 's endogenous variables to affect all other countries' variables. For example. Beetsma and Giuliodori (2011) used a panel VAR to study the spillovers of government spending shocks in certain European economies and their principal trade partners. Also, Canova and Cicarelli (2012) use a panel VAR to analyze the transmission of interest rate shocks in the US to other advanced economies.

In this sense, a panel VARX model is an adequate tool for studying the impact, across countries and time, of capital flows to EMEs' house prices (or to any other macroeconomic variable chosen for that matter).

Hence, let $i = 1, \dots, N$ be the number of countries in our sample, $j = 1, \dots, n$ be the number of endogenous variables for each i and let $m = 1, \dots, M$ be the number of exogenous variables. If p -lags are included then for all i and for all $t = 1, \dots, T$ we have:

$$y_{i,t} = \sum_{i=i}^N \sum_{j=1}^n \sum_{k=1}^p A_{ij,t}^k y_{ij,t-k} + F_{i,t} W_t + u_{i,t} \quad (1)$$

where $y_{i,t}$ is a $(N \times 1)$ vector of endogenous variables. $A_{ij,t}^k$ is a $(n \times n)$ matrix of coefficients representing the response of country i 's endogenous variables to the k^{th} lag of the endogenous variable j of all N countries at time t . $F_{i,t}$ is a $(n \times M)$ matrix capturing the effect of the exogenous variables on country i 's endogenous variables at time t . W_t is a $M \times 1$ vector of exogenous variables common to all i and $u_{i,t}$ is a $(n \times 1)$ vector of disturbances such that $u_{i,t} \sim N(0, \Sigma_{ii,t})$. Note that $\Sigma_{ii,t}$ is a $(n \times n)$ matrix where each element is, in principle, allowed to be time varying.

³Summary statistics for all variables described in this section are shown in Appendix B.

Canova and Ciccarelli (2013) noted that a model such as the one in equation 1 has the following characteristics: First, it allows lag values of all other countries' endogenous variables to have an impact in country i 's endogenous variables (*dynamic interdependencies*). Second, the disturbances can be correlated across different countries in the sample; i.e. $\text{corr}(u_{i,t}u_{-i,t}) \neq 0$ for all $i, -i = 1, \dots, N$ (*static interdependencies*). Third, all parameters in the matrices $A_{ij,t}$ and the vector of disturbances $u_{i,t}$ can be country specific for all i (*cross-sectional heterogeneity*). Fourth, the estimated coefficients as well as the variance-covariance matrix can be time varying (*dynamic heterogeneity*).

Nevertheless, estimating a model that satisfies all four properties is quite difficult, even with Bayesian techniques, due to the curse of dimensionality. For example, for each endogenous variable j of country i with M exogenous and p lags the number of parameters to estimate is $(Njp + M)$. Then, for all n endogenous variables and all N countries, the total number of parameters to be estimated is $Nn(Nnp + M)$. As a result, Canova and Ciccarelli (2013) suggest imposing restrictions on the model.

Given the short dimension of our panel ($N = 12$ and $T = 34$) and the results of Rebucci (2010), who found that Panel VARs with *cross-sectional heterogeneity* can only be efficiently estimated when the dimension of the data at least satisfies $N > 20$ and $T > 40$, we can assume that there is no *cross-sectional heterogeneity* in the model but we still allow for the intercept to be different across countries. Thus, stacking over all i and allowing for *dynamic* and *static interdependencies*, as well as *dynamic heterogeneity* the model becomes:

$$Y_t = A_i + \sum_{k=1}^p A_t^k Y_{t-k} + F_t W_t + u_t \quad t = 1, \dots, T \quad (2)$$

where A_i is a vector of constants that capture country fixed effects, $Y_t = [y_{1,t} \dots y_{N,t}]'$, $F_t = [F_{1,t} \dots F_{N,t}]'$, $u_t = [u_{1,t} \dots u_{N,t}]'$ and A_t^k be $(Nn \times Nn)$ matrices.

Now, the time dimension in our sample is not be large enough to capture time variation so at this point lets assume that there is no *dynamic heterogeneity*.⁴ Hence, transposing equation 2 and defining $X_t = [Y_{t-1}' \dots Y_{t-p}' W_t']$ be $(1 \times k)$ and $B = [(A^1)' \dots (A^p)' F_t']'$ be $(k \times Nn)$ matrix and vectorizing the whole equation, we have:

⁴In the robustness test section we allow for *dynamic heterogeneity* but given that now the joint prior has the full weight to generate all the curvature for the posterior, the model fails to produce consistent results.

$$Y_t' = Z_t \beta + u_t \quad (3)$$

where we omit the vector A_i from the notation for simplicity, $Z_t = (I_{Nn} \otimes X_t)$ and $\beta = \text{vec}(B)$.

Equation 3 allows for *dynamic* and *static interdependencies*. The last one feature implies that the variance-covariance matrix of u_t is not block diagonal. In particular, $u_t \sim N(0, \sigma \Sigma_u)$ where the elements of each $(n \times n)$ matrix in Σ are not all equal to zero, $\sigma \sim IG\left(\frac{\alpha_0}{2}, \frac{\delta_0}{2}\right)$. Canova and Ciccarelli (2013) suggest to simplify this model by defining β as a linear combination of lower dimensional vectors θ such that:

$$\beta = \sum_{r=1}^5 \Xi_r \theta_r + e_t$$

These factors are defined as follows: θ_1 represents common factors across N and n with dimension $(s \times 1)$. θ_2 stands for within country common factors, so its dimension is $(N \times 1)$. θ_3 captures factors that are specific to each endogenous variable and has dimension of $(n \times 1)$. θ_4 represents lag-specific factors being of size $(p \times 1)$. θ_5 stands for factors of all exogenous variables so its dimension is $(M \times 1)$. $\Xi_1, \Xi_2, \Xi_3, \Xi_4, \Xi_5$ are matrices of dimensions $h \times s, h \times N, h \times n, h \times p$ and $h \times M$, with $h = Nn(Nnp + M)$. Lastly, e_t captures all factors of β not captured by θ_r with $e_t \sim N(0, \Sigma_u \otimes V)$ and $V = \sigma^2 I$.

