House Prices, Capital Inflows, and Risk Perception in the Global Financial Cycle

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Abstract

This study explores the interaction among house prices, capital inflows, and risk perception in global markets. Empirical analysis indicates that increases in capital inflows and an easing of risk perception in global markets induce appreciation in house prices. More importantly, it also reveals that the sensitivity of house prices to global risk perception is higher in countries that experience faster expansion of bank credit relative to their real economies. The results indicate that capital inflows and global risk perception play key roles in understanding house price dynamics and suggest that house price fluctuations are more strongly linked to US financial and monetary conditions in economies with rapidly growing financial systems.

Keywords: House prices, International capital inflow, Risk perception, Global financial cycle

JEL classification: F3

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1. Introduction

Many developed countries experienced large boom–bust cycles in house prices over the past two decades. Moreover, fluctuations in house prices co-move across countries, although there might be cross-country variations in domestic factors (Hirata et al., 2012). In recent literature (e.g., Rey, 2013; Passari and Rey, 2015), co-movements of asset prices are called the global financial cycle. These co-movements imply that external factors (e.g., capital inflows) and common global factors (e.g., risk perception in global markets) can affect house price dynamics.

To reveal key factors that contributed to the boom–bust cycles and co-movements, this study explores the interaction among house prices, capital inflows, and risk perception in global markets. Empirical analysis indicates that capital inflows and risk perception in global markets play a key role in understanding house price dynamics and, more importantly, fluctuations in house prices are more strongly associated with global risk perception in economies with rapidly growing financial systems.

This study offers three contributions. First, it provides a more complete picture of the interrelations of key factors affecting house prices. Empirical analysis on global imbalances (e.g., Bernanke, 2010; Sá et al., 2014) suggests that capital inflows induced appreciation in house prices. However, it did not focus on factors that determine the dynamics of capital inflows or investigate the effect of risk perception in global markets on house prices. This study fills these gaps.

Second, the analysis reduces concern arising from endogeneity. There might be a two-way causality between house prices and capital inflows. However, Bernanke (2010) and Miranda-Agrippino and Rey (2013) insufficiently dealt with this problem in their explorations of the interaction between the two variables. This study employs an instrumental variable (IV) method to reduce the endogeneity concern, which also enables us to jointly estimate the determinants of house prices and capital inflows, thus strengthening the first contribution.

The last but most important contribution is the novel findings on the sensitivity of house prices to the global financial cycle or risk perception in global markets; both are proxied by the CBOE volatility index (VIX). Previous research provides little systematic evidence regarding the responsiveness of domestic variables to VIX being heterogeneous across countries. For example, Passari and Rey (2015) indicated that there is no clear relationship between the degree of exchange rate flexibility and the sensitivity of asset prices to the VIX. Rey (2013) and Miranda-Agrippino and Rey (2013) also provide similar evidence on the relationship between the intensity of capital inflows and the sensitivity of house prices to the VIX. However, further analysis reveals that the sensitivity of house prices to the VIX is higher in countries that experience faster expansion of bank credit relative to their real economies. This finding suggests that house price fluctuations are more strongly linked to US financial and monetary conditions in economies with rapidly growing financial systems

because VIX is closely tied with federal fund rate shocks, as revealed in Bruno and Shin (2015b) and Rey (2013).

The remainder of this study is structured as follows: Section 2 describes materials and methods, Section 3 presents results and discussions, and Section 4 concludes.

2. Material and Methods

This study performs a panel IV regression involving quarterly growth of house price index (*ΔHouse*) and gross capital inflows (*Inflow*) as the dependent and endogenous variables, respectively.[2,3] This regression uses instruments that affect the endogenous variables but are not related to variations in the dependent variable (error term). The models contain one of the two instruments described below.

