Economic Systems 47 (2023) 101008

Contents lists available at ScienceDirect

Economic Systems

journal homepage: www.elsevier.com/locate/ecosys

Housing prices and macroprudential policies: Evidence from microdata

Bhupal Singh*

International Monetary Fund, Washington, DC, USA

A R T I C L E I N F O

JEL Classification:
Numbers: D15
E51
G51

Keywords:
Housing prices
Bank credit
Macroprudential policies

A B S T R A C T

This paper examines the efficacy of macroprudential policies in addressing housing prices in a developing country like India, utilizing two novel databases on city-level house prices in India. Though the empirical models provide evidence of a sizable effect of the fundamental factors in influencing house price dynamics, they also reveal strong countercyclical properties of macroprudential tools i.e., loan-to-value (LTV) limit, risk weights, and provisioning requirements, in influencing housing price movements. Among the macroprudential policy tools, the LTV limit emerges as the most potent one in influencing the price dynamics. A granular investigation of the effectiveness of macroprudential tools suggests that the countercyclical effect of the regulatory ratios for large-sized mortgages is much stronger as compared with those for the small-sized mortgages, attributed mainly to investment motives associated with the large-sized loans. We also find the presence of asymmetry in the impact of loosening versus the tightening of the LTV limit, which can be attributed to the procyclical behavior of the house prices.

1. Introduction

The housing booms and busts of the early twenty-first century have catalyzed a proliferation of research on the factors causing house price cycles and their macroeconomic implications. The role of the housing market during the global financial of 2008 provided fresh impetus to the understanding of factors underlying housing market dynamics and credit cycles. It is argued that the housing boom before the bust of the late 2000s, was marked by strong house price appreciation bolstered by a combination of strong income and population growth relative to the housing stock, lower interest rates, and easier credit standards (Duca et al., 2010). These developments have prompted efforts to better incorporate housing and financial channels into macro models, improve housing models, develop macroprudential tools, and reform the financial system (Duca et al., 2021).

The importance of asset prices in emerging market economies (EMEs) has significantly risen with the rapid urbanization, development of housing markets and greater participation of households. Urbanization, captured by the share of the urban population, rose from about 40–60 % between the mid-eighties and 2019 in the middle and upper middle income developing countries. At the same time, rapid financial deepening led to a significant rise in bank credit-GDP ratio from about 50 % in the mid-1980s to 116 % in 2019, which, in turn, led to greater access of households to mortgage finance and the emergence of a strong credit demand channel in

* Correspondence to: International Monetary Fund, 1900 Pennsylvania Avenue NW, Washington, DC 20431 USA.
E-mail address: bhupalsingh1@gmail.com.

https://doi.org/10.1016/j.ecosys.2022.101008
Received 3 September 2021; Received in revised form 22 January 2022; Accepted 10 May 2022
Available online 17 August 2022
0939-3625/

the housing markets. A comparison of house price movements in major EMEs before and after the global financial crisis suggests that while the pre-crisis phase was marked by significant growth in real house prices, a sizeable deceleration or decline occurred in the post-crisis period. This reinforces the argument of the existence of strong house price cycles in EMEs and the associated challenges for financial and macroeconomic stability.

Against the above backdrop, we seek to examine the effectiveness of macroprudential policies in influencing housing prices in a large developing economy like India. While giving due recognition to the long-run fundamental drivers of housing prices, our key motivation is to examine (a) the effectiveness of macroprudential policies in affecting house price movements, while controlling for their fundamental drivers, and (b) the differential effects of macroprudential tools for small versus large size mortgages.

For empirical examination of the above questions, we consider dynamic panel data (DPD) estimators. The endogeneity problems often hamper a proper assessment of macroprudential effects i.e., macroprudential measures are usually taken in response to developments in credit and asset prices (Alam et al., 2019). The DPD estimators, which use the difference GMM estimator, consider this simultaneity problem by including lags of the dependent variable as covariates and unobserved panel-level effects. The unrestricted lag structures of the DPD estimators are useful to model the sluggish adjustment.

The empirical findings suggest that among the major macroeconomic determinants, per capita income emerges as an important factor influencing house prices. The estimators suggest strong backward-looking house price expectations operating in the housing market. The conclusion about the role of long-run drivers is further strengthened by the role played by demography. Secondly, among the macroprudential measures, the loan to value ratio (LTV) emerges as the most important countercyclical tool in influencing housing price movements. A common thread across our empirical estimates is that a change in the LTV ratio for large-size loans has a much stronger countercyclical effect in influencing house prices compared to a change in the LTV ratio for small-size loans. The intuitive reason behind this finding is the strong speculative motive driving the growth in large-sized loans, whereas the owner-occupied nature of the small-sized mortgages makes them less speculative. The findings of a strong asset substitution effect driven by relative asset returns add credence to our hypothesis of speculative motives. Another important macroprudential tool, the risk weights on housing assets of commercial banks, also significantly impacts real housing prices. Similarly, standard asset provisioning on banks' housing loans is found to have a sizeable influence on house prices.

This paper contributes to the empirical work in the context of an emerging market country in the following ways. As policymakers in EMEs use various types of tools to respond to the risks arising from housing booms and busts, country-specific studies help understand the effectiveness of such tools in maintaining financial stability. Working in this direction, we utilize novel granular data sets on house prices and macroprudential tools, which are scarcely used in the empirical work in the EME setting. Firstly, we use two novel databases of city-level house prices in India. Secondly, granular city-wise data on median LTV limit, loan-to-income ratio, and EMI ratio have been utilized, which are scantly used to evaluate the role of macroprudential policies in EMEs. Thirdly, this paper evaluates the relative effectiveness of macroprudential tools designed for small versus big size mortgages in influencing house prices.