This factorization reduces the number of parameters to estimate from $Nn(Nnp + M)$ to $s + N + n + p + M$ transforming equation 3 into a SUR model where the explanatory variables are now averages of specific endogenous and exogenous variables, then the model becomes:

$$Y_t' = \sum_{r=1}^5 \tilde{Z}_{r,t} \theta_r + \varepsilon_t \quad (4)$$

where $\tilde{Z}_{r,t} = Z_t \Xi_r$ and $\varepsilon_t = u_t + Z_t e_t$.

Equation 4 is known as a static factor model and its estimation is as follow. Let $(\theta, \sigma^2, \Sigma_u)$ have a semi-conjugate prior and $\theta \sim N(\theta_0, \Omega_0)$, $\Sigma_u \sim IW(z_0, Q_0)$, and $\sigma^2 \sim IG(0.5\tilde{\alpha}_0, 0.5\tilde{\delta}_0)$ with known hyperparameters $(\theta_0, \Omega_0, z_0, Q_0, \tilde{\alpha}_0, \tilde{\delta}_0)$. Given these distributions and parameters, the Gibbs sampler is implemented to obtain sequences for (θ, σ, Σ) from their joint posterior distribu-

tions.⁵ In the estimation of equation 4 we make use of diffuse priors. Hence, the hyperparameters mentioned above are set accordingly. For instance, θ_0 is a vector of zeros while Ω_0 is a diagonal matrix with large enough diagonal elements so as to produce an uninformative prior and $\tilde{\alpha}_0, \tilde{\delta}_0$ are both set to 0.001, see Kadiyala (1997), Canova and Pappa (2007), Ciccarelli et al. (2012) and Appendix A for more details on the estimation procedure.

The vector of endogenous variables for each country i consists on the log-difference of domestic GDP, short-run real interest rates (defined as the difference between lending rates and CPI inflation), FDI and portfolio flows as a percentage of GDP, and the log-difference of house prices. The vector of exogenous variables contains the log-difference of US GDP, US short-run interest rates and the log-difference in the Chicago VIX index. The variables enter the model ordered as listed and the estimation is done by introducing two lags of the endogenous variables.

The logic for the ordering of the endogenous variables is as follows: First, we assume that GDP contemporaneously affects all other variables. Second, short-term interest rates have an immediate impact on capital flows (FDI or portfolio) and house prices but affect GDP with a lag. Third, capital flow variables are assumed to have a contemporaneous effect on house prices only.

Impulse responses together with Bayesian credible sets at 68% are shown in Figure 7. The figure shows that an increase in GDP growth of 100 basis points raises house price inflation by 25 basis points. This positive effect is statistically significant and persists for 5 additional quarters after the shock, resulting in an accumulated impact on house prices of 74 basis points.

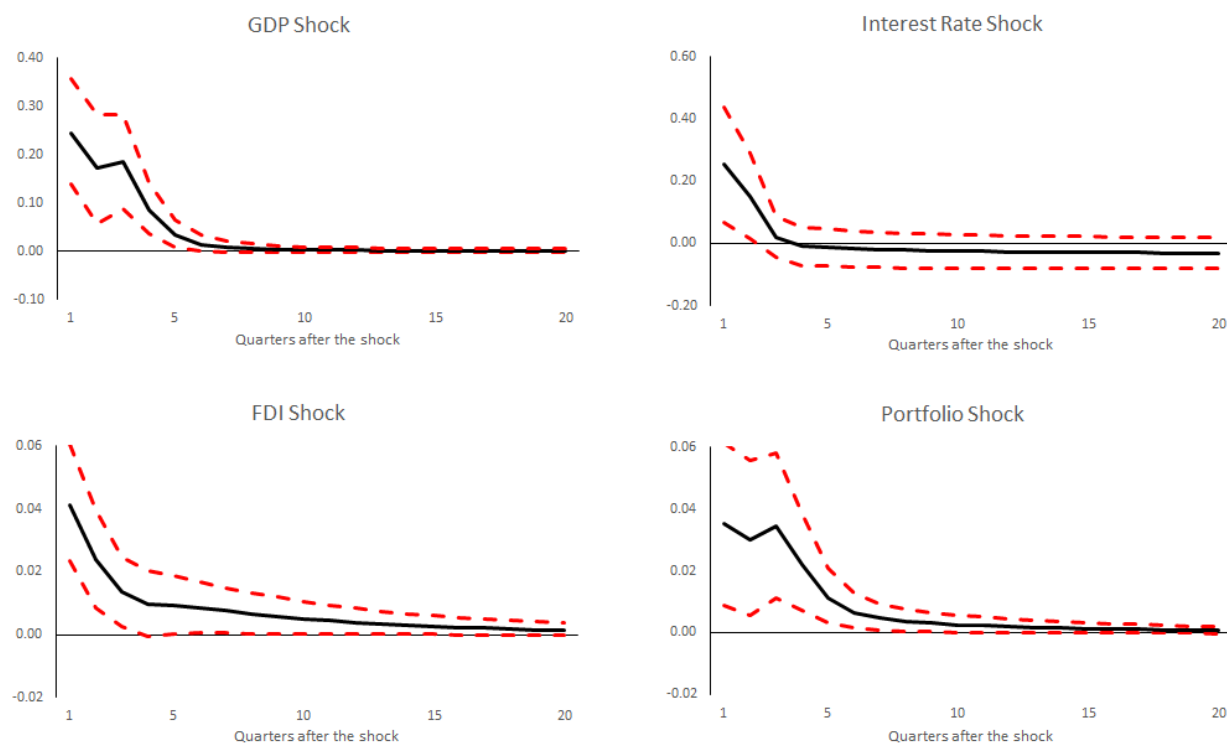
Unexpectedly, a 1 percentage point rise in short-run interest rates also has a positive and significant effect on house prices turning negative two quarters after the shock. One possible explanation for such a counter-intuitive result is given by Sutton et al. (2017). They analyze the relationship between interest rates and house prices in advanced economies and EMEs and found that house prices responded positively to increases in short-run interest rates. According to these authors, this may be the result of a sluggish adjustment of housing demand caused by the elevated costs to acquire or sell a house.