The first instrument is global leverage (lagged level and current growth denoted as *Global_Lev* and *ΔGlobal_Lev*, respectively), defined as the ratio of assets over equity of US broker–dealers. Bruno and Shin (2015a) find that global leverage is the key driver of capital inflows. However, the risk-taking capacity of US agents may be irrelevant to house prices in a particular country, at least directly.

The second instrument is global flow (*Global_Flow*), defined as the sample sum of gross capital inflows excluding inflows to the country under consideration (Blanchard et al., 2015). Considering Rey's (2013) findings, global flow can be correlated with gross inflows to each country because gross flows co-move at the global level. However, global flow is clearly irrelevant to the variations within the country under consideration because data on the country are excluded from the flow.

Empirically, the effects of these instruments on endogenous variables may vary across countries. Thus, for half the specifications, the models contain interaction terms of the instruments with country-specific dummies as the alternative set of instruments. These specifications may be less restrictive on the sensitivity of the endogenous variables to the instruments.

Moreover, following Bruno and Shin (2015a) and Miranda-Agrippino and Rey (2013), the models also contain the following control variables: lagged level and current growth of the VIX as a proxy for the global financial cycle or risk perception in global markets (*VIX* and *ΔVIX*, respectively),

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[2] Explanation in this section largely follows Tobe (2017), who uses the same identification strategy for exploring fluctuations in domestic credit growth.

[3] Data on capital inflows are divided by external liability to avoid undesirable effects of outliers that undertake large cross-border capital transactions relative to the scale of their real economy (e.g., Ireland and Switzerland). Results hold true even when inflows are normalized relative to GDP. In that case, however, F-statistics in first-stage regressions often decrease to below 10, which raises concerns regarding weak instruments. Trimming outliers by winsorizing cannot fully resolve this problem.

local stock market volatility (*Stock_Vol*), change in long-term interest rates (*ΔLong_Rate*), GDP growth rate (*ΔGDP*), inflation rate (*Inflation*), and change in real effective exchange rates (*ΔREER*). Furthermore, to explore the sensitivity of house prices to the VIX, the models also contain the current and lagged interaction terms of the growth of the VIX with the growth of bank credit to GDP ratio (*ΔVIX*ΔCredit*) as additional specifications. Appendix A provides further details on these variables. All controls except the growth of VIX and its interaction terms are lagged by one-quarter. The sample comprises quarterly data spanning the 1990Q1–2015Q3 period and 22 developed countries (Appendix B).

3. Results and Discussion

Table 1 presents results from panel regression models. Models 1, 3, 5, and 7 (Models 2, 4, 6, and 8) use global leverage (global flow) as an instrument. Columns (1) and (2) show the results of the first- and second-stage regressions of Model 1, respectively.

In the first stage, global leverage (lagged level and current growth) is positively correlated with capital inflows, consistent with Bruno and Shin (2015). As for controls, the coefficient for GDP growth is also positively significant, implying pro-cyclicality of capital inflows. Other controls are insignificant in this stage, but the F-statistic is sufficiently high (larger than 10). Thus, there might be little concern about weak instruments.

In the second stage, capital inflows are positively correlated with house prices at the 1% significance level, indicating that capital inflows contribute toward house price appreciation. Moreover, the VIX (current growth) is negatively correlated with house price, indicating that risk perception in global markets is also a key driver of house price dynamics. Long-term interest rate and GDP growth also show expected signs.

Results are similar when global flow is included as an instrument instead of global leverage (Model 2). Column (3) shows global flow as positively correlated with capital inflows, indicating that capital inflows co-move across the sampled countries. GDP growth rate coefficient loses significance in this model, but the F-statistic remains sufficiently high. Moreover, column (4) indicates that the coefficient for capital inflows remains positively significant. In this model, coefficients for both lagged level and current growth of the VIX are negatively significant. The principal results are maintained when the models use the interaction terms of the instrument with country-specific dummies described in the last section as an alternative set of instruments (Models 3

and 4).[4]