The remainder of the paper is organized as follows. Section 2 assesses the theoretical literature to evaluate the role of key macroeconomic factors in influencing the house price cycles as well as the relative efficacy of macroprudential tools. The analytical framework presented in Section 3 aims to answer the key questions of our research. Given the vexed data issues on the housing market, we provide a methodological discussion on the databases used in this study in Section 4. Section 5 analyses empirical results utilizing two separate novel databases on housing prices in India. Key findings are summarized in Section 6.

2. Literature

The co-movement of the housing market and the macroeconomy and the transmission of macroeconomic shocks i.e., unexpected changes in the credit supply and interest rate changes on house prices, has been well recognized (see Ito, 1993; Bowen, 1994; Green, 1997; Baffoe-Bonnie, 1998; Case, 2000; Wen, 2001; Jud and Winkler, 2002; Seko, 2003; Catte et al., 2004; Hwang and Quigley, 2004). The episodes of the boom-bust cycles have been damaging to both financial stability and macroeconomy due to their deeper impact through the wealth effect channel and the balance sheet channel. Housing price busts are found to be less frequent than equity price busts, however, enduring nearly twice as long and associated with nearly double the output losses, with sizeable effects on consumption and banking sectors that are heavily exposed to real estate (IMF, 2003). Many financial crises are found to be the result of bubbles in housing markets (Herring and Wachter, 2003; Reinhart, 2012). Of nearly 50 systemic banking crises in recent decades, more than two-thirds were preceded by boom-bust patterns in house prices (Claessens et al., 2012). In sum, the damaging real effects of the banking crisis set the ground for the emergence of the macroprudential dimension of financial regulation to minimize the negative externalities from the financial sector to the real economy (see Reinhart and Rogoff, 2009).

There are several channels through which house prices respond to both the fundamental and financial variables. Household net financial wealth appears to be a key determining factor of house prices. The accumulation of financial net wealth by households exerts upward pressure on housing demand and thus, contributes to the rise in house prices. The rising share of mortgages in the asset portfolio of banks has reinforced the credit and housing market nexus through the credit channel. An expansion in credit supply lowers lending interest rates and stimulates current and future economic activity. Thus, property prices tend to increase due to higher expected returns on property and a lower discount factor. Greater access to credit, particularly for the credit-constrained households, could also augment the demand for housing (Goodhart and Hofmann, 2008). Thus, several studies have underscored the role of bank credit as an important factor in steering house prices (Collyns and Senhadji, 2002; Fitzpatrick and McQuinn, 2004; Tsatsaronis and Zhu, 2004, Mian and Sufi, 2009, 2018; Andrews, 2010; Cerutti et al., 2017). Higher housing prices and appreciated value of housing assets may expand the borrowing capacity of house buyers – often called the collateral channel (Adelino et al., 2015; Loutskina and Strahan, 2015). In the existing theoretical literature, the nexus between housing price and bank credit is established through the collateral channel, which is based on the premise that banks will lend more on the strength of more valuable collateral on their balance sheet (e.g., Kiyotaki and Moore, 1997). Thus, a rising market valuation of housing collateral also leads to improvement in the risk on mortgage lending and emboldens the banking system to take on more risk on their balance sheets and expand loan supply. On the other hand, a decline in house prices caused by the housing bust may lead to higher risk weights on the banking balance sheet, necessitating greater risk provisioning, thus, leading to a strong contraction in lending, which in turn, engenders further negative shocks in the housing market. Besides domestic credit availability, the boom in real house prices is also fueled by capital inflow channels and an easy liquidity environment (Reinhart, 2012).

An increase in credit supply driven by loose lending constraints for the mortgage market has also been recognized as the key driver of the unprecedented rise in home prices, the surge in household debt, the stability of debt relative to house values before the great recession (Justiniano et al., 2019). Furthermore, household balance sheets and their interaction with lending practices emerge as fundamental features of the financial accelerator (see Mian and Sufi, 2018; Gertler and Gilchrist, 2018).

An important question often raised is whether low-interest rates drive the households to lever up mortgages and bid up house prices? The monetary policy channel of house price operates by changing the level of short-term interest rates. This, in turn, affects the longer end of the interest rate curve, including the mortgage credit rates, thus affecting the affordability of house purchases and housing demand. Falling interest rates reduce the user cost of housing through savings on financing costs. The experience of the recent decades shows that long-term bond yields declined along with the moderation of policy rates, which stimulated housing purchases for investment purposes and thus led to higher returns on housing investment.

Home buyers' expectations and speculative behavior are also recognized as an important channel of housing prices movement (see Engsted and Pedersen, 2015; Shiller, 2005; Shiller, 2008). When housing prices are increasing quickly and the expectations of future price increases remain strong, investors could look for higher returns by entering buying and selling transactions, leading to greater turnover and further higher prices. This speculative behavior may reinforce demand pressures and price spiral. This kind of behavior has been exhibited in several episodes of asset market bubbles. Speculative behavior also works through higher leverage in credit markets, reflected in the high loan-to-income ratio, and plays an important role in reinforcing the nexus between credit markets and house prices. The proclivity of investors to extrapolate past appreciation in house prices in forming expectations leads to overshooting of prices from the fundamentals (Abraham and Hendershott, 1996).