House price inflation in EMEs also augments after a positive shock of capital flows, although these shocks have a smaller impact than GDP or interest rates. For example, an increase in FDI flows has a positive impact (of 4 basis points at the time of the shock) that disseminates three quarters after the shock resulting in an accumulated effect on house price inflation of 12 basis points. In turn, a unit increase in portfolio flows has a smaller initial effect (3.5 basis points) but the persistence of this shock is higher lasting for 7 quarters after the shock leading to an accumulated

⁵See Kadiyala (1997) and Canova and Ciccarelli (2013) for full algebraical derivation of equation 4, the derivation of the posterior distributions and the steps of the Gibbs sampler.

response of 16 basis points in house price growth.

Figure 7: Response of House Prices to a Unit Shock



These impulse response functions are obtained from estimating a panel VARX where the order of the variables is GDP, short-run interest rates, FDI to GDP and house prices. Red dashed lines represent the 68% Bayesian credible set.

3.1 The Role of Mortgage Credit

One factor that is not captured by equation 4 is housing demand. As noted by Cesa-Bianchi et al. (2015), one would want to introduce a measure of residential investment. Unfortunately, such data is not available for EMEs. However, data on mortgage credit for EMEs is available from central banks. Thus, even if we do not explicitly have a quantity variable for housing demand we have at hand mortgage credit flows as a percentage of national GDP as a proxy.

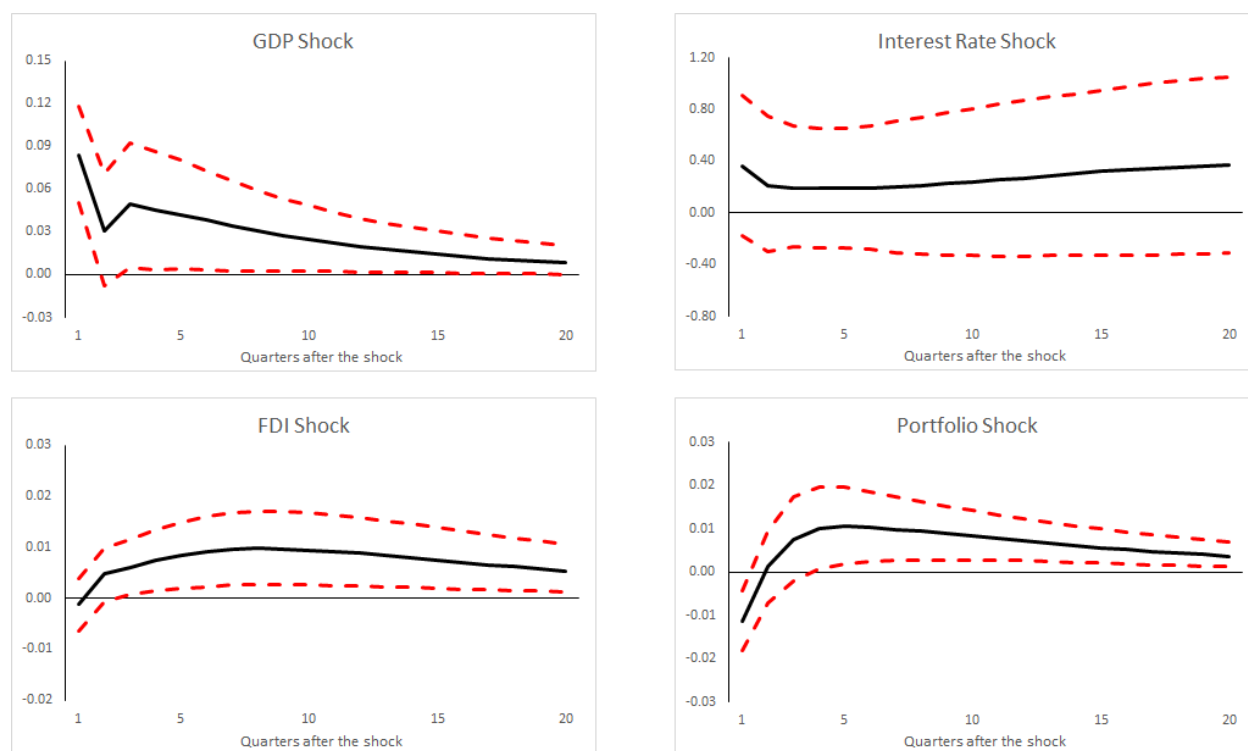
Now, what is left is to define the order in which the credit variable will enter the model. Given that house prices are sticky, it is plausible to assume that mortgage credit reacts faster to macroeconomic shocks. Hence, the panel VARX is estimated with the following order of endogenous variables: the log-difference of domestic GDP, short-run real interest rates, FDI and portfolio flows as a percentage of GDP, mortgage credit as a percentage of GDP and the log-difference of house prices (see the robustness section for results with a different ordering of the endogenous variables).

