

Capital Inflow Shocks and House Prices: Aggregate and Regional Evidence from Korea*

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Over the course of the recent global financial crisis, emerging economies experienced massive swings in capital inflows. In this paper, we estimate a VAR model to assess the impact of capital inflow shocks, which are identified using a set of sign restrictions, on house prices in Korea. We base the analysis on three alternative measures of capital inflows: net total inflows, net portfolio inflows and gross total inflows. The results suggest that capital inflow shocks have a significantly positive and persistent effect on real house prices. Although shocks to capital inflows are found to be substantially more important for Korean asset markets than for other OECD countries, their overall explanatory power is modest. Using regional house price data we also show that capital inflow shocks have an asymmetric effect on property markets across the seven largest Korean cities and across different parts of Seoul.

Keywords: Capital Inflows, House Prices, Monetary Policy, Sign Restrictions, VAR
JEL Classification: F32, F41, E32

I. Introduction

The recent financial crisis in many industrial economies was reflected in massive swings in international capital flows to emerging market economies.¹ In particular, cross-border flows to emerging economies exhibited again the boom-bust pattern that resembles previous financial crises. A dramatic

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¹ The dynamics of global capital flows during the recent financial crisis are studied in Milesi-Ferretti and Tille (2011), Forbes and Warnock (2011) and Förster, Jorra and Tillmann (2012).

withdrawal of international investments by global investors following the Lehman collapse in 2008 was followed by a quick and voluminous return of capital flows in 2009 when ultra-loose monetary conditions in the US and other economies and the resulting yield differential pushed capital back to emerging market economies.

In his account of the recent unconventional monetary measures taken by the US Federal Reserve and their impact on capital flows, Morgan (2011) argues that about 40% of the increase in the US monetary base under QE1 eventually resulted in increased gross capital outflows. With their relatively solid macroeconomic and financial development, Asian economies, much more than e.g. countries in Latin America or Emerging Europe, received the bulk of these flows.²

A common concern is that the abundance of global liquidity results in massive capital inflows that pose risks to financial stability in the receiving countries as flows increase domestic liquidity and might fuel asset price bubbles.³ Chen et al. (2012), among others, argue that the recent rounds of Quantitative Easing were associated with spillover effects boosting asset prices globally. Given their crucial role in the monetary transmission mechanism and its contribution to financial stability, the consequences of capital inflows driven by global push-factors for housing markets are particularly relevant.

In this paper we analyze the impact of capital inflow on house prices and equity prices, taking Korea as an example. For that purpose, we estimate a VAR model to gauge the dynamic effects of capital inflow shocks. A reduced-form VAR approach is well suited to quantify the effect of capital inflows as it is consistent with a wide range of economic models. Moreover, given that various transmission channels between capital inflows and asset prices coexist, applying a VAR model delivers results that do not hinge on just one transmission channel. In fact, capital inflows extend domestic saving and will thus lead to an expansion of credit to households and firms. A rapid expansion of credit will eventually become unsustainable. Domestic financial institutions which have access to abundant liquidity, might lend excessively to property markets. In addition, cheap global liquidity together with unusually low interest rates in industrial countries will provoke a search-for-yield behavior where investors take on higher risks in emerging economies' asset markets.

² The development of capital flows to Asia during the financial crisis is analyzed by IMF (2011 a, b) and Tille (2011).

³ Bernanke (2010) explicitly links capital flows to house price bubbles.

The identification of capital inflow shocks is not trivial as in small open economies many macroeconomic shocks typically result in capital movements across borders. Thus, we have to carefully identify capital inflow shocks. In this paper, we employ sign restrictions as proposed by Sá, Towbin and Wieladek (2011) to identify exogenous shocks to foreigners' demand for domestic assets, i.e. capital inflow shocks. Our notion of capital flow shocks corresponds to capital flows driven by push-factors such as monetary policy in advanced economies or global risk aversion.

We base the analysis on three alternative measures of capital inflows, net total inflows, net portfolio inflows and gross total inflows. The results suggest that capital inflow shocks have a significantly positive and persistent effect on real house prices. Shocks to capital inflows are found to be substantially more important for Korean asset markets than for other OECD countries.

In a companion paper, see Tillmann (2013), we use that identification scheme to analyze capital flow shocks in a panel of Asian economies. Besides focusing on the Korean case, this paper also allows for a second novelty. As a key contribution, we evaluate the extent to which the sensitivity of house prices to capital inflow shocks differs across Korean cities. Put differently, we ask whether the results obtained from nation-wide house price data are informative for major metropolitan regions. Using regional house price data we show that capital inflow shocks have an asymmetric effect on property markets across the seven largest Korean cities and across the northern and the southern half of Seoul, respectively. This result suggests that macroprudential policy measure might be best suitable to curb the impact of inflows on asset prices as these measures can be tailored to regional housing markets.⁴

The remainder of the paper is organized as follows: Section two connects the paper to different strands of the literature. The VAR model and the data set are introduced in section three. Section four discusses the identification of capital inflows shocks. The main results, including a set of robustness checks, are presented in section five. In section six we evaluate whether the sensitivity of house prices to capital inflows differs across major Korean cities. The final section draws conclusions.

⁴ For a survey on macroprudential measures see Crowe et al. (2011), Pradhan et al. (2011) and Ostry et al. (2011). The policy responses to capital inflows taken by Korean authorities are sketched in Chung (2010).

II. Related literature

A number of papers address the connection between capital inflows and asset market developments. In this literature, the VAR approach, either on an individual country basis as in this paper or in a panel set-up, takes center stage. In the following we briefly related this paper to the available literature.

The paper draws heavily on Tillmann (2013), who in turn uses the identification approach of Sá, Towbin and Wieladek (2011) to estimate the effect of capital inflow shocks in a panel of economies from emerging Asia in the post-1999 period. The key contribution of these papers is to use sign restrictions to identify capital inflow shocks in an otherwise standard VAR model. The identification via sign restrictions avoids the need to impose an often arbitrary ordering onto the variables which plagues the identification using the well-known Cholesky decomposition. Such a triangular identification scheme requires that the direction of causality between capital inflows, monetary policy responses and asset price movements within a given quarter to be restricted *ex ante*. Given the complex nature of the macroeconomic relationships and responses involved, this approach is often considered arbitrary. Tillmann (2013) finds that capital inflows have a significantly positive impact on house prices and account for a fraction of house price changes that is twice as large as in OECD countries. While a panel approach has its virtues in light of the short sample period available after the disruptions of the Asian financial crisis, it cannot shed light on country-specific developments. This paper closes this gap and uses a similar approach to study capital inflows to Korea.

Kim and Yang (2009) present a similar exercise within a more conventional, recursively identified VAR model, which suffers from the problem of imposing an arbitrary ordering of the variables as discussed before. They show that capital inflow shocks have a significantly positive impact on Korean stock prices but not on house prices. When the capital flow measure is narrowed to include only portfolio flows, the impulse response remains insignificant. Kim and Yang (2011) adopt the same approach to a panel VAR estimated on five Asian economies. It turns out that capital flow shocks explain only a small portion of asset price fluctuations.

A related strand of the literature studies the sensitivity of house prices to monetary policy shocks. Prominent contributions include Assenmacher-Wesche and Gerlach (2008) and Goodhart and Hofmann (2008), who estimate panel VARs on OECD countries to show that monetary policy shocks have a

significant effect on asset prices. Bracke and Fidora (2008) focus on the asset price responses in Asian emerging economies. He identifies monetary policy shocks by using sign restrictions and aggregate individual economies by using GDP weights. Monetary policy shocks are shown to explain a large part of asset price fluctuations. The studies of Vargas-Silva (2008), Mallick and Sousa (2012), Carstensen, Hülsewig and Wollmershäuser (2009) and Hristov, Hülsewig and Wollmershäuser (2011) provide VAR evidence, derived from country-specific or panel data, on the impact of monetary policy shocks. These papers, however, do not address capital inflow shocks or cover Asian economies.

A separate branch of the literature focuses on the relationship between the (negative) current account balance as a measure of capital inflows and various asset markets. Fratzscher, Juvenal and Sarno (2010) use a VAR with a sign-restriction identification scheme to assess the impact of asset market shocks on the U.S. current account. Reduced-form evidence on the relationship between asset prices and the current account balance typically finds a robust negative correlation between the growth rate of house prices and the change in a country's current account balance, see e.g. Kole and Martin (2009), Aizenman and Jinjarak (2009), Adam, Kuang and Marcet (2012), Jinjarak and Sheffrin (2011) and Kannan, Rabanal and Scott (2011).

Kim (2004) surveys the important role of housing for the Korean economy, while the determinants of property prices in Asian economies are studied by Zhu (2006) and Glindro et al. (2011). Cho and Ma (2006) show the long run negative relation between Korean house prices and Korean interest rates in a cointegration study. The comovement of house prices across Korean cities and regions is studied by Song (2008). He finds that more than 70% of house prices in the five largest Korean cities are driven by a single nationwide factor.