The nexus between the lending standards and housing prices is empirically highlighted by many studies (Crowe et al., 2011; IMF, 2011; Igan and Kang, 2011; Lim et al., 2011; Wong et al. 2011; Cerutti et al., 2015; Morgan et al., 2015; Ozge and Olmstead-Rumsey, 2018). Indeed, an expanding housing mortgage market in developing countries in the last few decades and the episodes of financial instability have led to greater focus on the role of financial factors in causing house price bubbles. This development, in turn, has led to the evolution of a regulatory framework to systematically respond to house price cycles. The recognition of macroprudential policies in dealing with asset price booms, including housing, could be partly attributed to the bluntness of monetary policy in arresting the excessive growth in asset prices. Korinek and Simsek (2016), argue that interest rate policy is inferior to macroprudential policy in dealing with excessive leverage. Thus, the alternate policy paradigm known as the macroprudential framework has evolved to respond to the credit and asset price boom-bust cycles. The goal is to protect the bank's balance sheet during the boom period by restraining excessive lending causing higher non-performing assets and during downturns by minimizing losses.

As part of macroprudential policy, several regulatory tools have evolved to limit the boom-bust episodes in the housing market viz., loan-to-value (LTV) limit, risk weights on housing loans, provisioning, or dynamic provisioning for loan losses on standard or sub-standard assets, and debt-to-income (DTI) ratio. LTV limit, the most deployed regulatory measure, imposes a hard-borrowing constraint on households to borrow from banks. This, in effect, aims to limit the home buyers' borrowings against asset collateralization within certain prudential limits. Thus, it operates as a countercyclical tool in the face of inflated asset prices, easy borrowing constraints, and excessive credit expansion. Another powerful regulatory tool is the DTI ratio that limits the leverage of home buyers and thus directly contributes to moderation in the demand for excessively leveraged residential properties. These tools are particularly countercyclical in the sense that they can be easily unwound during a recessionary phase in the housing market and can significantly enhance household access to credit. Though their asymmetric effectiveness during the boom and bust cycles could be a limiting factor.

Ample empirical evidence is available on the effectiveness of macroprudential measures like capital ratio requirements and non-standard liquidity measures in achieving a slowdown in house price inflation (Igan and Kang, 2011; Jiménez et al., 2012, Vandenbussche et al., 2012). The appeal of macroprudential measures in dampening growth in housing credit cycles and growth in house prices is also underscored by some other studies (Kuttner and Shim, 2012; Arregui et al., 2013; Zhang and Zoli, 2014; Tressel and Zhang, 2016; Ozge and Olmstead-Rumsey, 2018; Richter et al., 2018). There is also an argument in support of the nonlinear effects of LTV changes on household credit (Alam et al., 2019).

Thus, the literature recognizes the role of shifts in the key fundamentals, like income, interest rates and bank credit, in engendering house price booms or busts. At the same time, the nexus between the hosing prices and credit markets opens the debate on the role of tightening or loosening credit standards fueled by regulatory policies. This debate has turned more focused since the episodes of housing and financial crisis in the last few decades and the role played by the regulatory standards. How monetary, macroprudential, and other policies affect house prices cycles has assumed an important place in the discussions on the role of house prices in financial crises. Thus, there has also been an adequate focus as to what role macroprudential policies can play in limiting the excessive expansion in mortgage credit and tackling the risks of housing price boom-busts, particularly keeping in mind the limitation of the monetary policy.

3. Analytical framework

The inverted-demand approach to housing prices implies that real house prices are driven by the user cost of housing, real incomes, and the housing stock (see Kearl, 1979; Hendry, 1984; Poterba, 1984; DiPasquale and Wheaton, 1994). Among the fundamental factors that affect the housing demand over the long run are household income is recognized as a key determinant (De Wit and Van Dijk, 2003; Davis and Heathcote, 2005; Iacoviello and Neri, 2010; Goodhart and Hofmann, 2008; Adams and Fuss, 2010; Madsen, 2012; Cerutti et al., 2015). The argument put forth is that liquidity constraints explain the sensitivity of house prices to income shocks. Besides this, demographic characteristics such as size and density of urban population and the workforce participation rates exert significant influence on house prices (Mankiw and Weil, 1989; Égert and Mihaljek, 2007; Doorn et al., 2019). The empirical literature highlights that a shift in demography is a key long-term determinant of house prices (Fitzpatrick and McQuinn, 2004; Terrones and Otrok, 2004; Ahearne et al, 2005; Egert and Mihaljek, 2007; Takats, 2012). Tax exemptions granted for investment in residential housing to promote ownership of dwellings (Poterba, (1984), interest rates on mortgages (Case, 2000; Catte et al., 2004, Tsatsaronis and Zhu, 2004; Iacoviello, 2005; Assenmacher-Wesche and Gerlach, 2008; Goodhart and Hofmann, 2008; Adams and Fuss, 2010; Zan and Wang, 2012), flexibility in debt financing, and the return on other competing physical or financial assets. Relative return on housing assets vis-à-vis competing for assets in the household portfolio, such as equities and bonds, could influence investment decisions in housing, hence housing demand and prices – indicating the presence of a strong substitution effect. The macroprudential policies regulating the mortgage market, notably the LTV limits, DTI ratio, and risk weights for capital requirements for banks, also have an impact on the housing market by altering the cost and quantity of credit, thus, influencing the housing demand.

Housing supply by its very nature tends to be sluggish, therefore, demand-side factors assume importance in determining short-run fluctuations. Among the fundamental supply-side factors that influence house prices over the medium to the long-run horizon, availability and cost of land and construction costs are identified as the key drivers (Bourassa and Hendershott, 1995; McCarthy and Peach, 2002; Bodman and Crosby, 2004; Adams and Fuss, 2010). Rent as an indicator of the user cost of housing, also significantly influences housing prices. Tax incentives for promoting the supply of housing (Capozza et al., 1996; Green and Vandell, 1999), and regulatory framework for the housing sector also play an important part in augmenting housing supply and hence influence the prices. However, these demand and supply-side factors are not exhaustive, and many other variables may interact to explain the housing price dynamics.