Figure 8 shows the responses of mortgage credit to shocks in GDP, short-run interest rates, FDI and portfolio flows. A rise in GDP has a positive and highly persistent impact on mortgaged credit. At the time of the shock it increases by 9 basis points, but the accumulated effect is of around 55 basis points. In turn, the response of mortgage credit to increases in interest rates is not statistically significant.

Capital flows variables generate a hump shape response in mortgage credit that begins with a negative impact, but it then becomes positive and statistically significant in the following three quarters. Note that portfolio flows have a more negative effect than FDI flows. The accumulated response of an FDI shock in mortgage credit is of 15 basis points, whilst that of portfolio flows amounts to only 12 basis points.

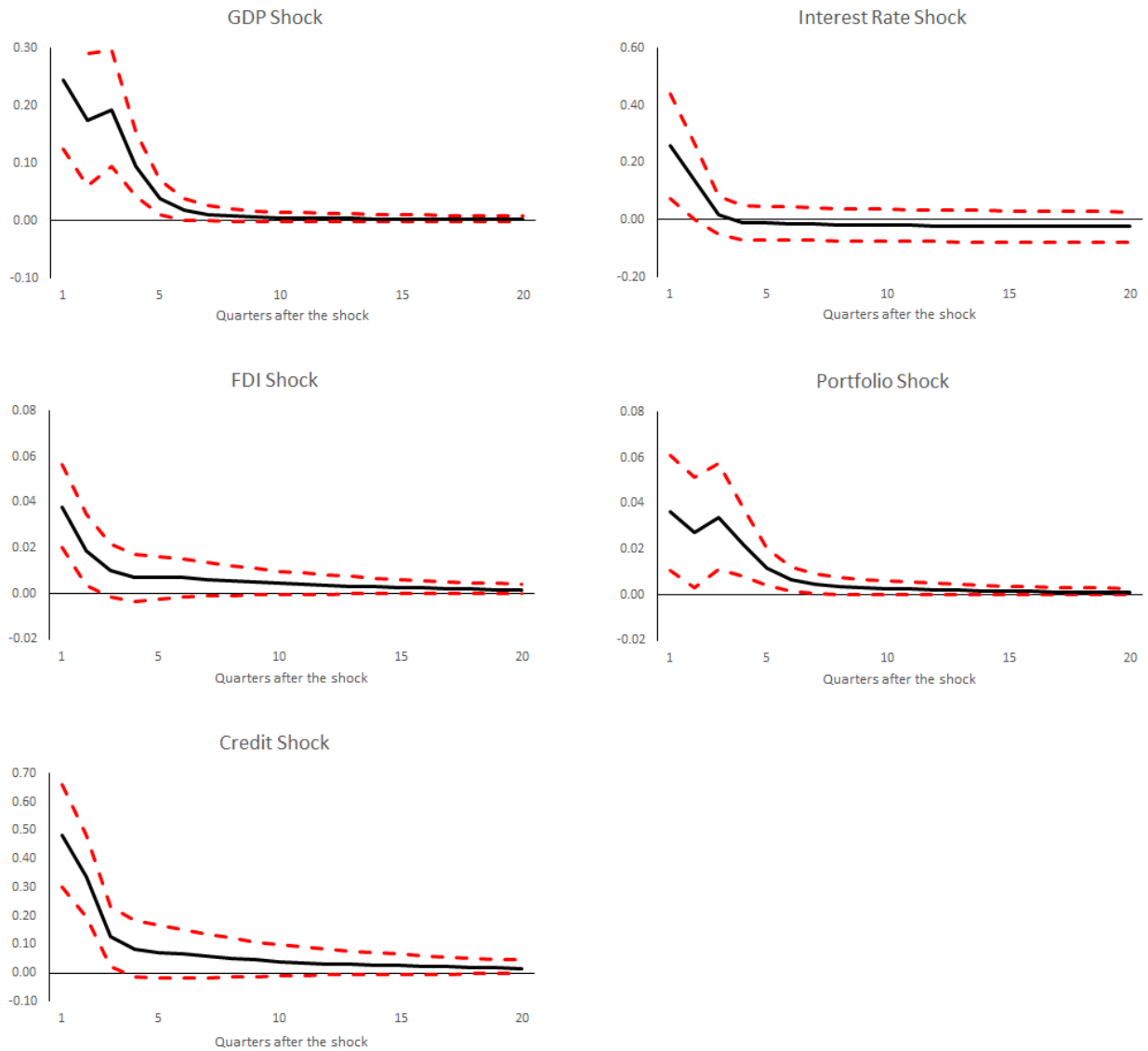
Mortgage credit has an important effect on house price inflation. A unit increase in mortgage credit has a positive initial effect of 50 basis points. This shock persists for up to 3 quarters resulting in an accumulated response of around 95 basis points, which is even higher than the 74 basis points from the accumulated effect of a GDP shock, see Figure 9.

Figure 8: Response of Mortgage Credit to a Unit Shock



These impulse response functions are obtained from estimating a panel VARX where the order of the variables is GDP, short-run interest rates, portfolio flows to GDP and house prices. Red dashed lines represent the 68% Bayesian credible set.