III. The VAR approach

Since the present paper is not a contribution to the methodology, we do not present the full details of the estimation and identification procedure. The interested reader can refer to Uhlig (2005) and Fratzscher, Juvenal and Sarno (2010) for thorough expositions. Here we give only the gist of the sign restrictions approach.

The estimated VAR model of order q takes the form

$$Y_t = B_0 + \sum_{i=1}^q B_i Y_{t-i} + u_t,$$

where Y_t is an $m \times 1$ vector of observables. B_i are $m \times m$ coefficient matrices and u_t is the vector of one-step ahead prediction errors with a variance-covariance matrix Σ . The vector B_0 collects the intercept terms.

To recover the structural shocks v_t behind the reduced form residuals, the restrictions emerging from the covariance structure are not sufficient. In addition, we follow Uhlig's (2005) seminal (pure) sign-restrictions approach. As mentioned before, standard VARs are typically identified by imposing restrictions on the contemporaneous relationships among the variables. This is equivalent to imposing a recursive ordering onto the variables in Y_t .

Table 1. The identifying restrictions

Variable in the VAR	Impact of capital inflow shock	Horizon
Capital inflows	+	3 quarters
Output	+	3 quarters
Price level	unrestricted	
Asset prices	unrestricted	
REER appreciation	+	3 quarters
Long rate	-	3 quarters
Short rate	unrestricted	

Table 2. Lag order selection

Lag order	AIC	SIC	HQ
$q = 0$	33.546	33.819	33.649
$q = 1$	18.884	21.067	19.709
$q = 2$	19.905	22.999	20.452
$q = 3$	17.942	23.945	20.210
$q = 4$	17.436	25.349	20.426

Here, the identification is achieved by imposing restrictions on the sign of the impulse responses of the endogenous variables following the seminal contribution of Uhlig (2005). He shows that an impulse vector can be recovered

by combining n_1 draws from the VAR posterior and n_2 draws from an independent uniform prior. We stop after obtaining n_3 impulse response functions with the desired sign over a horizon K . The error bands are calculated using the draws kept. We set $n_1 = n_2 = 2000$ and $n_3 = 1000$.

The VAR contains seven quarterly data series: net capital inflows in percent of GDP ($FLOWS_t$), log real GDP (GDP_t), the log consumer price index (P_t), the log real effective exchange rate ($REER_t$), a log real asset price ($ASSET_t$), the long-term bond yield ($LONG_t$) and the short-term money market interest rate typically used to proxy the Bank of Korea's monetary policy stance ($SHORT_t$). All variables enter the VAR in levels. Hence, the vector of observations is

$$Y'_t = (FLOWS_t, GDP_t, P_t, REER_t, ASSET_t, LONG_t, SHORT_t).$$

The choice of these variables is guided by two considerations: first, the VAR model should be as close as possible to standard models used in the literature; second, the model should remain as parsimonious as possible while at the same time allowing a rigorous identification of capital inflow shocks.

In the benchmark specification, $FLOWS_t$ represent net total capital inflows defined as the sum of foreign direct investment, portfolio inflows, derivatives inflows and other types of inflows. Two alternative specifications substitute net total capital inflows by a narrower measure covering only net portfolio inflows or gross total capital inflows.⁵ Moreover, in the benchmark specification $ASSET_t$ stands for real (residential) house prices. To compare the results, we also substitute real house prices by real equity prices. A higher value of $REER_t$ means a real appreciation of the domestic exchange rate.

The macroeconomic data series and the stock price data are taken from the IMF's International Financial Statistics Database, and the short-term interest rate was provided by the Bank of Korea, while the real effective exchange rate series and the series on house prices are obtained from the BIS's website.⁶ The estimation period starts in the first quarter of 1999, after the disruptions caused by the Asian financial crisis, and ends in the fourth quarter of 2011. This rather

⁵ As discussed in Forbes and Warnock (2011), among others, "gross inflows" are "net" items reflecting the difference between foreign purchases of domestic assets and foreign sales of domestic assets. Thus, gross flows can also become negative.

⁶ The original IFS series report capital flows in USD. We convert these series to KRW using the nominal exchange rate provided by the IFS and divide the result by nominal GDP.

short sample period is determined by the need to exclude the Asian crises in order to avoid structural breaks. As a matter of fact, the short sample period implies that the results should be interpreted with some caution.

Estimating the VAR model necessitates a choice of the lag order q . Table 2 presents three different lag selection criteria, i.e. the Akaike criterion (AIC), the Schwarz information criterion (SIC) and the Hannan-Quinn information criterion (HQ). As so often, these three criteria recommend different lag orders. While the SIC and the HQ suggest to include just one lag, the AIC, which puts much smaller weight on the loss of degrees of freedom once more lags are included, signals the inclusion of up to four lags. We choose an intermediate value and include two lags of the endogenous variables.

IV. The Identifying Restrictions

The set of restrictions imposed in this paper is summarized in Table 1. We interpret a shock to net capital inflows as an exogenous unexpected inflow of foreign capital unrelated to domestic fundamentals. Thus, capital inflow shocks can be thought of as being the consequence of monetary policy and liquidity conditions in industrial countries, changes in global risk aversion of investors, or contagion effects from other countries.

To translate this notion of capital inflow shocks into our VAR model, this type of shocks has to be distinguished from other shocks that would also eventually lead to an increase in capital inflows. Shocks to domestic technology or domestic demand, for example, would also attract foreign capital.

Here we adopt the identification scheme of Sá, Towbin and Wieladek (2011), which we augment with a constraint on the output response as in Tillmann (2013). An expansionary capital inflow shock is supposed to increase capital inflows, leads to an increase in economic activity, puts appreciation pressure on the real effective exchange rate and lowers long term interest rates. The restrictions are imposed for a horizon of $K = 3$ quarters.

We choose restrictions that are fairly non-controversial in the literature on capital flows. The restrictions used to identify capital inflow shocks are consistent with the empirical findings of Cardarelli, Elekdag and Kose (2010), who conclude that shocks to capital inflows have an expansionary effect on GDP and lead to a real appreciation. The positive effect on output is also supported by Kim and Kim (2013) for a set of emerging economies in Asia. The close association between capital inflows and appreciation pressure on the

domestic exchange rate is also documented by Jongwanich (2010) in a dynamic panel model.

A key restriction is that on the long-term interest rate. While other shocks such as a positive technology shock or a demand shock would also lead to capital inflows, these kinds of shocks would typically raise (real) interest rates. Thus, to distinguish a shock to capital inflows stemming from an exogenous increase in foreigner's demand for domestic assets, probably caused by monetary policy in advanced economies, the negative interest rate response imposed here is crucial.⁷ Again, this restriction is in line with a large body of empirical evidence. Jongwanich (2010) shows that capital inflows lower long-term interest rates. Likewise, Pradhan et al. (2011) find that an increase in nonresident participation in local bond markets by one percentage point reduces nominal long-term bond yields by about five basis points on average.

The response of real asset prices, i.e. either house prices or equity prices, is the central focus of this paper. Consequently, we leave the asset price response unrestricted. Since the asset price response to capital inflow shocks crucially depends on whether monetary policy tightens or loosens monetary conditions, we also leave the response of the short-term interest rate, i.e. the policy instrument of the Bank of Korea, unrestricted. Finally, the response of the price level is unrestricted to gauge the inflationary consequences of sudden inflows of foreign capital.

V. Results

We first present the results from the specifications discussed in the previous sections. After that, two modifications of the VAR specification are shown in order to corroborate the robustness of the findings.

Impulse responses

The resulting impulse response functions are depicted in Figure 1 to 6. All figures show the response of the seven endogenous variables to a capital inflow shock one standard deviation in size. The confidence bands are constructed using the 16th and 84th percentiles of the accepted responses.

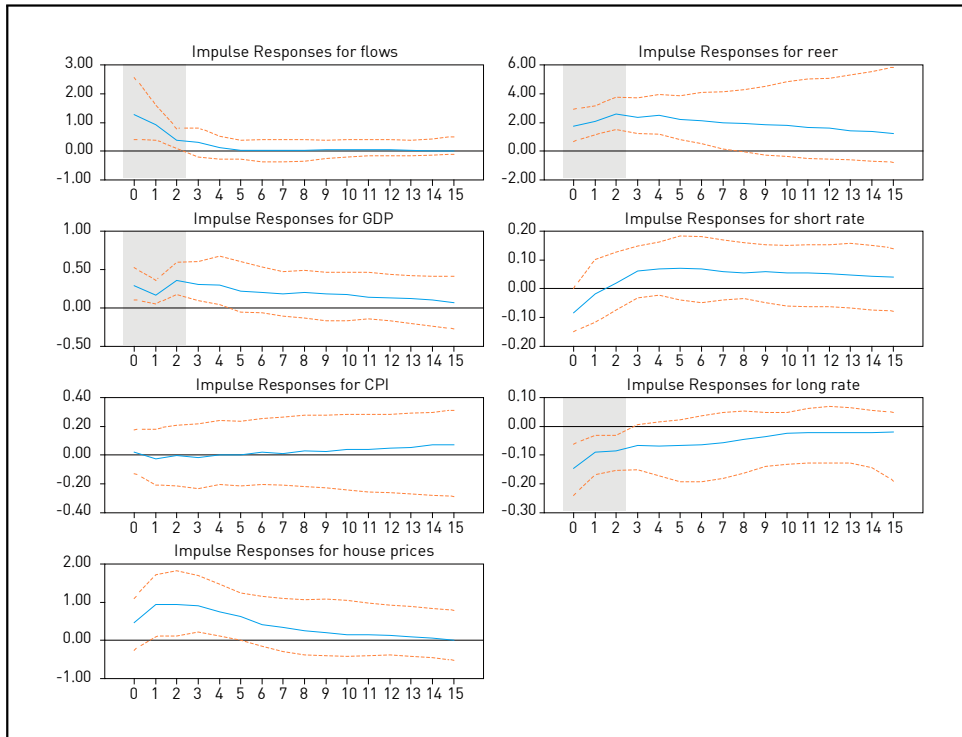
Figure 1 shows the baseline results obtained from a VAR with net total capital inflows and house prices. A shock to capital inflows is associated with an