We formulate a simple reduced-form model of house prices of the following form,

$$\sum_{i=1}^{n} pHi(t) = \varphi \sum_{i=1}^{n} Zi(t) + \frac{1}{\lambda} \sum_{t=1}^{T} Xi(t) + \frac{1}{\theta} \sum_{t=1}^{T} Yi(t) \tag{1}$$

where Zi represents a vector of the demand side fundamental determinates of house prices comprising income, population and labor market indicators, bank credit, mortgage cost, and monetary policy rates, that will influence the demand and hence house prices. Xi contains supply-side constraints and Yi, a vector of macroprudential tools available with the policy authority. Thus, the elasticities of house prices to key macroeconomic variables can be defined as,

$$\frac{\partial p}{\partial y} > 0 \frac{\partial p}{\partial pop} > 0; \frac{\partial p}{\partial crd} > 0; \frac{\partial p}{\partial rm} < 0; \frac{\partial p}{\partial r} < 0; \frac{\partial p}{\partial rp} < 0$$

where y = household income, pop = size of the city population, which also captures the labor force, rm = interest rate on mortgages, r = monetary policy rate, and rp = relative asset price return – reflecting the opportunity cost of investing in housing assets.

With rising income, the homeownership ladder effect also comes into play, where households trade their existing homes for higher value homes due to accumulated higher equity from existing homes and improvement in their debt-servicing capacity (see Ortalo-Magne and Rady, 2006; Ho and Wong, 2008). A higher concentration of households in a city generates greater demand for housing for a limited supply of housing units, which in turn, pushes up the prices. An easy financing condition, reflected in higher credit supply (*crd*), may favorably impact the demand for housing and hence the price and vice-versa. A monetary policy tightening (*r*) would lead to a decline in housing prices by raising the funding cost for banks. Similar is the effect of rising mortgage costs (*rm*).

The supply curve of housing is generally inelastic in the short run, whereas the long-run supply curve is relatively elastic. The degree of supply response may also be conditioned by the physical as well as the institutional factors operating in the housing market, including the extant regulatory regime. The impact of supply shocks on house prices can be posited as,

$$\frac{\partial p}{\partial concoix} > 0; \frac{\partial p}{\partial tax} < 0;$$

The above formulation implies that shock to the construction cost (*concoix*) has the effect of causing an increase in the cost of inputs for the housing market, which in turn, leads to an increase in the housing prices. On the other hand, tax concessions offered to housing companies for affordable housing (*tax*), particularly in a developing country, tend to augment the housing supply and lower the price. On the other hand, personal income tax rebates extended to households for owner-occupied housing purchases can incentivize housing demand and could put pressure on house prices.

The important macroprudential covariates in the model are the prudential ceilings on the LTV limit (*ltv*), risk weights on mortgage financing (*rw*), and provisioning for standard and sub-standard assets (*asstprov*), that influence the ability of banks and non-bank financial intermediaries to lend against real estate collateral. The regulatory structure that incentivizes lending decisions based on the current market value of the property, increases the sensitivity of credit to housing market conditions. In other words, when the banking system can expand credit supply due to appreciation in the value of housing collaterals, it could generate greater demand for housing properties. Aoki et al. (2004) and Iacoviello (2005) explain a financial accelerator effect through house prices when households' ability to borrow depends on the value of housing collateral. On the contrary, conservative valuation guidelines that are anchored to historical prices would tend to lag current market trends and thus exert a countercyclical effect on credit supply. Thus, the conservative regulatory guidelines tend to dampen the collateral value of the housing assets and hence the ability of the financial system to expand housing credit, which translates into lower demand for housing units and moderation in prices. Thus, credit market regulatory measures are used to determine the level of risk that can be taken for a secured loan. Typically, given the theoretical setting of the role of macroprudential policies in navigating credit and asset prices, the house price elasticities can be of the following form,

$$\frac{\partial p}{\partial ltv} > 0; \frac{\partial p}{\partial rw} < 0; \frac{\partial p}{\partial asstprov} < 0$$

For empirical analysis, endogeneity issues and reverse feedback effects from dependent to explanatory variables underscore the suitability of panel data estimators. More specifically, the dynamic panel data (DPD) estimators resolve the simultaneity problem by including lags of the dependent variable as covariates and unobserved panel-level effects as illustrated below.[1]

$$\mathrm{P}_{it} = \sum_{j=1}^{k} \delta y_{i,t-j} + \gamma X_{it} + \theta Z_{it} + \phi \quad \Pi_{it} + \upsilon_i + \varepsilon_{it}, \quad i = 1, \cdots k \quad and \quad t = 1, \ldots, n \tag{2}$$

where P_{it} represents house price in the city i at time t; X_{it} is a vector of macroeconomic covariates of house prices and Z_{it} is the vector of supply-side variables. The macroprudential covariates are represented by Π_{it}. δ, γ and θ and ϕ are parameters to be estimated; υ_i are the panel-level effects which may be correlated with X_{it} or ε_{it}. ε_{it} are *i.i.d.* that comes from a low-order moving-average process, with variance $\sigma^2\varepsilon$.

4. Data issues

A rich analysis of the housing sector in developing countries is generally constrained by the availability of granular data on housing prices and housing inventories and stocks. In India, there are a few databases on city-level housing prices, all of which are of relatively recent origin.[2] Based on their coverage, cross-sectional and time-series dimensions, a credible compilation methodology, and the official or non-official sources of data collection, we choose the Reserve Bank of India (RBI)'s House Price Index (HPI) and the National Housing Bank (NHB)'s Residex for the empirical exercise. The RBI's HPI is a weighted average price index using the Laspeyres' method with 2010–11 as the base year, covering 10 major cities, and is computed based on transaction data received from housing registration authorities in ten major cities.[3] First, the simple average of houses in each category (i.e., small, medium, and large) for each ward/ administrative zone is calculated based on the floor space area (FSA). Second, the proportion of the number of houses transacted in the three categories of FSA within a ward/zone during the base year is taken as weights. Finally, the quarterly ward/zone weighted average price relatives are computed. These weighted relative prices are averaged, using the proportion of the number of houses transacted in each ward to the total number of houses transacted in the city during the base period as the weights.