Figure 9: Response of House Prices to a Unit Shock



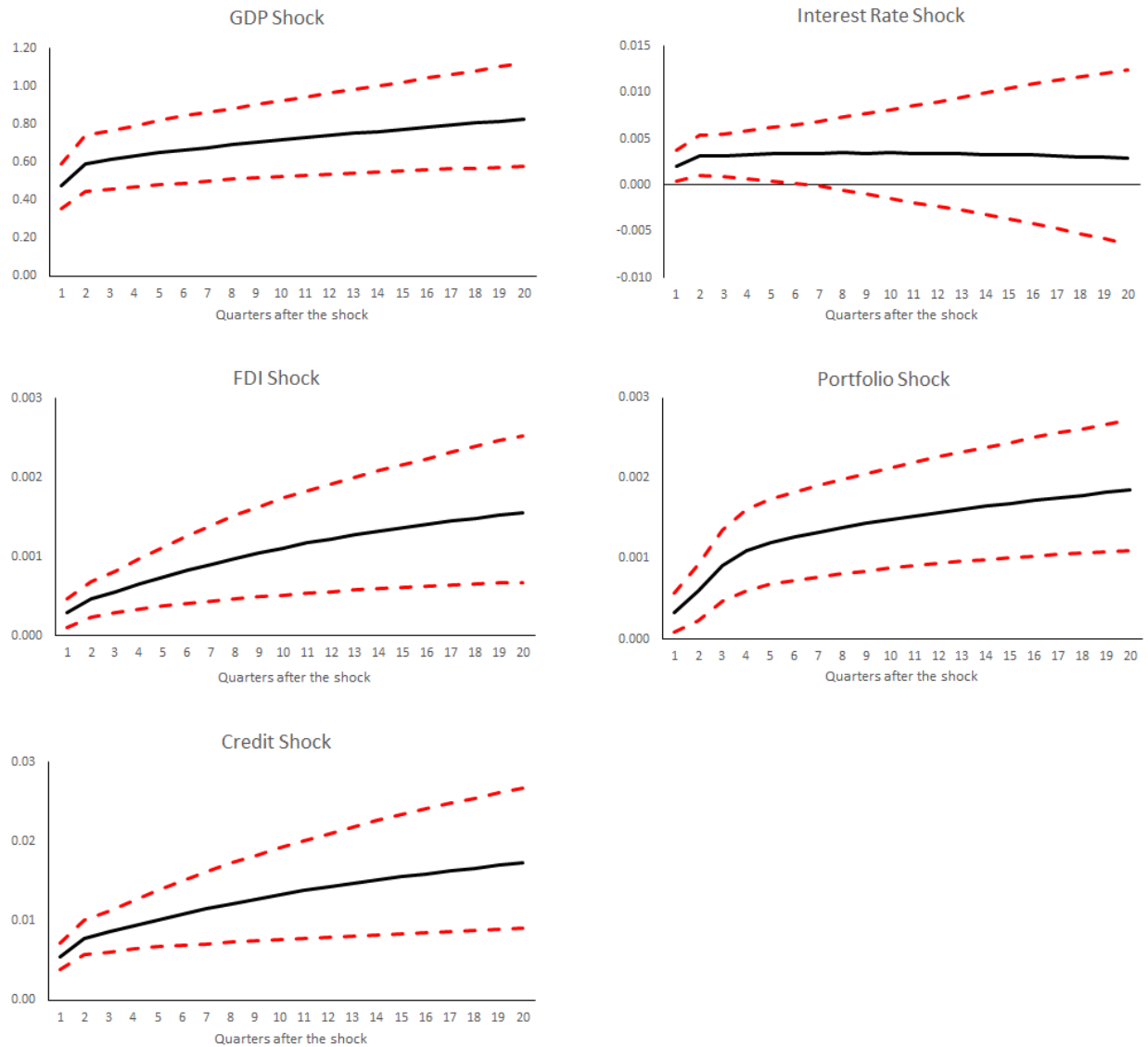
These impulse response functions are obtained from estimating a panel VARX where the order of the variables is GDP, short-run interest rates, FDI to GDP, mortgage credit to GDP and house prices. Red dashed lines represent the 68% Bayesian credible set.

3.2 Robustness Tests

The following robustness tests were performed: First, equation 4 was estimated introducing the capital flows variables one at a time with and without the mortgage credit variable. Second, we changed the order of the endogenous variables as follows: GDP, house prices, short-term interest rates and then the capital flows variables. This order follows Cesa-Bianchi et al. (2015) specifi-

cation, whose purpose was to set an order that resembles a Neo-Keynesian model; i.e. a demand equation (represented by GDP growth), an inflation equation (in this case housing inflation) and a monetary policy rule that react to inflation developments (short-run interest rates). Third, re-estimate the model introducing up to 4 lags of the dependent variables. In almost all these scenarios, the response of house prices to both capital flow variables did not change, but in the last case where there was a slight widening of the credible sets.

Figure 10: Response of House Prices to a Unit Shock



These impulse response functions are obtained from estimating a panel VARX where the order of the variables is GDP, short-run interest rates, FDI to GDP, mortgage credit to GDP and house prices. Red dashed lines represent the 68% Bayesian credible set.

Fourth, we introduce the properties of “cross-section and dynamic heterogeneity” transforming our static factor model into a dynamic factor model; i.e. we allowed our model for heterogeneous slopes and time varying coefficients, see Figure 10. Unfortunately, the estimation of this model produced "explosive" responses, with the exception of the interest rate shock, in the sense that all shocks had positive significant effects on house price inflation that grew over time. In general, the results are quite robust to most different specifications explained above.

4 Conclusions

This work contributes to the literature by analyzing the impact of FDI and portfolio flows to house prices in EMEs from two different points of view: First through the estimation of a static factor panel VARX model whose properties consist in allowing for the endogenous variables of country i to be affected by the variables of the other countries and by letting the disturbances across countries to be correlated. Second, by introducing mortgage credit flows, as a proxy for housing demand, in order to account for the transmission channel from capital flows to credit and from this to house prices. Up to our knowledge, this is the only paper that attempts such an approach for EMEs.