⁷ See Sá, Towbin and Wieladek (2011) for a detailed discussion of that issue.

increase in the inflows to GDP ratio of about one percentage point. The shock leads to an expansionary effect on output that outlasts the restricted response in the first three quarters. The same is true of the real effective exchange rate, which significantly appreciates by two percent for about seven quarters. Apparently, capital inflows do not have inflationary consequences as the response of the CPI is essentially flat. Monetary policy as reflected by the evolution of the short-term interest rate tightens about three quarters after the shock, although this response lacks empirical significance.

The response of house prices is the core empirical result of interest. Capital inflows generate a significant house price boom which is associated with a persistent increase of real house prices of about one percent for a period of

Figure 1. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and house prices



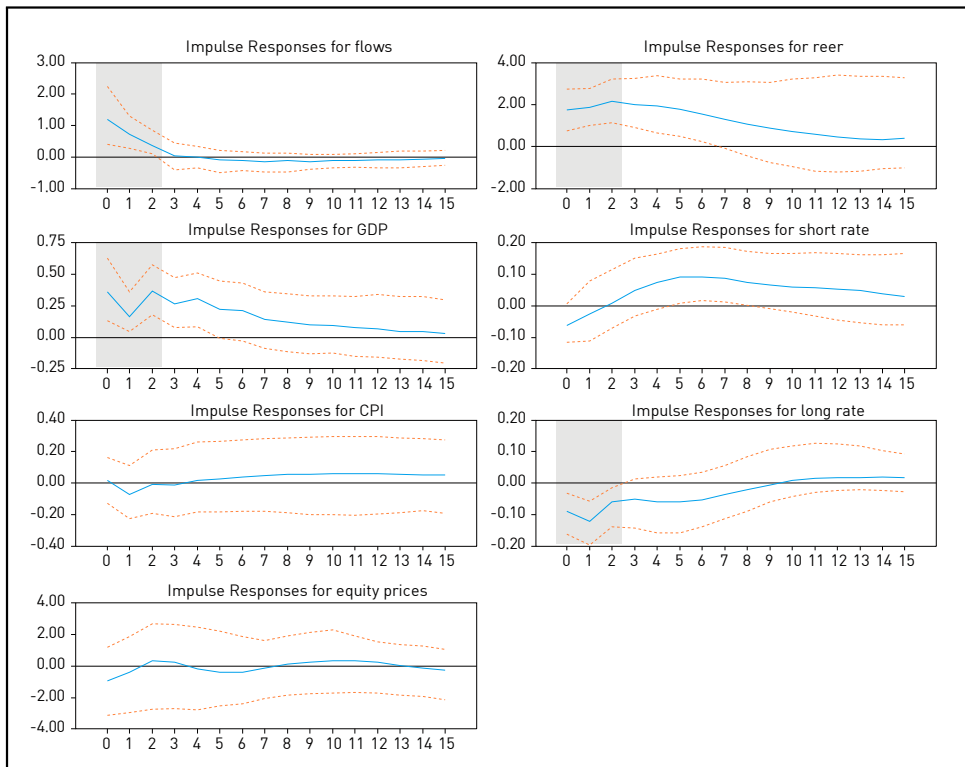
Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

five quarters.

The following figures show the corresponding impulse response functions for the alternative VAR modifications. Most macroeconomic responses are similar to the baseline specification. Figure 2 shows that once we replace house prices by equity prices, the equity price response is no longer significant. Instead, we now see a significant monetary tightening following five or six quarters after the shock.

Using net portfolio inflows instead of net total inflows leads to an insignificant house and equity price response, see Figure 3. In Figure 4, equity prices even fall following a portfolio inflow shock. This result, however, is of borderline

Figure 2. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and equity prices

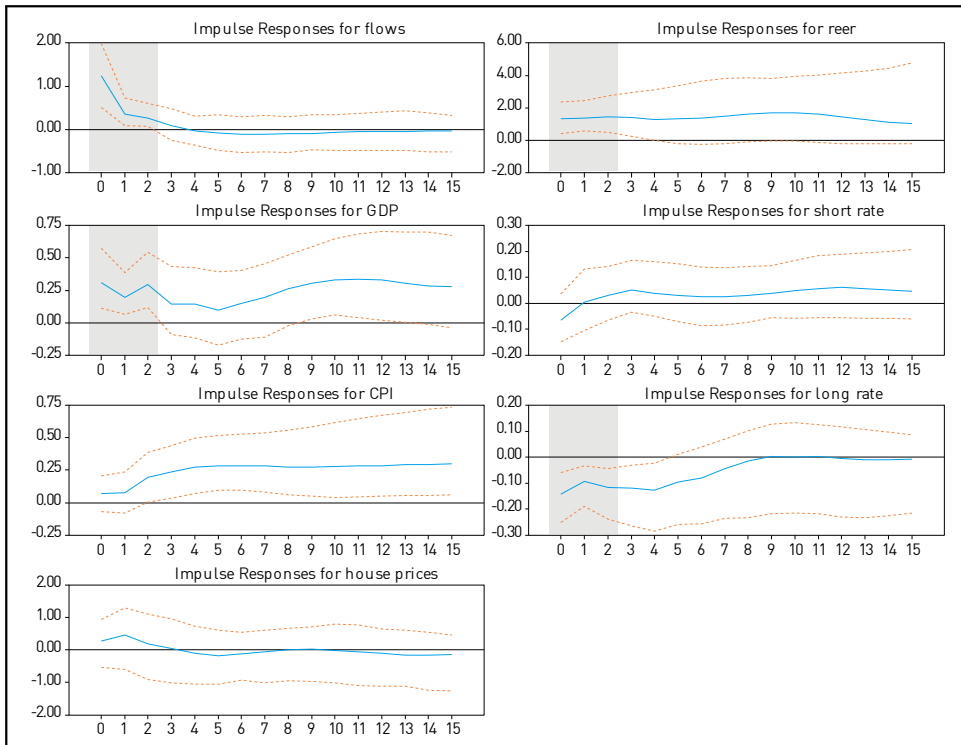


Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

significance. A shock to gross capital inflows, see Figure 5, raises house prices significantly. Interestingly, the house price response occurs much later than in the VAR based on total inflows. House prices start to appreciate significantly only after five quarters. Again, monetary policy is found to raise short-term interest rates in the wake of shocks to gross capital inflows.

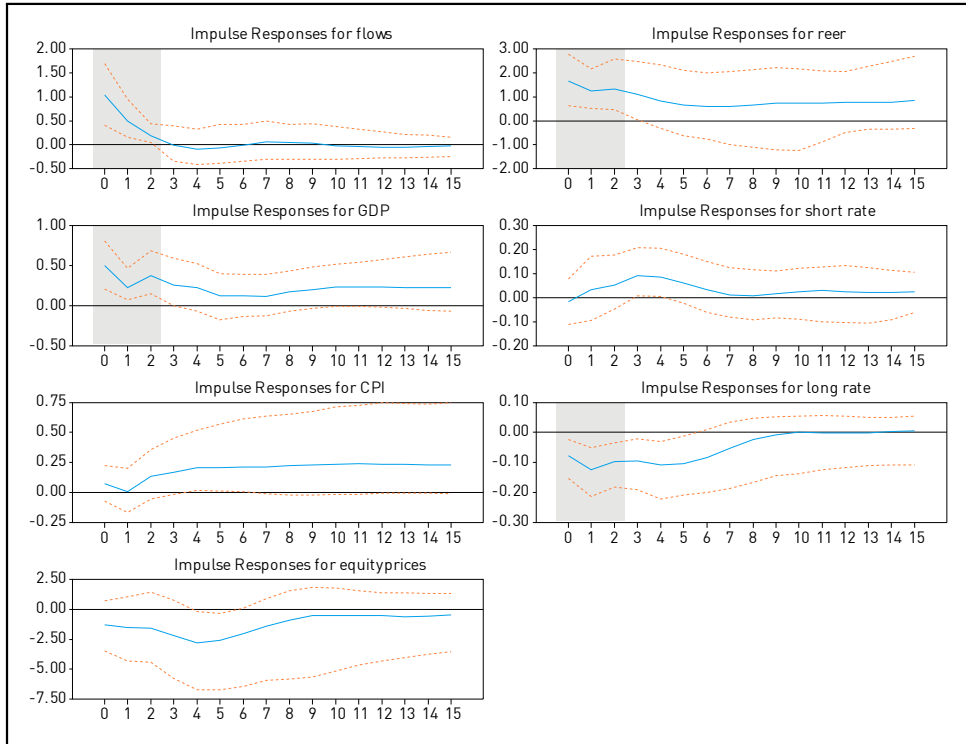
While a shock to net and gross total inflows raises house prices significantly, shocks to portfolio inflows have little effect on property prices. This is particularly interesting as the policymakers often focus on portfolio inflows when discussing measures to dampen asset price fluctuations.