Table 1. Results of Panel IV Regression (quarterly change series)

	Model 1		Model 2		Model 3	Model 4	Model 5		Model 6		Model 7	Model 8
	1st stage $Inflow_t$	2nd stage $\Delta House_t$	1st stage $Inflow_t$	2nd stage $\Delta House_t$	2nd stage $\Delta House_t$	2nd stage $\Delta House_t$	1st stage $Inflow_t$	2nd stage $\Delta House_t$	1st stage $Inflow_t$	2nd stage $\Delta House_t$	2nd stage $\Delta House_t$	2nd stage $\Delta House_t$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Endogenous variable												
$Inflow_t$		0.168***		0.090***	0.065**	0.079***		0.169***		0.090***	0.063**	0.077***
		(0.043)		(0.027)	(0.025)	(0.023)		(0.044)		(0.027)	(0.025)	(0.023)
Instruments												
$Global\_Lev_{t-1}$	0.065***						0.066***					
	(0.015)						(0.015)					
$\Delta Global\_Lev_t$	0.179***						0.180***					
	(0.036)						(0.037)					
$Global\_Flow_t$			0.716***						0.717***			
			(0.101)						(0.099)			
Control variable												
VIX_{t-1}	0.004	-0.003	0.009	-0.003*	-0.003*	-0.003*	0.004	-0.003	0.009	-0.003*	-0.003*	-0.003*
	(0.007)	(0.002)	(0.008)	(0.002)	(0.002)	(0.002)	(0.007)	(0.002)	(0.008)	(0.002)	(0.002)	(0.002)
ΔVIX_t	0.005	-0.004*	0.008	-0.004*	-0.004*	-0.004*	0.006	-0.004*	0.009	-0.004*	-0.004*	-0.004*
	(0.005)	(0.002)	(0.006)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)	(0.006)	(0.002)	(0.002)	(0.002)
ΔVIX_t*$\Delta Credit/GDP_t$							-0.694**	-0.136	-0.652**	-0.184**	-0.200**	-0.192**
							(0.249)	(0.095)	(0.266)	(0.092)	(0.084)	(0.091)
ΔVIX_{t-1}*$\Delta Credit/GDP_{t-1}$							-0.183	-0.165*	-0.201	-0.177**	-0.182**	-0.179**
							(0.332)	(0.088)	(0.276)	(0.083)	(0.080)	(0.083)
$Stock\_Vol_{t-1}$	-0.006	0.002	-0.002	0.001	0.000	0.001	-0.006	0.001	-0.002	0.000	0.000	0.000
	(0.005)	(0.001)	(0.005)	(0.001)	(0.001)	(0.001)	(0.005)	(0.001)	(0.005)	(0.001)	(0.001)	(0.001)
$\Delta Long\_Rate_{t-1}$	0.274	-0.253***	0.069	-0.226**	-0.218**	-0.223**	0.311	-0.239***	0.106	-0.209**	-0.199**	-0.204**
	(0.645)	(0.088)	(0.698)	(0.091)	(0.093)	(0.094)	(0.648)	(0.089)	(0.699)	(0.091)	(0.092)	(0.093)
ΔGDP_{t-1}	0.688***	0.119*	0.305	0.188***	0.210***	0.198***	0.685***	0.120*	0.303	0.189***	0.213***	0.201***
	(0.206)	(0.066)	(0.214)	(0.056)	(0.067)	(0.057)	(0.199)	(0.066)	(0.206)	(0.057)	(0.068)	(0.058)
$Inflation_{t-1}$	0.173	-0.123	0.211	-0.110	-0.105	-0.108	0.213	-0.115	0.248	-0.099	-0.093	-0.096
	(0.487)	(0.140)	(0.531)	(0.126)	(0.125)	(0.125)	(0.488)	(0.140)	(0.533)	(0.126)	(0.125)	(0.125)
$\Delta REER_{t-1}$	0.011	0.000	0.015	0.002	0.003	0.002	0.009	-0.001	0.012	0.000	0.001	0.001
	(0.081)	(0.015)	(0.077)	(0.015)	(0.016)	(0.016)	(0.081)	(0.015)	(0.077)	(0.015)	(0.016)	(0.016)
$\Delta House_{t-1}$	0.203	0.397***	0.218*	0.425***	0.434***	0.429***	0.202*	0.395***	0.218*	0.423***	0.432***	0.428***
	(0.119)	(0.075)	(0.118)	(0.077)	(0.075)	(0.076)	(0.115)	(0.073)	(0.115)	(0.075)	(0.073)	(0.074)
Constant	-0.153**	-0.005	-0.002	0.004	0.008	0.006	-0.155**	-0.005	-0.002	0.004	0.008	0.006
	(0.060)	(0.009)	(0.025)	(0.006)	(0.006)	(0.005)	(0.061)	(0.009)	(0.025)	(0.006)	(0.006)	(0.005)
AR(1)	0.050	0.066	0.051	0.056	0.052	0.054	0.051	0.064	0.053	0.053	0.048	0.051
Fixed effect	Y		Y		Y	Y	Y		Y		Y	Y
Liner trend	Y		Y		Y	Y	Y		Y		Y	Y
F-stat	17.00	-	14.08	-	-	-	17.48	-	16.57	-	-	-
Wald χ^2	-	194.13	-	205.43	315.43	192.66	-	208.45	-	271.84	358.28	334.60
Sargan-Hansen test	2.518		-		77.021	38.248	2.233		-		78.450	38.475
(p-value)	(0.112)				(0.000)	(0.005)	(0.135)				(0.000)	(0.005)
R^2	0.125	0.177	0.191	0.263	0.290	0.276	0.126	0.179	0.192	0.267	0.297	0.282
Observation	1732		1732		1732	1732	1732		1732		1732	1732
# Country	22		22		22	22	22		22		22	22