The RBI has also conducted a quarterly Residential Asset Price Monitoring Survey (RAPMS) since July 2010 for housing loans disbursed by select banks/housing finance companies (HFCs) across 13 major cities.[4] The survey collects the following indicators on the housing market (i) loan to value (LTV) limit[5]; (ii) EMI-to-income (ETI) ratio; (iii) house price to income (HPTI) ratio[6]; and (iv) loan to income (LTI) ratio.

The NHB's Residex was initially computed with the financial year 2012–13 as the base. Subsequently, a new series with the financial year 2017–18 as a new base year has been introduced. To maintain continuity in the time series data, NHB's Residex 2012–13 series has been recalculated using a backward linking factor. At present, the geographical coverage consists of 50 cities in India including 18 State/Union Territory capitals (Fig. 1).

The variables used in this study are: (i) RBI's house price index for 10 major cities with 2010–11 as the base; (ii) NHB's house price index for 33 major cities with 2017–18 as the base; (iii) real district/state domestic product (SDP) per capita (SDP used for a particular city for which domestic product data are not available); (iv) real house price index (i.e., house price index of a city deflated

[1] The lag dependent variable also introduces history in the model.

[2] Other databases on house price databases in India, include the Knight Frank residential property price index, Liases Foras, Cushman and Wakefield, and Jones Lang Lasalle. Issues regarding the methodology, coverage, and period limit their use.

[3] The cities included in the RBI sample are large metropolitan cities viz., Mumbai, Delhi, Chennai, Kolkata, Bengaluru, Lucknow, Ahmedabad, Jaipur, Kanpur, and Kochi.

[4] The cities included in the survey are Mumbai, Chennai, Delhi, Bengaluru, Hyderabad, Kolkata, Pune, Jaipur, Chandigarh, Ahmedabad, Lucknow, Bhopal, and Bhubaneswar.

[5] Loan to value is the ratio of the mortgage debt to the value of the underlying housing property. This ratio is a measure of financial leverage in the housing market.

[6] It is represented as the ratio of median house prices to median disposable incomes of homebuyers, expressed as a percentage or as years of income. This forms a key component of mortgage lending decisions.

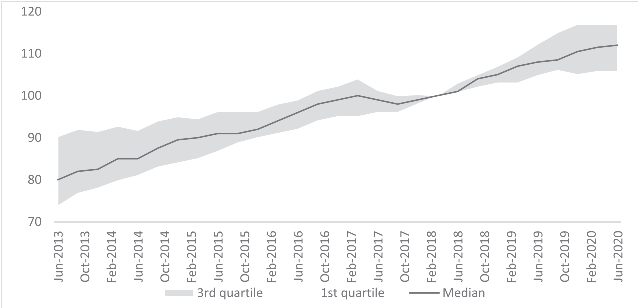

Fig. 1. House prices across 50 cities in India (NHB house price index, 2012–13 = 100).

by CPI index for the respective city/state)[7]; (v) city population size in millions; (vi) construction cost index with the base year 2011–12; (vii) state-wise CPI for housing to capture housing rent; average per account domestic commercial bank loans for residential housing; (viii) weighted average interest rate on housing loans of commercial banks; (ix) index of stock prices relative to the RBI's HPI (i.e., BSE Sensex or Nifty ÷ HPI * 100); (x) index of stock prices relative to the NHB's Residex (i.e., BSE Sensex or Nifty ÷ Residex * 100); (xi) RBI's policy repo rate; (xii) median LTV limit for housing loans in India; (xiii) LTV for large-size loans; (xiv) LTV for small size loans[8]; (xv) asset provisioning ratio on housing loans of commercial banks; (xvi) median loan to income (LTI) ratio; and (xvi) median equal monthly loan installment (EMI) to income ratio. We use two variants of the construction cost index. We first use the building cost index (Base October 2007 = 100) compiled by the CEIC for several Indian cities. For the remaining cities in our sample, we construct a construction cost index as a weighted index of materials used in construction, which includes metallic mineral products and non-metallic mineral products. Though, such an index lacks the cost of land, nevertheless, it provides the best available proxy for the construction cost. The nominal variables have been deflated using the CPI index.

The present study uses annual data for the period 2008–09–2018–19. For some variables monthly or quarterly data have been averaged to compute the annual numbers. The data are sourced from the following sources: Database on Indian Economy of the Reserve Bank of India; Basic Statistical Returns (BSR) of scheduled commercial banks in India, RBI; UN population database; NHB Residex database; CEIC; Central Statistical Office, Government of India.

5. Empirical results

5.1. Stylized facts

India, like many other EMEs, has exhibited a significant rise in the degree of urbanization with the share of the urban population rising from 23 % to 35 % between 1980 and 2019. The portfolio allocation of households across asset categories in India suggests that buildings constituted about 38 % of the total asset holdings of urban households in 2018, while land comprised another 49 % share.[9] If the developing countries converge fast to the level of urbanization of advanced countries, it will lead to large rural-urban migration and hence a significant rise in the demand for urban dwellings. Thus, the housing market is likely to become sizeable and may have much larger wealth effects, hence a sizable influence on business cycles. In the post-global financial crisis period, nominal house price growth in India has remained largely above the nominal income growth for the most part ending 2015–16 (Fig. 1), indicating worsening affordability i.e., house price income ratio and EMI to income ratio (see Figs. 2 and 3). (Fig. 4).