Figure 3. Impulse responses to a capital inflow shock obtained from VAR model with net portfolio inflows and house prices



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 4. Impulse responses to a capital inflow shock obtained from VAR model with net portfolio inflows and equity prices



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 5. Impulse responses to a capital inflow shock obtained from VAR model with gross total inflows and house prices

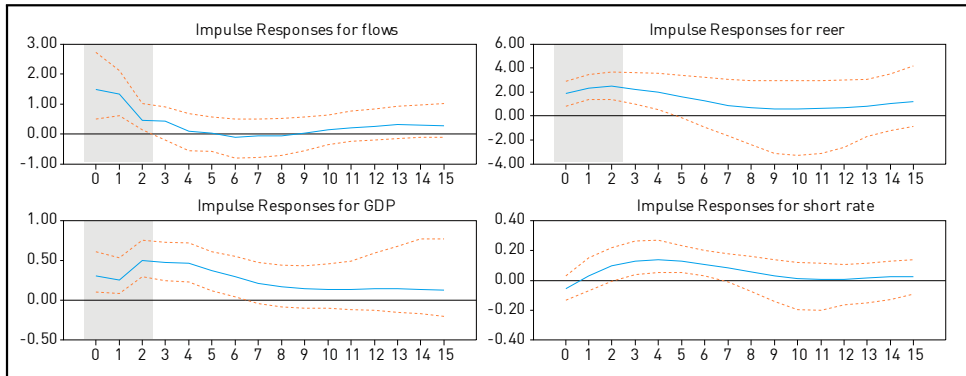
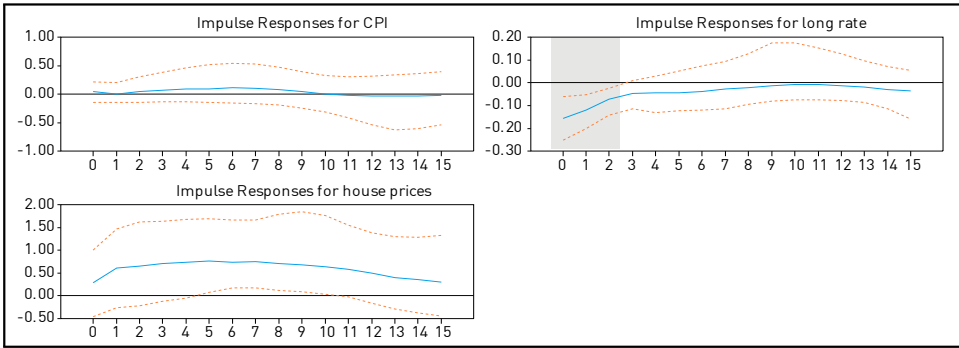
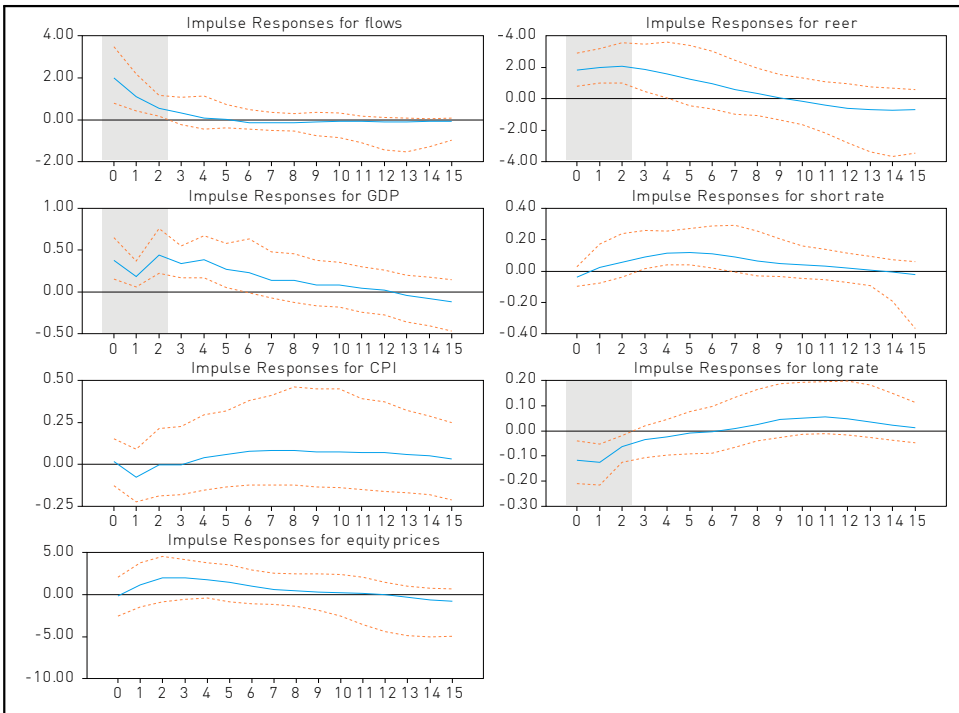


Figure 5. Continued



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 6. Impulse responses to a capital inflow shock obtained from VAR model with gross total inflows and equity prices



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Variance decomposition

Table 3 reports the share of the asset prices' forecast error variance attributable to capital inflow shocks. This decomposition shows that capital inflows, depending on the forecast horizon, account for roughly 10% to 14% of asset price movements. Their relevance does not differ between house price and equity price developments, respectively. According to the study of Sá, Towbin and Wieladek (2011), capital inflow shocks -on average- explain 5% to 7% of house price movements in OECD countries for horizons up to three years. Thus, in Korea shocks to capital inflows are twice as important as in the average OECD economy. These findings are not dependent on whether we use net total capital inflows, portfolio inflows or gross inflows. The modest role of capital inflow shocks as modeled here for domestic asset prices stands in contrast to recent concerns by policymakers from emerging economies blaming monetary policy in mature economies for causing excessive capital movements. Based on a high-frequency data set, Fratzscher, Lo Duca and Straub (2012) also find that unconventional policies in the US explain only a small share of capital flows to emerging economies.

Table 3. Forecast error variance decomposition

VAR model with	forecast horizon	variance share of asset price explained by capital inflow shock in VAR model with		
		net total inflows	net portfolio inflows	gross total inflows
house prices	1	0.11	0.10	0.10
	4	0.13	0.12	0.11
	8	0.14	0.14	0.13
	12	0.14	0.14	0.13
equity prices	1	0.11	0.09	0.11
	4	0.12	0.13	0.12
	8	0.13	0.14	0.13
	12	0.13	0.14	0.13

Shocks

Besides the impulse response functions and the corresponding forecast error variance decomposition, the VAR models also deliver the series of identified capital inflow shocks. These shocks are plotted in Figures 7 to 12 for the alternative specifications. The shock series from the baseline model, see Figure 7, persuasively reflect the evolution of the global financial crisis since 2008. The

third and fourth quarter of 2008 are characterized by negative capital inflow shocks as global investors repatriated their funds following the Lehman collapse. Triggered by the onset of a wave of unconventional monetary policy measures in many mature economies since mid-2009, which lead to massive injections of liquidity, and a promise to keep interest rates low for an extended period of time, large positive capital inflow shocks are observed. The quick reversal in capital inflow shocks is even more pronounced when derived from the VAR with portfolio inflows. See Figures 9 and 10. In sum, the series of shocks complies with the observable evolution of capital flows to Korea.