Note: Standard errors clustering at the country level are reported in parentheses. ***, **, and * denote significance at 1, 5, and 10 percent levels, respectively. Models 3 and 7 use interaction terms of global leverage with country-specific dummies as instruments. Models 4 and 8 use interaction terms of global flow with country-specific dummies as instruments.

To explore the sensitivity of house prices to the global financial cycle or risk perception in global markets, Models 5–8 contain the interaction terms of the growth of the VIX with the growth of bank credit to GDP ratio as an additional explanatory variable. The principal results remain unchanged:

[4] First stage results are omitted because of space constraints.

coefficients for capital inflows are positively significant and those for the VIX are negatively significant in the second stage. Moreover, coefficients for the interaction terms on house price are negatively significant in all specifications. This result indicates that the sensitivity of house prices to the VIX is higher in countries that experience faster expansion of bank credit relative to their real economies and suggests that fluctuations in house prices are more strongly linked to US financial and monetary conditions in economies with rapidly growing financial systems because VIX is closely tied with federal fund rate shocks, as revealed by Bruno and Shin (2015b) and Rey (2013). Furthermore, the result is in line with Jordà et al. (2016a) who suggested that local boom–bust cycles of credit creation are closely synchronized with the global cycle in more leveraged countries (measured by bank credit to GDP ratio).

One explanation of this result is that the bank credit to GDP ratio may contain information on levels of leverage or risk taking in each country. Gourinchas and Obstfeld (2012) and Jordà et al. (2016a, 2016b) regarded the ratio as a measure of leverage. Moreover, Gourinchas and Obstfeld (2012) and Jordà et al. (2016b) revealed that the ratio acts as a reliable "early warning indicator" that informs us of excess risk taking by local agents. In general, economies or agents with higher leverage or risk taking are more vulnerable to external shocks. Thus, house prices in economies with higher growth of the bank credit to GDP ratio may be more sensitive to external financial conditions, such as VIX.[5]

Additional analyses show that the results almost hold when (1) the models are estimated by a different estimation method using lagged right-hand-side variables (Appendix C) and (2) the models use deviations of the bank credit to GDP ratio from its trend (1-year moving average) instead of the growth of the ratio (Appendix D). A possible concern is that, in many over-identified models, the Sargan–Hansen test rejects the null hypothesis of the instruments being uncorrelated with the error term. However, the main results are similar to those of just-identified models and the models that pass the test. Thus, making an incorrect interpretation due to estimation bias might be of little concern.