The rapid development of the formal housing market is accompanied by significant expansion in the size of the mortgage market with the participation of banks and non-banks. This has drawn greater attention to the nexus between credit and house prices from the perspective of housing boom-bust cycles. A reasonable body of literature has evolved around the primacy of macroprudential policies to correctly identify the asset bubbles and address risk concentrations and interlinkages with the financial system that may pose financial stability risks. Macroprudential policies have been actively used in India to respond to credit cycles, particularly regarding housing prices (see Appendix Table A1).

5.2. Results from housing price models based on the RBI's housing price index

For the empirical estimation, we use panel data for a cross-section of cities in India spanning 2008–09–2018–19. The summary statistics of the variables used in the model are presented in Appendix Table A2.

[7] Consumer Price Index Numbers for Industrial Workers (CPI-IW) with base 2001 = 100, is used as deflator because these indices are available city-wise.

[8] Following the Reserve Bank of India guidelines (2017) on LTV ratio, the small-sized loans are classified as the lowest slab of loans up to Rs. 3 million and the large-sized loans those with a value Rs. 7.5 million or more.

[9] National Statistical Office (NSO), Government of India conducted the latest survey on All India Debt & Investment Survey as a part of the 77th round of National Sample Survey (NSS) for the period ended June 2018.

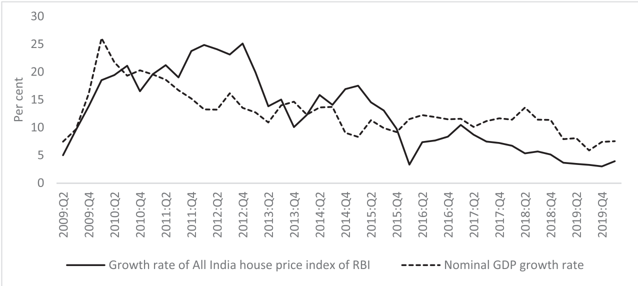

Fig. 2. Nominal house price and income growth.
Source: Author's calculations.

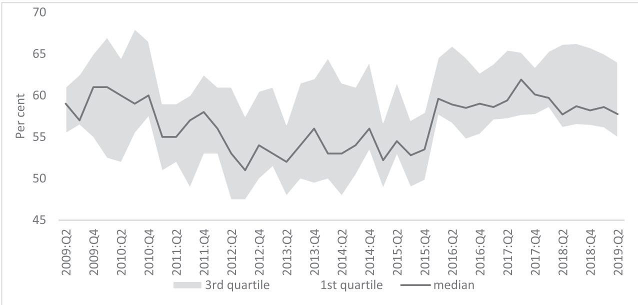

Fig. 3. Median house price to income ratio across the cities in India.
Source: Author's calculations.

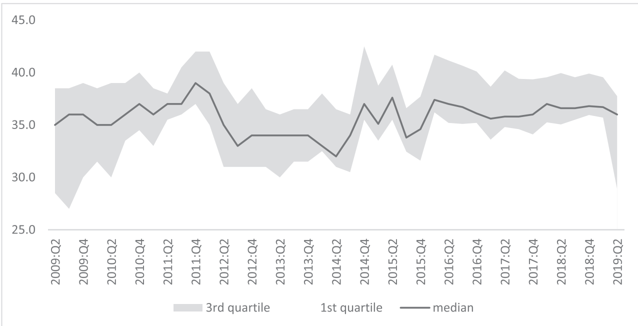

Fig. 4. Median EMI to income ratio across the cities in India.
Source: Author's calculations.

All the estimated models are found to be statistically robust. The detailed results obtained from dynamic panel data (DPD) estimators and the related diagnostics are provided in Tables 1 and 2. The unrestricted lag structures of the DPD estimators are useful to model the sluggish adjustment. The Sargan test, conducted to ascertain the validity of over-identifying restrictions, suggests that the instruments are valid. The Arellano-Bond test does not reject the null hypothesis of no second-order serial correlation.

The finding of the strong income effect is consistent with the argument that liquidity constraints might explain the excessive sensitivity of house prices to income shocks (Stein, 1995; Ortalo-Magné and Rady, 1999, 2006). The significant role played by lagged house prices highlights the backward-looking behavior of house prices. The demographic impact captured by the size of the urban population of a city in our model has a significant positive impact on house prices. Rent as an indicator of user cost, also significantly influences housing prices. On the role of the opportunity cost of housing investments, we observe that an increase in the relative return on stock market assets leads to a significant reduction in house prices – indicating the presence of a strong substitution effect. Among the supply-side factors, construction cost, an important indicator of housing supply, affects house prices significantly. Higher construction cost leads to a decrease in return from housing and thus reduce housing supply. Thus, in a supply-constrained market, a small slowdown in the supply can lead to more than a proportionate increase in prices.

Given the increasing share of mortgage financing, the bank credit channel emerges as an important driver of house prices. With further expansion in the mortgage market in the future, housing and credit dynamics may turn out to be stronger. A tightening of monetary policy rate increases the funding cost for the banks, which in turn spills over to lending cost and thus, reduces loan demand

Table 1
Arellano-Bond panel data estimators for real house prices.