Figure 7. Capital inflow shocks obtained from the VAR model with net total inflows and house prices

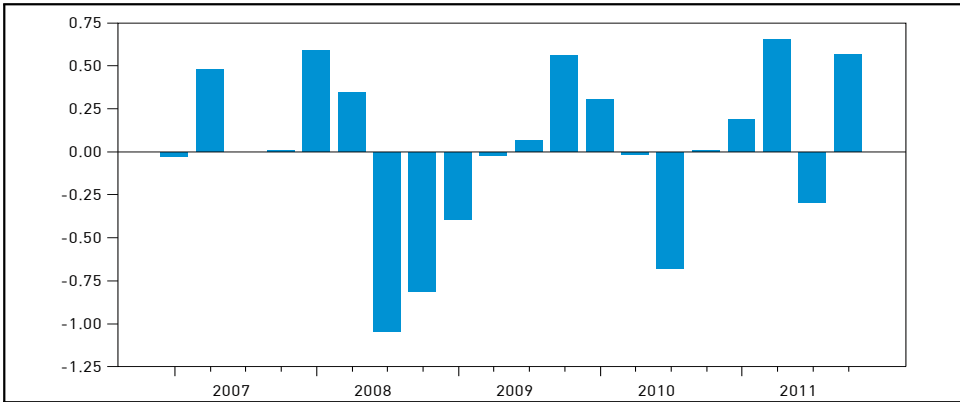


Figure 8. Capital inflow shocks obtained from the VAR model with net total inflows and equity prices

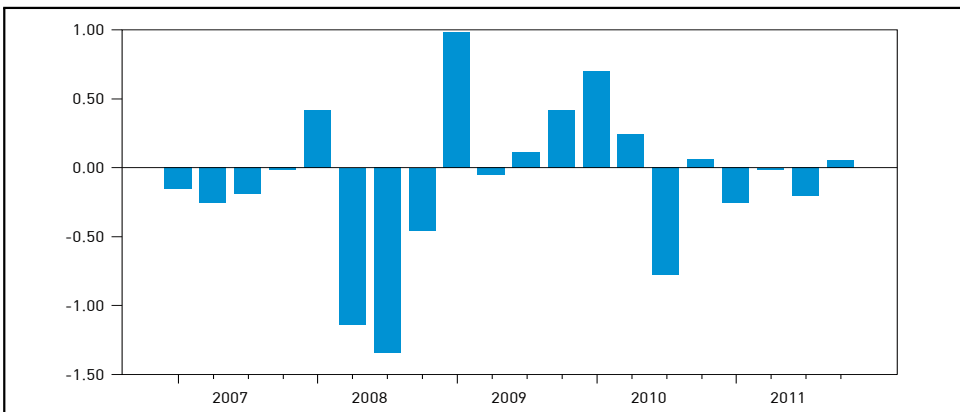


Figure 9. Capital inflow shocks obtained from the VAR model with net portfolio inflows and house prices

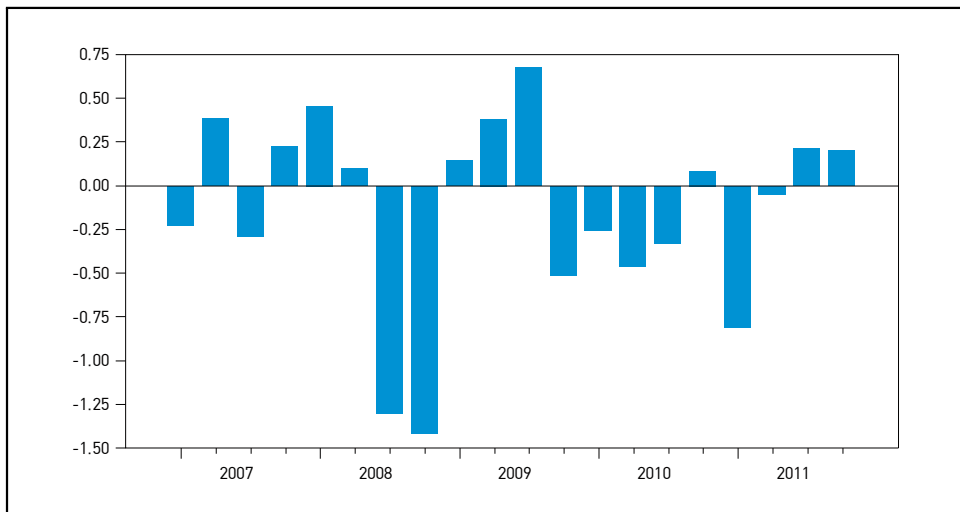


Figure 10. Capital inflow shocks obtained from the VAR model with net portfolio inflows and equity prices

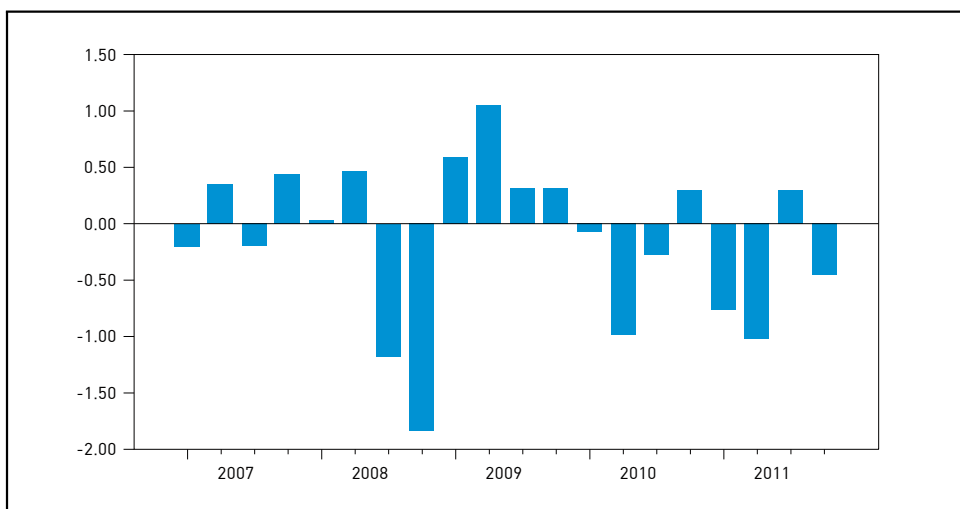


Figure 11. Capital inflow shocks obtained from the VAR model with gross total inflows and house prices

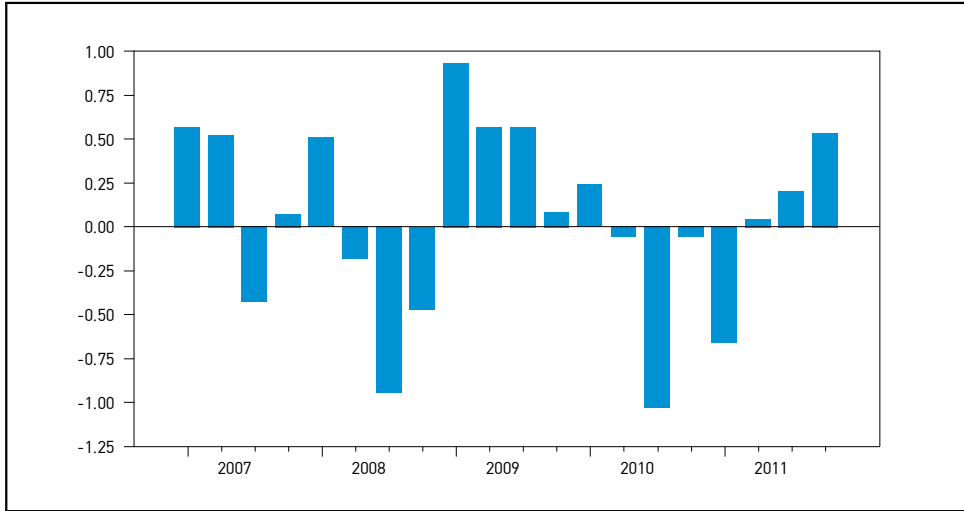
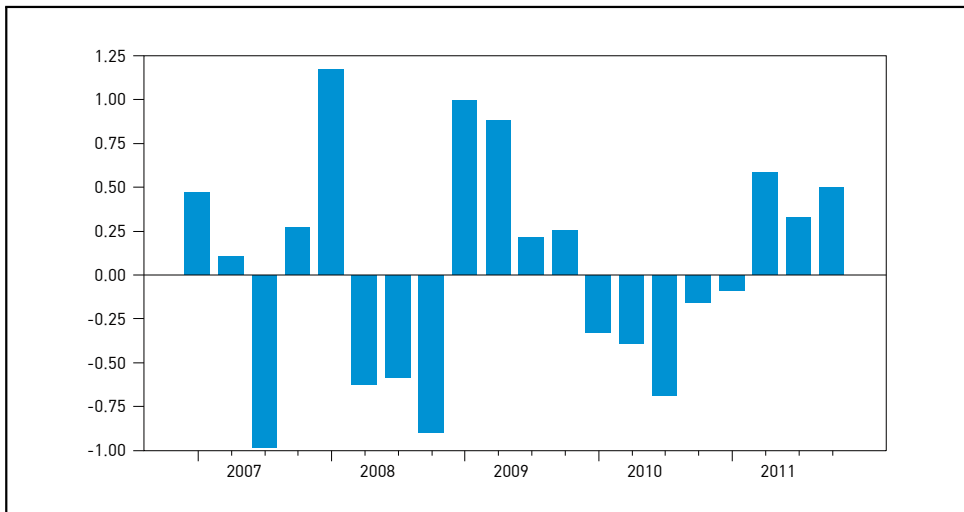


Figure 12. Capital inflow shocks obtained from the VAR model with gross total inflows and equity prices