4. Conclusion

This study explored the interaction among house prices, capital inflows, and risk perception in global markets. Empirical analysis yielded the following key results: (1) increases in capital inflows and an easing of risk perception in global markets induce appreciation in house prices and (2)

[5] It is also possible that the effects of global risk perception on house prices might be amplified through financial systems.

sensitivity of house prices to global risk perception is higher in countries that experience faster expansion of bank credit relative to their real economies. The results indicate that capital inflows and global risk perception play a key role in understanding house price dynamics. They also suggest that fluctuations in house prices are more strongly linked to US financial and monetary conditions in economies with rapidly growing financial systems.

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Appendix A. Variables and Data Sources

ΔHouse: Residential property price index (log difference). Source: BIS.

Inflow: Gross capital inflow (divided by external liability). Source: IMF.

Global_Lev: US broker–dealer leverage defined as the ratio of asset over equity (logged). Source: FRB.

ΔGlobal_Lev: US broker–dealer leverage defined as the ratio of asset over equity (log difference). Source: FRB.

Global_Flow: Sample sum of gross inflow leaving out the inflow to the country under consideration (divided by sample sum of external liability leaving the country under consideration). Source: IFS.

VIX: CBOE VIX index of implied volatility of S&P index options (logged). Source: FRED.

ΔVIX: CBOE VIX index of implied volatility of S&P index options (log difference). Source: FRED.

Stock_Vol: 12-month standard deviation of return of local stock price index (logged). Source: FRED.

ΔLong_Rate: Change in interest rate on a 10-year government bond. Source: OECD.

ΔGDP: GDP growth rate. Source: OECD.

Inflation: Inflation rate. Source: IFS.

ΔREER: Real effective exchange rate (log difference). Source: BIS.

ΔCredit: Ratio of total bank credit to the private nonfinancial sector to GDP (log difference). Source: BIS.

CreditDev: Deviation of bank credit to the non-financial private sector to GDP ratio from its trend (calculated by a four-quarter moving average). Source: BIS.

Appendix B. Sampled Countries

Australia	Austria	Belgium	Canada	Denmark
Finland	France	Germany	Greece	Ireland
Italy	Japan	Korea	Netherlands	New Zealand
Norway	Portugal	Spain	Sweden	Switzerland
United Kingdom	United States			

Appendix C. Results of Panel Regression (Fixed-effect model)