The results point to a significant and positive impact of FDI and portfolio flows in house price inflation of EMEs with some minor difference between the responses to FDI and portfolio shocks. First, at the time of the shock, FDI has somewhat a higher effect than portfolio flows but the effect of the last one is more persistent (the FDI shock persist for 4 quarters but the portfolio shock does it for 7 quarters after the shock).

This work also finds that the inclusion of a proxy for residential investment, in this case mortgage credit flows as a percentage of GDP, is an important factor in house price dynamics. First, the response of house prices to capital flows does not change with the introduction of such variable. Second, an increase in mortgage credit has a higher positive impact on house prices than any of the other endogenous variables included.

These findings are quite robust to different specifications of the model such as using additional lags, introducing capital flows variables one a time with and without the mortgage to GDP variable, and to the different ordering of the endogenous variables. Unfortunately, extending the model to allow for heterogeneous slopes and time-varying coefficients produce explosive responses.

Lastly, note that even if this work somehow touches housing credit dynamics and their relationship with capital flows in EMEs, a more in-depth study using more detailed data is required to understand such a connection. In addition, future research should analyze the influence that a specific economy has on mortgage credit volumes of EMEs within the same region. For example,

given the significant influence of China, it could be the case that mortgage credit in this country could have some influence on the housing markets of other Asian EMEs.

References

- Aizenman, J., Jinjark, Y., 2014. Real estate valuation, current account and credit growth patterns, before and after the 2008-9 crisis. *Journal of International Money and Finance* 48 (PB), 249–270.
URL <https://ideas.repec.org/a/eee/jimfin/v48y2014ipbp249-270.html>
- Beetsma, R., Giuliodori, M., February 2011. The Effects of Government Purchases Shocks: Review and Estimates for the EU. *Economic Journal* 121 (550), 4–32.
URL <https://ideas.repec.org/a/ecj/econjl/v121y2011i550pf4-f32.html>
- Bernanke, B. S., 2010. Monetary policy and the housing bubble: a speech at the Annual Meeting of the American Economic Association, Atlanta, Georgia, January 3, 2010. Speech 499, Board of Governors of the Federal Reserve System (U.S.).
URL <https://ideas.repec.org/p/fip/fedgsq/499.html>
- Canova, F., Ciccarelli, M., 2012. Cyclical fluctuations in the Mediterranean basin. *Journal of International Economics* 88, 162–175.
- Canova, F., Ciccarelli, M., Mar. 2013. Panel Vector Autoregressive Models: A Survey. CEPR Discussion Papers 9380, C.E.P.R. Discussion Papers.
URL <https://ideas.repec.org/p/cpr/ceprdp/9380.html>
- Canova, F., Pappa, P., 2007. Price differential in monetary unions: The role of fiscal shocks. *Economic Journal* 117, 713–737.
- Cesa-Bianchi, A., Cespedes, L. F., Rebucci, A., March 2015. Global Liquidity, House Prices, and the Macroeconomy: Evidence from Advanced and Emerging Economies. *Journal of Money, Credit and Banking* 47 (S1), 301–335.
URL <https://ideas.repec.org/a/wly/jmoncb/v47y2015is1p301-335.html>
- Cheung, Y.-W., Chow, K. K., Yiu, M. S., August 2017. Effects of capital flow on the equity and housing markets in Hong Kong. *Pacific Economic Review* 22 (3), 332–349.
URL <https://ideas.repec.org/a/blapacecr/v22y2017i3p332-349.html>
- Chow, H. K., Xie, T., 2016. Are House Prices Driven by Capital Flows? Evidence from Singapore. *Journal of International Commerce, Economics and Policy* 7 (1), 1–21.
- Ciccarelli, M., Ortega, E., Valderrama, M. T., Nov. 2012. Heterogeneity and cross-country spillovers in macroeconomic-financial linkages. Working Paper Series 1498, European Central Bank.
URL <https://ideas.repec.org/p/ecb/ecbwps/20121498.html>

- Favilukis, J., Kohn, D., Ludvigson, S. C., Nieuwerburgh, S. V., Jan. 2012. International Capital Flows and House Prices: Theory and Evidence. NBER Working Papers 17751, National Bureau of Economic Research, Inc.
URL <https://ideas.repec.org/p/nbr/nberwo/17751.html>
- Feng, L., Lin, C.-Y., Wang, C., 2017. Do Capital Flows Matter to Stock and House Prices? Evidence from China. *Emerging Markets Finance and Trade* 53 (10), 2215–2232.
URL <https://doi.org/10.1080/1540496X.2016.1180283>
- Hernandez-Vega, M., 2019. Estimating capital flows to emerging market economies with heterogeneous panels. *Macroeconomic Dynamics* 23, 2068–2088.
- Kadiyala, K.R., K. S., 1997. Numerical methods for estimation and inference in bayesian-var models. *Journal of Applied Econometrics* 12, 99–132.
- Kim, S., Yang, D., April 2011. The Impact of Capital Inflows on Asset Prices in Emerging Asian Economies: Is Too Much Money Chasing Too Little Good? *Open Economies Review* 22 (2), 293–315.
URL <https://ideas.repec.org/a/kap/openec/v22y2011i2p293-315.html>
- Kim, S., Yang, D. Y., 2014. Do Capital Inflows Matter to Asset Prices? The Case of Korea. Palgrave Macmillan US, New York, pp. 51–82.
URL https://doi.org/10.1057/9781137368768_3
- Olaberria, E., Aug. 2012. Capital Inflows and Booms in Assets Prices: Evidence From a Panel of Countries. Working Papers Central Bank of Chile 675, Central Bank of Chile.
URL <https://ideas.repec.org/p/chb/bcchwp/675.html>
- Rebucci, A., September 2010. Estimating VARs with long stationary heterogeneous panels: A comparison of the fixed effect and the mean group estimators. *Economic Modelling* 27 (5), 1183–1198.
URL <https://ideas.repec.org/a/eee/ecmode/v27y2010i5p1183-1198.html>
- Sa, F., Towbin, P., Wieladek, T., Feb. 2011. Low interest rates and housing booms: the role of capital inflows, monetary policy and financial innovation. Bank of England working papers 411, Bank of England.
URL <https://ideas.repec.org/p/boe/boeewp/0411.html>
- Sutton, G., Mihaljek, D., Subelyte, A., Oct. 2017. Interest rates and house prices in the United States and around the world. BIS Working Papers 665, Bank for International Settlements.
URL <https://ideas.repec.org/p/bis/biswps/665.html>
- Taguchi, H., Tian, L., Jul. 2017. Capital flows, money supply and property prices: The case of China. MPRA Paper 80730, University Library of Munich, Germany.
URL <https://ideas.repec.org/p/pramprapa/80730.html>