Robustness

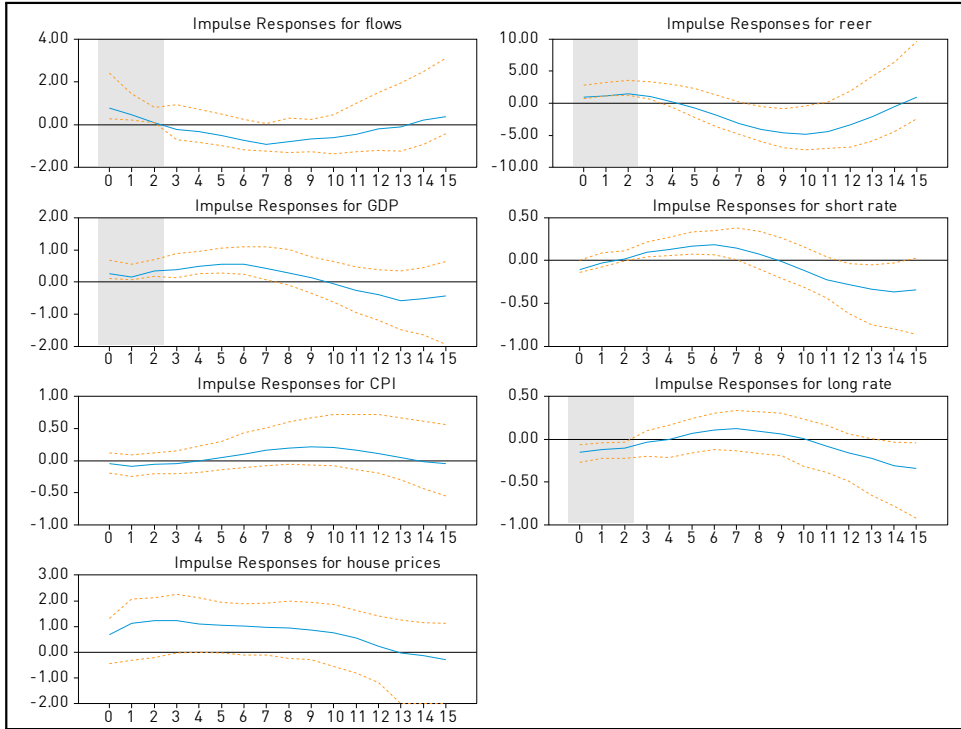
To evaluate whether the previous set of findings is robust to changes in the estimation sample and the choice of sign restrictions, we now present results from four modifications. The first concerns the sample period. Since our baseline sample includes the financial turbulence since 2008, we re-estimate the VAR up to the second quarter of 2008, i.e. we truncate the sample before the Lehman collapse. The resulting impulse responses are presented in Figure 13. As a result, house prices again respond with an increase of about one percent. Although this effect is more persistent than in the baseline results, it is not statistically significant. The house price response might be suppressed by a significant policy tightening, as reflected in the increase in the money market interest rate, which is absent from the baseline model.

The second and third modification pertains to the set of sign restrictions. As discussed before, we extend the restrictions proposed by Sá, Towbin and Wieladek (2011) by a restriction on the output response. Since we include capital inflows as a ratio over GDP, the joint restriction on capital inflows over GDP and GDP alone in fact imply a very large increase in the level of capital inflows. Relaxing the constraint on output, see the impulse responses in Figure 14, leads to quantitatively unchanged results. The house price response, although similarly shaped, is again on the border of significance. Nevertheless, we believe the output response is necessary to model property price booms and economic expansions fuelled by capital inflows.

In a third modification, we relax the restriction on the real exchange rate response. To the extent capital inflows are absorbed by an accumulation of foreign exchange reserves held by the Bank of Korea, the pressure on the real exchange rate can be contained. In the case of Korea, the Monetary Stabilization Bonds issued by the Bank of Korea could be used to sterilize the impact on domestic liquidity. Figure 15 presents the results for a specification without an explicit REER restriction. While the house price response remains significant, we see that the real exchange rate persistently appreciates even if being unconstrained. Thus, the restriction on the real exchange rate used before is an innocuous constrained.

Finally, Figure 16 shows the impulse response functions for a model estimated on four rather than just two lags of the variables. All results remain fairly unchanged. In particular, the house price response remains significant.

Figure 13. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and house prices estimated up to the second quarter of 2008



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 14. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and house prices, but without a sign restriction on GDP

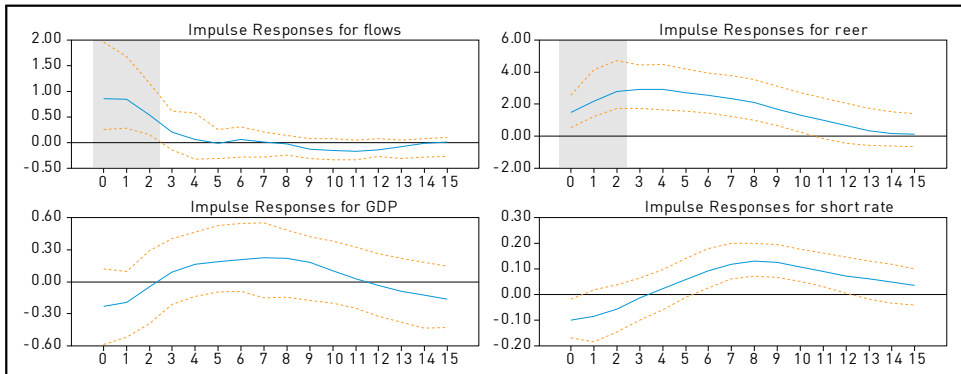
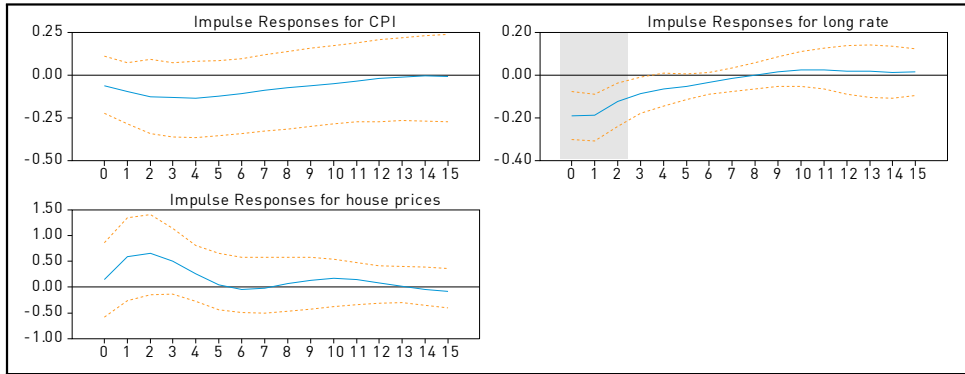
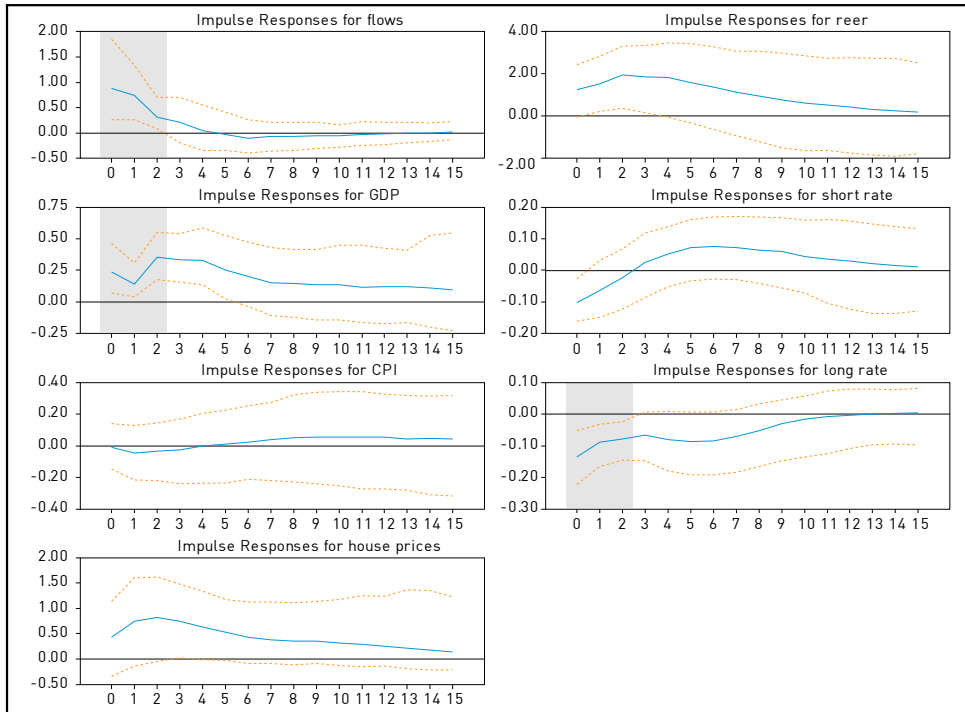