	Dependent Variable: $\Delta House_t$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Inflow_{t-1}$	0.034***	0.034***			0.032***	0.032***		
	(0.008)	(0.008)			(0.008)	(0.008)		
VIX_{t-1}	0.003		0.002		0.003		0.002	
	(0.003)		(0.002)		(0.003)		(0.002)	
ΔVIX_{t-1}	-0.013**	-0.011***	-0.012***	-0.010***	-0.013***	-0.011***	-0.012***	-0.010***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
ΔVIX_{t-1}*$\Delta Credit/GDP_{t-1}$					-0.231	-0.229*	-0.317*	-0.318*
					(0.135)	(0.132)	(0.179)	(0.176)
ΔVIX_{t-2}*$\Delta Credit/GDP_{t-2}$					-0.150**	-0.145**	-0.166***	-0.162**
					(0.057)	(0.055)	(0.058)	(0.057)
$Stock\_Vol_{t-1}$	-0.005**	-0.003*	-0.005**	-0.003*	-0.005***	-0.004**	-0.005**	-0.004**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
$\Delta Long\_Rate_{t-1}$	-0.202	-0.198	-0.264	-0.259	-0.182	-0.177	-0.242	-0.236
	(0.146)	(0.149)	(0.165)	(0.168)	(0.142)	(0.145)	(0.161)	(0.164)
ΔGDP_{t-1}	0.560***	0.547***	0.571***	0.562***	0.554***	0.541***	0.564***	0.555***
	(0.089)	(0.089)	(0.072)	(0.071)	(0.089)	(0.088)	(0.074)	(0.073)
$Inflation_{t-1}$	-0.105	-0.113	0.000	-0.006	-0.094	-0.102	0.012	0.006
	(0.119)	(0.121)	(0.131)	(0.132)	(0.121)	(0.123)	(0.135)	(0.137)
$\Delta REER_{t-1}$	0.039*	0.040*	0.049**	0.049**	0.036*	0.038*	0.046*	0.047**
	(0.021)	(0.021)	(0.022)	(0.022)	(0.021)	(0.021)	(0.022)	(0.022)
Constant	0.001	0.008**	0.004	0.011**	0.002	0.009**	0.004	0.011***
	(0.008)	(0.003)	(0.007)	(0.004)	(0.008)	(0.003)	(0.007)	(0.004)
AR(1)	0.075	0.079	0.051	0.053	0.071	0.075	0.051	0.054
Fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Liner trend	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.143	0.139	0.115	0.113	0.150	0.146	0.123	0.120
Observation	1728	1728	1979	1979	1717	1717	1962	1962
# Country	22	22	22	22	22	22	22	22

Note: Standard errors clustering at the country level are reported in parentheses. ***, **, and * denote significance at 1, 5, and 10 percent levels, respectively.

Appendix D. Results of Panel Regression (Fixed-effect model, with alternative bank credit to GDP ratio measure)

	Dependent Variable: $\Delta House_t$			
	(1)	(2)	(3)	(4)
$Inflow_{t-1}$	0.029***	0.029***		
	(0.008)	(0.008)		
VIX_{t-1}	0.003		0.003	
	(0.003)		(0.002)	
ΔVIX_{t-1}	-0.013***	-0.011***	-0.012***	-0.010***
	(0.002)	(0.001)	(0.001)	(0.001)
ΔVIX_{t-1}*$CreditDev_{t-1}$	-0.003***	-0.002***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
ΔVIX_{t-2}*$CreditDev_{t-2}$	-0.002***	-0.001**	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
$Stock\_Vol_{t-1}$	-0.006***	-0.004**	-0.005***	-0.004**
	(0.002)	(0.001)	(0.002)	(0.001)
$\Delta Long\_Rate_{t-1}$	-0.172	-0.167	-0.230	-0.224
	(0.131)	(0.135)	(0.149)	(0.153)
ΔGDP_{t-1}	0.537***	0.522***	0.543***	0.532***
	(0.084)	(0.083)	(0.068)	(0.067)
$Inflation_{t-1}$	-0.094	-0.105	0.012	0.002
	(0.132)	(0.135)	(0.147)	(0.150)
$\Delta REER_{t-1}$	0.036	0.037	0.044*	0.044*
	(0.021)	(0.021)	(0.023)	(0.023)
Constant	0.002	0.011***	0.004	0.012***
	(0.008)	(0.003)	(0.007)	(0.003)
AR(1)	0.071	0.075	0.055	0.057
Fixed effect	Y	Y	Y	Y
Liner trend	Y	Y	Y	Y
R^2	0.151	0.147	0.123	0.120
Observation	1695	1695	1928	1928
# Country	22	22	22	22

Note: Standard errors clustering at the country level are reported in parentheses. ***, **, and * denote significance at 1, 5, and 10 percent levels, respectively.