Tillmann, P., 2013. Capital inflows and asset prices: Evidence from emerging Asia. *Journal of Banking & Finance* 37 (3), 717–729.
URL <https://ideas.repec.org/a/eee/jbfina/v37y2013i3p717-729.html>

A Model Estimation

Equation 4 can be estimated for each period once the matrices Ξ_r are defined. Hence, the model can be expressed as:

$$Y = \sum_{r=1}^5 \tilde{Z}_r \theta_r + \varepsilon$$

The prior distributions of θ , Σ_u and σ are:

$$\begin{aligned} \pi(\theta | \theta_0, \Omega_0) &\propto \exp\left(-\frac{1}{2}(\theta - \theta_0)\Omega_0(\theta - \theta_0)'\right) \\ \pi(\Sigma_u) &\propto |\Sigma_u|^{-\frac{Nn+1}{2}} \\ \pi(\sigma) &\propto \sigma^{-\frac{\tilde{\alpha}_0}{2}-1} \exp\left(-\frac{\tilde{\delta}_0}{2\sigma}\right) \end{aligned}$$

After tedious algebra using Bayes rule, the likelihood function and the above implies the full joint posterior distribution can be obtained as:

$$\begin{aligned} f(\theta, \Sigma_u, \sigma | y) &\propto \prod_{t=1}^T \left[\exp\left(-\frac{1}{2}\sigma^{-1}(y_t - \tilde{Z}_t \theta)\Sigma_u^{-1}(y_t - \tilde{Z}_t \theta)'\right) \right] \times \\ &\exp\left(-\frac{\tilde{\delta}_0}{2\sigma}\right) \times \exp(\sigma^{-\frac{NnT+\tilde{\alpha}_0}{2}-1}) \times \\ &|\Sigma_u|^{-\frac{T+Nn+1}{2}} \times \exp\left(-\frac{1}{2}(\theta - \theta_0)\Omega_0(\theta - \theta_0)'\right) \end{aligned}$$

As it is common in this type of models, integrating the above function is only possible by using numerical approximations and working with the conditional distributions. The conditional distribution of θ is:

$$\begin{aligned} \pi(\theta | y, \sigma, \Sigma_u) &\propto \exp\left(-\frac{1}{2}(\theta - \bar{\theta})'\Theta^{-1}(\theta - \bar{\theta})\right) \\ \bar{\theta} &= (\tilde{Z}'_{\Sigma_u} \tilde{Z}' + \Theta_0^{-1})^{-1} \\ \bar{\Theta} &= \tilde{\Theta} (\tilde{Z}'_{\Sigma_u} y + \Theta_0^{-1} \theta_0) \end{aligned}$$

The conditional distribution of Σ_u is of the form:

$$\begin{aligned}\pi(\Sigma_u|y, \theta, \sigma) &\propto |\tilde{\Sigma}_u|^{-\frac{T+Nn+1}{2}} \exp\left(-\frac{1}{2}\text{tr}\left[\tilde{\Sigma}_u^{-1}\bar{S}\right]\right) \\ \bar{S} &= \sigma^{-1} (Y - \check{Z}I_\theta) (Y - \check{Z}I_\theta)' \\ Y &= (y_1 \ y_2 \dots y_T) \\ \check{Z} &= (\check{Z}_1 \ \check{Z}_2 \dots \check{Z}_T) \text{ and } I_\theta = (I_T \otimes \theta)\end{aligned}$$

Finally, the conditional distribution of σ is given by:

$$\begin{aligned}\pi(\sigma|y, \theta, \Sigma_u) &\propto (\sigma)^{-\frac{\bar{\alpha}}{2}-1} \exp\left(-\frac{\bar{\delta}}{2\sigma}\right) \\ \bar{\alpha} &= NnT + \alpha_0 \\ \bar{\delta} &= [\text{tr}((Y - \check{Z}I_\theta)(Y - \check{Z}I_\theta)'\Sigma_u^{-1}) + \delta_0]\end{aligned}$$

Together with the initial values for the hyperparameters $(\theta_0, \Omega_0, z_0, Q_0, \tilde{\alpha}_0, \tilde{\delta}_0)$ (see Table A.1) the posterior distribution can be recovered implementing the Gibbs sampler as in Canova and Ciccarelli (2013).