Figure 14. Continued



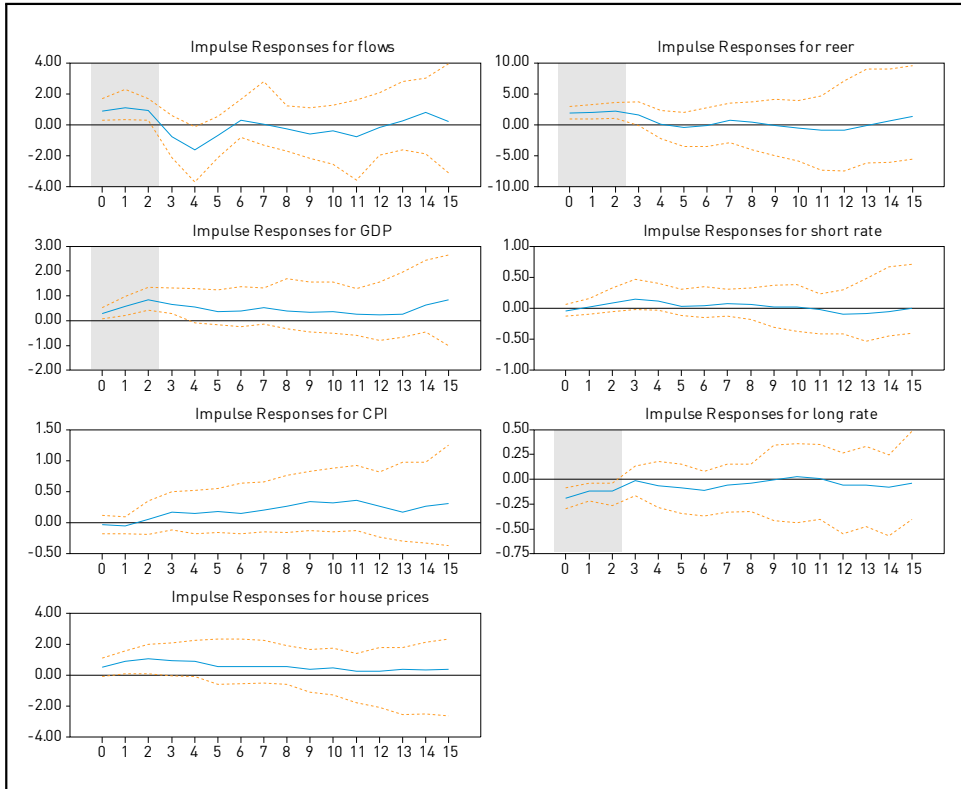
Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 15. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and house prices, but without a sign restriction on REER



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

Figure 16. Impulse responses to a capital inflow shock obtained from VAR model with net total inflows and house prices with four lags



Notes: Each figure depicts the median response (solid line) and the 16th and 84th percentiles of the accepted draws as a confidence band (dotted lines). The shaded areas indicate the restrictions imposed.

VI. Aggregate vs. Regional Effects

The analysis in the previous section showed the response of the aggregate Korean house price index to a capital inflow shock. Given the uneven distribution of economic activity across Korean metropolitan areas with a very high degree of centralization in Seoul, the capital, it is interesting to gauge how representative these aggregate response patterns are.⁸ For that purpose we collect house price indexes for the seven largest Korean cities: Seoul, Incheon, Busan, Daejeon, Daeju, Gwangju and Ulsan.⁹ The three different VAR models

⁸ See Park, Bahng and Park (2010) for an analysis of regional differences in Korean property price dynamics.

are estimated seven times, each time with the nationwide house price index being replaced by one of these seven regional house price series. All other variables remain unchanged. This delivers seven sets of different impulse response functions; one for each of the seven cities. Comparing these impulse responses reveals whether the sensitivity of house prices to capital inflows differs across cities. A similar analysis is conducted with respect to house prices within Seoul. We estimate two separate VARs with house prices in the northern part and the southern part of Seoul. With its rapid expansion, the southern part might be particularly prone to capital inflows from abroad.

Note that it is one advantage of the sign restrictions approach to shock identification that changing the house price series is an innocuous modification as we do not have to impose a certain contemporaneous interaction among the variables. Put differently, in a standard recursive VAR replacing national house prices with prices in, say, Ulsan, is likely to change the causality within the current quarter as prices in Ulsan might exhibit a different relationship with aggregate macroeconomic variables than nation-wide house prices. Under the sign restrictions approach, however, we can easily substitute the variable without affecting the identification scheme.

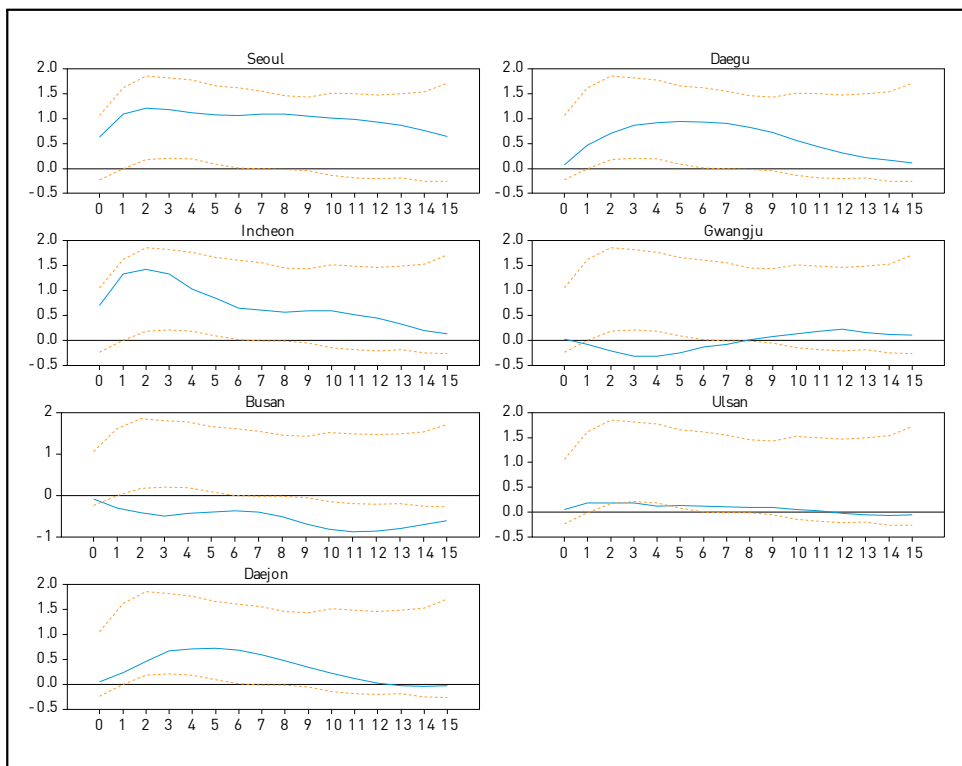
The resulting impulse response functions for the seven Korean cities are shown in Figures 17 to 19. In each figure we contrast the city-specific median impulse response with the confidence bands of the responses of aggregate house prices. Based on net total capital inflows the house prices response in most cities lies within the confidence bounds of the aggregate house price response. Put differently, the house price response appears largely symmetric across cities. Only in Busan and Gwangju house prices respond far less to capital inflows. Based on net portfolio flows, see Figure 17, the response in Busan and Ulsan is significantly below that of the nation-wide house price index, while house prices exhibit an above average appreciation in Daejeon and Daegu. The largest degree of regional heterogeneity obtains for the VAR model with gross capital inflows, see Figure 19. While house prices in Seoul and Incheon increase by more than the nation-wide average, prices in Gwangju and Busan increase by far less or even fall after a capital inflow shock. The size of this regional discrepancy in terms of the difference in maximum house prices responses is about two percentage points.

Figure 20 shows the impulse responses for a similar experiment, in which aggregate house prices are replaced by house prices in either the northern part

⁹ Regional house price data is taken from the CEIC database.

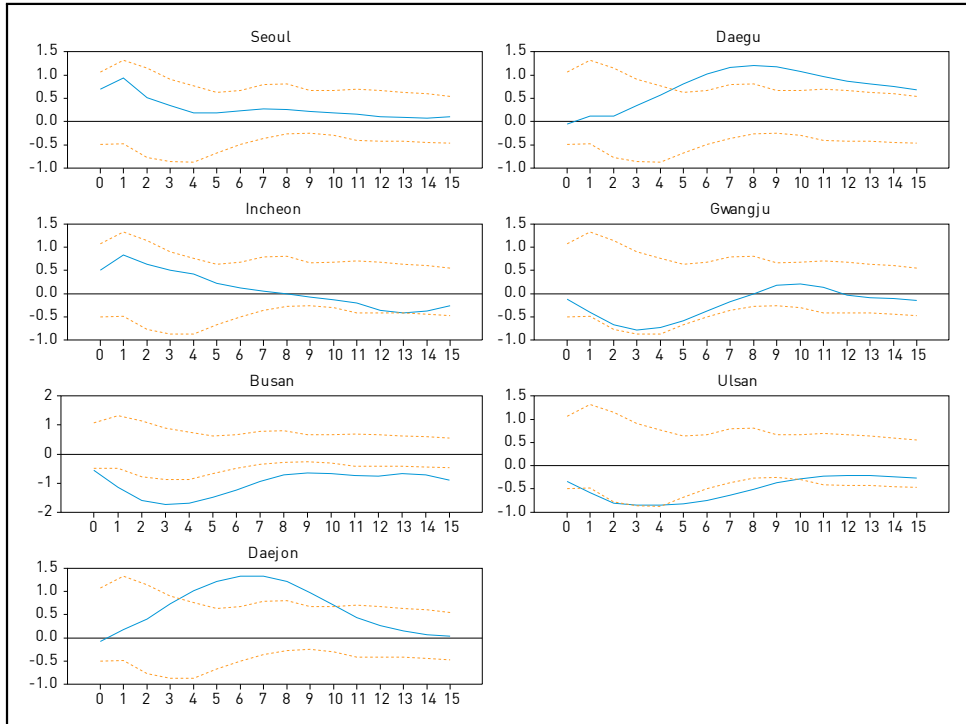
of Seoul, the historical and administrative center, or the booming southern part of Seoul, which was rapidly growing over the past decades and is home to many multinational companies. Again the confidence bands are those from the aggregate house price response. While the sensitivity of house prices to capital flows in the northern part of Seoul is fairly representative for the entire country, the response in the southern part is significantly stronger.