Dependent variable: RBI's real house price index								
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log house price(t-1)	0.29**	0.38***	0.30***	0.23**	0.23**	0.16***	0.26***	0.16*
	(2.71)	(6.89)	(5.36)	(2.17)	(2.17)	(3.59)	(2.74)	(1.89)
Log real per capita income(t-1)	0.17***	0.20**	0.15**	0.38***	0.38**		0.17*	0.20**
	(6.11)	(2.11)	(2.41)	(2.84)	(2.84)		(1.93)	(2.18)
Log city population(t-1)			0.40**					
			(2.15)					
Log constructions cost(t-1)	0.32***			0.21*	0.21*			
	(4.09)			(1.71)	(1.71)			
Log real rental index	0.33***							
	(4.16)							
Log ratio of real stock price to real house price	-0.53***	-0.53***	-0.61***	-0.58***	-0.58***	-0.86***	-0.27***	-0.82***
	-(7.13)	(−7.74)	(−7.97)	(−7.18)	(−7.18)	(−16.07)	(−3.87)	(−9.74)
Log real credit per account		0.15***				0.14**		
		(3.01)				(2.45)		
Real interest rate on housing mortgages (t-1)	-0.01***							
	-(4.84)							
Real policy rate		-0.02**		-0.04***	-0.04***	-0.02**		
		(−2.20)		(−4.24)	(−4.24)	(−2.55)		
Real policy rate (t-1)			-0.03***			-0.02***		
			(−3.64)			(−5.63)		
Log median LTV ratio			0.28***			0.44***		0.59***
			(2.95)			(3.14)		(3.34)
Log regulatory LTV ratio for large-size loans				1.10***				
				(3.29)				
Log regulatory LTV ratio for small-size loans					0.40***			
					(3.29)			
Log regulatory risk weights on the banks' housing loans						-0.18***		-0.16***
						(−12.07)		(−8.63)
Log median housing loan-to-income (LTI) ratio							0.45**	
							(2.66)	
Log median housing EMI to income ratio							-0.70***	
							(−3.41)	
Log of asset provisioning for banks' standard housing assets(t-1)								-0.09***
								(−3.50)
Wald χ2	2765.13(0.0)	1576.8(0.0)	2402.8(0.0)	10,235.3(0.0)	10,235.3(0.0)	5930.1(0.0)	239.9(0.0)	4054.74(0.0)
Sargan test: chi2	64.71(0.09)	56.48(0.09)	60.1(0.09)	9.68(0.99)	9.75(0.99)	9.98(0.99)	28.59(0.38)	9.90(0.99)
Arellano-Bond test for AR(1): Z-stats	-2.27(0.02)	-3.10(0.00)	-2.21(0.03)	-1.88(0.06)	-1.89(0.06)	2.73(0.01)	-2.87(0.01)	-2.91(0.00)
Arellano-Bond test for AR(2): Z-stats	-0.90(0.37)	-0.38(0.70)	-1.58(0.12)	-0.63(0.53)	-0.61(0.53)	1.62(0.11)	1.43(0.15)	-1.91(0.06)
No. of instruments	58	49	50	50	50	51	32	51
No. of groups	10	9	10	10	10	10	8	10
T	9	9	9	9	9	9	5	9

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* represent significance level of 10 %, respectively.
** represent significance level of 5 %, respectively.
*** represent significance level of 10 %, 5 % and 1 %, respectively.

Table 2
Blundell-Bond system estimators for real house prices.

Dependent variable: RBI's real house price index

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log real house price(t-1)	0.38 * **	0.47 * **	0.41 * **	0.27 * **	0.27 * **	0.30 * **	0.53 * **	0.36 * **
	(7.99)	(3.64)	(6.52)	(4.14)	(7.89)	(5.21)	(11.46)	(3.15)
Log real per capita income(t-1)				0.25 * *	0.34 *	0.37 *		0.16 *
				(2.48)	(1.83)	(1.90)		(1.89)
Log city population(t-1)			0.12 * **				0.13 * **	
			(3.06)				(4.67)	
Log real construction cost			1.46 * **		0.24 *	0.48 * **	1.68 * **	
			(8.26)		(1.79)	(4.22)	(8.85)	
Log real construction cost(t-1)		0.59 *						0.98 * **
		(1.85)						(5.94)
Log real rental index	0.63 * **							
	(6.92)							
Log ratio of real stock price to real house price	-0.62 * **	-0.57 * **	-0.68 * **	-0.42 * **	-0.46 * **	-0.44 * **	-0.57 * **	-0.56 * **
	(−10.82)	(−5.09)	(−7.10)	-(5.87)	(−7.38)	(−7.13)	(−9.70)	(−6.04)
Log real credit per account	0.14 * **							
	(4.03)							
Log real credit per account (t-1)		0.18 * *						
		(2.11)						
Real interest rate on housing mortgages			-0.02 * **	-0.02 * **				
			(−4.17)	-(3.06)				
Real policy rate	-0.03 * **	-0.01 * **					-0.03 * **	-0.01 * *
	(−2.94)	(−3.81)					(−3.24)	(−2.02)
Log median LTV ratio for housing loans	0.43 * **							
	(3.48)							
Log regulatory LTV ratio for large-size housing loans				1.04 * **	1.23 * **			
				(8.69)	(7.57)			
Log regulatory LTV ratio for small-size housing loans						0.59 * **		
						(9.34)		
Log regulatory risk weights on the banks' housing loans			-0.18 * **				-0.10 * **	
			(−4.32)				(−3.42)	
Log regulatory risk weights on the banks' housing loans (t-1)		-0.13 * **	-0.29 * **	-0.12 * **			-0.17 * **	
		(−5.54)	(−7.51)	-(4.89)			(−5.95)	
Log median housing loan-to-income ratio (t-1)								0.56 * **
								(3.78)
Log asset provisioning for banks' standard housing assets					-0.13 * *	-0.14 * *	-0.14 * **	-0.17 * **
					(−2.37)	(−2.24)	(−3.02)	(−4.34)
Wald χ2	12,246.5(0.0)	3661.67	19,522.5(0.0)	3342.2(0.0)	17,041.1(0.0)	21,229.4(0.0)	32,615.1(0.0)	10,000.0(0.0)
Sargan test: chi2				6.69(0.99)	7.03(0.99)	6.58(0.99)	70.15(0.07)	16.33(0.75)
Arellano-Bond test for AR(1): Z-stats	-2.11(0.04)	1.84(0.07)	1.68(0.09)	1.91(0.06)	1.73(0.08)	1.71(0.09)		
Arellano-Bond test for AR(2): Z-stats	-0.42(0.67)	1.44(0.15)	0.67(0.50)	1.13(0.26)	1.39(0.16)	1.43(0.15)		
No. of instruments	58	59	60	59	59	59	61	28
No. of groups	10	10	10	10	10	10	10	8
T	9	10	10	10	10	10	10	4