Table A.1: Hyperparameters Values

θ_0	A vector of zeros
Ω_0	10^5
z_0	$N \times G + 5$
Q_0	\hat{Q}_0^{OLS}
$\tilde{\alpha}_0$	0.001
$\tilde{\delta}_0$	0.001

$\hat{Q}_0 = \text{diag}(Q_{11}, \dots, Q_{1N})$ and Q_{1i} is the estimated variance-covariance matrix of each individual country VAR by OLS.

Values are taken from Kadiyala (1997) and Canova and Ciccarelli (2013).

B Summary Statistics

		Mean	Std. Dev.	Min.	Max.
Real House Price Inflation	Brazil	0.9	2.4	-3.6	5.2
	Chile	0.4	2.8	-5.8	6.1
	Colombia	0.9	2.6	-7.6	7.4
	Czech-Rep	0.2	1.6	-3.4	4.3
	Hong-Kong	1.5	4.7	-12.3	14.3
	India	1.9	2.4	-2.5	6.0
	Korea	0.3	1.4	-2.3	4.8
	Malaysia	0.9	1.4	-2.1	4.1
	Mexico	0.4	1.8	-3.4	4.4
	Peru	1.1	6.6	-15.6	16.2
	Singapore	0.1	3.5	-13.2	14.8
	Thailand	0.7	1.9	-2.9	6.5
FDI to GDP	Brazil	3.2	1.4	0.8	6.7
	Chile	7.0	4.1	-1.5	19.7
	Colombia	4.3	2.2	1.2	17.8
	Czech-Rep	5.1	4.4	-4.3	25.2
	Hong-Kong	29.5	18.8	-17.9	99.8
	India	1.7	0.9	0.5	4.4
	Korea	1.0	0.6	-0.3	2.9
	Malaysia	3.2	2.1	-3.2	8.0
	Mexico	2.8	1.3	-0.2	8.5
	Peru	3.9	2.5	-4.6	10.2
	Singapore	18.7	8.3	-11.0	38.0
	Thailand	2.8	2.1	-8.0	6.4
Portfolio Flows to GDP	Brazil	0.9	2.0	-5.1	4.6
	Chile	2.2	2.6	-2.5	9.0
	Colombia	1.9	2.0	-2.6	6.4
	Czech-Rep	2.1	4.7	-10.7	28.7
	Hong-Kong	6.9	16.9	-57.3	70.3
	India	1.0	1.4	-2.0	4.7
	Korea	1.6	2.8	-7.4	9.6
	Malaysia	1.5	7.7	-24.6	22.7
	Mexico	1.8	2.4	-3.6	8.5
	Peru	2.0	2.9	-4.5	9.8
	Singapore	1.8	4.5	-10.4	15.4
	Thailand	0.8	2.9	-5.9	8.6

		Mean	Std. Dev.	Min.	Max.
Real GDP Growth Rate	Brazil	0.6	1.2	-4.1	2.5
	Chile	0.9	1.0	-1.2	3.3
	Colombia	1.0	0.9	-2.6	3.4
	Czech-Rep	0.7	0.9	-3.5	2.3
	Hong-Kong	0.9	1.3	-3.9	6.1
	India	1.7	1.2	-1.4	5.3
	Korea	1.0	0.9	-3.3	2.9
	Malaysia	1.2	1.0	-3.7	3.0
	Mexico	0.5	1.0	-5.1	3.2
	Peru	1.2	1.1	-2.2	3.8
	Singapore	1.3	2.1	-3.6	8.1
Thailand	1.0	1.7	-6.3	9.4	
Real Interest Rate	Brazil	47.6	12.0	24.4	84.3
	Chile	7.3	3.0	3.1	16.4
	Colombia	13.4	3.8	7.8	27.4
	Czech-Rep	5.3	1.1	3.0	7.9
	Hong-Kong	5.5	1.9	2.8	10.8
	India	9.6	1.3	6.2	12.2
	Korea	5.3	1.4	2.5	9.4
	Malaysia	5.2	1.3	2.5	8.5
	Mexico	6.8	4.4	1.8	20.5
	Peru	19.5	5.6	-0.5	30.5
	Singapore	5.0	0.7	3.0	6.4
Thailand	4.4	2.3	-1.2	9.0	
Mortgage Credit to GDP	Brazil	0.6	0.6	0.0	1.8
	Chile	2.0	0.9	-0.4	3.9
	Colombia	0.5	0.4	-0.9	1.2
	Czech-Rep	1.7	1.2	0.0	8.0
	Hong-Kong	2.0	2.2	-2.2	7.3
	India	0.4	0.4	0.0	1.1
	Korea	1.1	1.3	-0.8	4.1
	Malaysia	3.1	1.3	0.0	10.0
	Mexico	0.2	0.2	0.0	1.0
	Peru	0.2	0.1	0.0	0.6
	Singapore	-0.1	0.3	-1.5	0.5
Thailand	1.3	0.9	0.0	3.4	
US Real GDP Growth Rate		0.5	0.6	-2.2	1.8
VIX Growth Rate		4.3	33.4	-45.5	160.0
US Interest Rate		1.6	1.5	0.1	5.0

C Correlation Between House Price Inflation and Short-run Interest Rates

Brazil	0.206 (0.2424)
Chile	-0.0366 (0.8371)
Colombia	-0.0666 (0.7084)
Czech-Rep	-0.8181*** (0.0000)
Hong-Kong	0.2727 (0.1187)
India	0.227 (0.1966)
Korea	0.1325 (0.4552)
Malaysia	-0.0137 (0.9386)
Mexico	-0.1915 (0.2779)
Peru	0.2858 (0.1013)
Singapore	0.3717*** (0.0304)
Thailand	0.1691 (0.3391)

P-values in parenthesis: * significant at 10% ** significant at 5% *** significant at 1%.