Figure 17. Effect of capital inflow shock on regional house prices obtained from VAR model with net total inflows



Notes: Each figure depicts the median house prices response in a particular metropolitan region (solid line) and the confidence band for the aggregate house price response (dotted lines)

Figure 18. Effect of capital inflow shock on regional house prices obtained from VAR model with net portfolio inflows



Notes: Each figure depicts the median house prices response in a particular metropolitan region (solid line) and the confidence band for the aggregate house price response (dotted lines)

Figure 19. Effect of capital inflow shock on regional house prices obtained from VAR model with gross total inflows

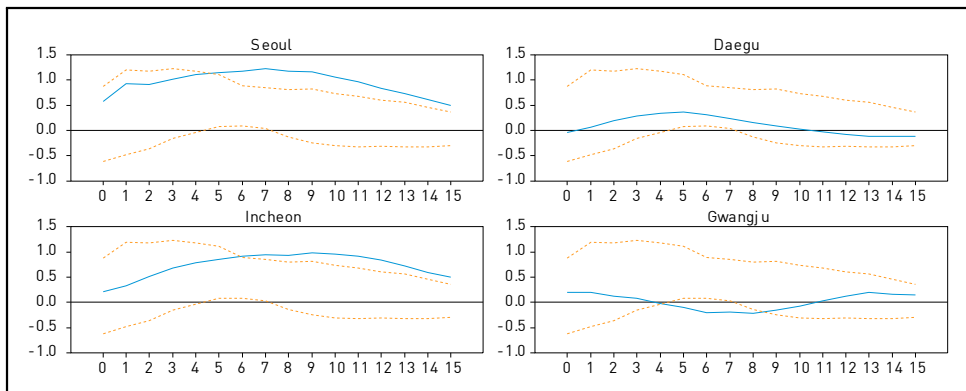
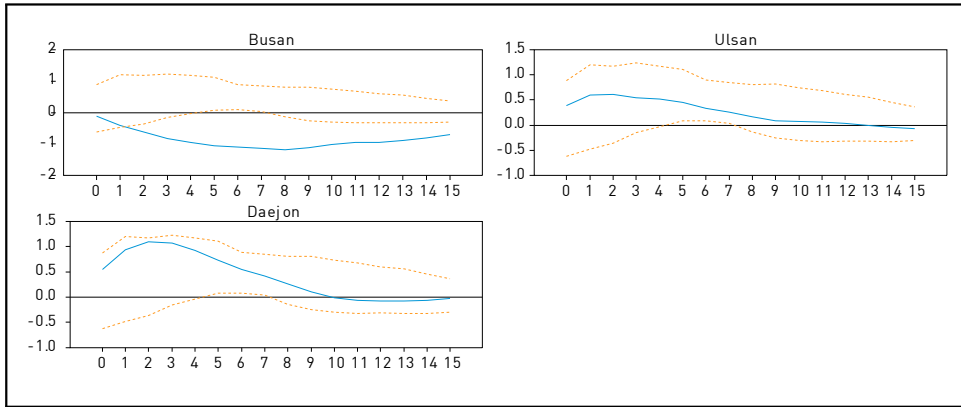
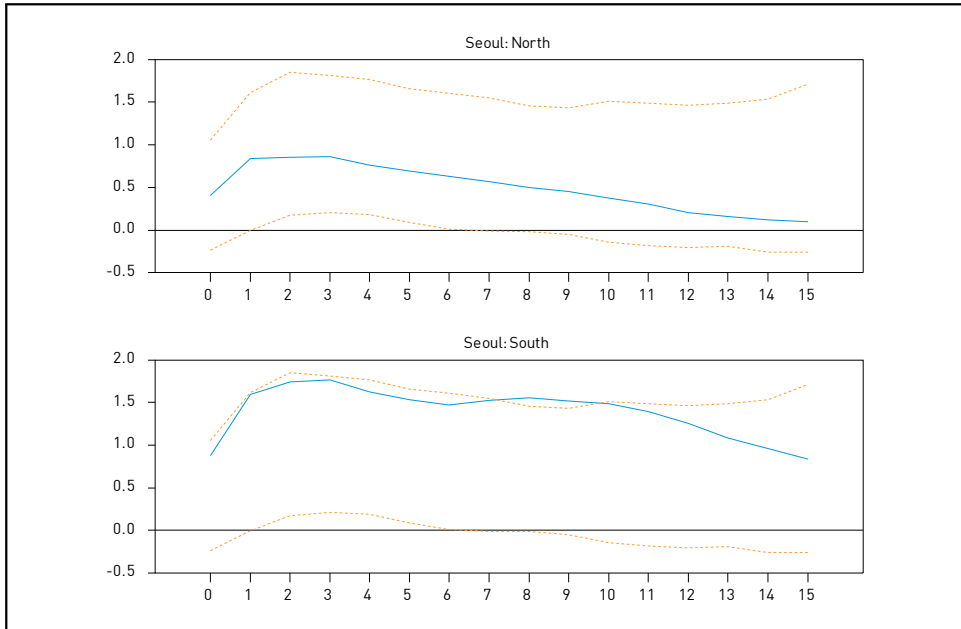


Figure 19. Continued



Notes: Each figure depicts the median house prices response in a particular metropolitan region (solid line) and the confidence band for the aggregate house price response (dotted lines)

Figure 20. Effect of capital inflow shock on house prices in different parts of Seoul obtained from VAR model with net total inflows



Notes: Each figure depicts the median house prices response in a part of Seoul (solid line) and the confidence band for the aggregate house price response (dotted lines)

The finding of sizable regional asymmetries in the responses to capital inflow shocks has important implications for the design of policy directed towards avoiding overheating property markets and house price bubbles, respectively. Our results tend to favor macroprudential policy measures such as maximum debt-to-income ratios or maximum loan-to-value-ratios over standard monetary policy measures such as adjustment of the short-term interest rates to combat property price bubbles. While the former set of tools can be tailored to the needs of regions housing market developments, the latter, i.e. a monetary tightening, is too blunt a tool as it affects all regional property markets symmetrically.

VII. Conclusions

Large and volatile capital inflows into emerging economies, while generally considered beneficial for growth and development, are often also associated with side effects such as real exchange rate changes, effects on domestic liquidity and an increase in the procyclicality of asset price movements. In this paper we took Korea as an example and quantified the response of house and equity prices to a shock in capital inflows. For that purpose a sample period was chosen that starts after the disruptions of the Asian financial crisis. Due to the short sample period, therefore, some degree of caution is required when interpreting the findings.

The VAR model estimated for that purpose revealed that suitably identified capital inflow shocks indeed have a significantly positive impact on domestic house prices. Capital inflows generate a house price boom which is associated with a persistent increase of real house prices of about one percent for a period of five quarters. Although shocks to capital inflows are found to be substantially more important for Korean asset markets than for other OECD countries, their overall explanatory power is modest. Using regional house price data we also show that capital inflow shocks have an asymmetric effect on property markets across the seven largest Korean cities and across different parts of Seoul.

These findings highlight the need to closely monitor asset price development in light of massive capital inflows. Korea, among other countries in the region, pioneered the use of macroprudential measures such as caps on loan-to-value ratios to contain the property price boom. The results in this paper support this policy as, first, exogenous capital flows stemming from foreign investors' search for yield might lead to asset price misalignments and, second, the impact is asymmetric across housing markets. The latter property makes it difficult to

combat asset price bubbles with an “aggregate tool” such as a conventional monetary tightening. It should be taken into account, however, that according to our results capital inflow shocks still account for only a small part of asset price movements. Furthermore, the effectiveness of the initiatives taken by the Korean authorities, e.g. the bank levy on non-core liabilities that became effective in 2011 or the adjustment of maximum loan-to-value ratios, has to be carefully analyzed when sufficient data is available.¹⁰

Finally, the sensitivity of asset markets to capital inflows implies risks for the Korean housing market when capital flows are reversed e.g. due to a monetary tightening in industrial countries.

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¹⁰ See Igan and Kang (2011) for a first attempt.

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