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10%, 5% and 1%, respectively.

and also the housing prices. Monetary policy changes have a significant impact on house prices, though a relatively small effect could be attributed to imperfections in the credit market.[10]

Among the key macroprudential tools with the central banks or other regulatory authorities, a 10-percentage point loosening of the median LTV limit leads to an average 3–6 % increase in real house prices. The estimates for the US economy by Duca et al. (2010) suggest that a 10-percentage point increase in the LTV limit yields about an 8–11% increase in house prices. Similarly, Crowe et al. (2011), observe that a 10-percentage point increase in maximum LTV allowed by regulations is associated with a 13% increase in nominal house prices for a cross-section of developed countries. It is interesting to note that the effect of a unit change in the regulatory prescribed LTV limit on large-sized loans is found to be significantly greater (1.0–1.2) than the effect of a change in the LTV limit for small-sized loans (0.4–0.6). It can be argued that while the large-sized loans tend to have underlying investment motives, the small-sized housing loans have limited speculative elements as these tend to be mainly the owner-occupied dwellings. While a unit tightening of risk weights on housing loans causes about a 14–21 basis point decline in house prices, a similar effect (13–20 basis points) is also observed in the case of a tightening of the asset provisioning requirements on mortgages. This again underscores a key role for macroprudential policies in responding to asset price cycles. The greater effectiveness of macroprudential tools in EME is also corroborated by their active use in EMEs as compared with advanced economies (Orsmond and Price, 2016). Affordability, as captured by equal monthly installment (EMI), has a significant impact on house prices. A rise in EMI leads to a decline in asset prices as the underlying demand goes down. The loan-to-income ratio – a measure of financial leverage – also plays an important role in reinforcing the nexus between credit markets and house prices. As a robustness check, alternative specifications based on the panel fixed-effects models are presented in Appendix Table A3. The conclusions are broadly similar to the dynamic panel data estimators.

To assess the impact of the tightening of macroprudential policies on housing prices, we used dummy variables. The estimates from the Arellano-Bond estimators suggest that a tightening of the LTV ratio leads to a significant negative effect on house prices. This impact is even stronger in the estimates obtained from the system estimators (see Appendix Table A5). However, in comparison to a tightening policy, relaxation in the LTV ratio has a greater impact on house prices, suggesting procyclicality in the behavior of housing asset prices. Thus, we find some evidence of asymmetry in the impact of tightening and loosening of the LTV policy.

5.3. Results from housing price models based on the NHB's residex

To validate the above conclusions, we utilize a broader dataset of house prices of the National Housing Bank covering 33 cities for the period 2010–2019. In what follows, we discuss results obtained from alternative specifications of the dynamic panel estimators, utilizing one-step and two-step methods. For testing over identifying restrictions, we use the Sargan test statistics which validates our instruments. Detailed results based on alternative specifications with the diagnostic tests are presented in Tables 3 and 4.

The estimates suggest a strong lagged effect of real house prices, which reiterates strong backward-looking expectations of real house prices. Lagged per capita income and population size are the key demand-side factors that play an important role in driving real house prices. Bank credit also has a significant contemporaneous effect on house prices, though the effect is relatively small as compared to other macroeconomic variables. The feedback loop between bank credit and property prices becomes entrenched when the housing sector is financed predominantly by mortgage loans. Higher return on other substitutable assets in the households' portfolio viz., stocks, may also shift the demand away from investment in housing assets and thus, drive down house prices. Égert and Mihaljek (2007) find that the house prices in OECD countries are negatively correlated with equity prices, implying substitution effects. A relative increase in stock prices vis-à-vis house prices has a significant negative impact on housing prices, reemphasizing the role of the opportunity cost of acquiring housing assets. We also find a significant contemporaneous and lagged negative effect of a tightening in policy rates and higher mortgage rates on house prices, which may work through the demand channel. Construction cost, a supply-side determinant, also has a significant contemporaneous as well as a lagged effect on housing prices. The impact of supply shocks turns more pronounced in markets where supply responds in a relatively sluggish manner to housing demand.

Among the macroprudential tools, the impact of the LTV ratio is found to be most dominant in influencing house prices. The results also underscore a stronger effect of a unit increase in the maximum LTV ratio for the large-sized housing loans on house prices compared to the effect of the LTV ratio associated with the small-sized loans. Risk weights on housing loans have significant contemporaneous and lagged effects on real housing prices. Similarly, asset provisioning also negatively influences house prices. Rising leverage in the housing market (i.e., loan-to-income ratio) tends to push up real house prices through the speculation channel. Similarly, we also find evidence of a strong role played by affordability (EMI to income ratio) in shaping the movement of real house prices – a rising EMI causing a dampening effect on real house prices. A robustness exercise, based on fixed effect estimators presented in Appendix Table A4, provides broadly similar conclusions.

Intending to capture the tightening effect of the macroprudential policy, we introduce a dummy variable in our estimators (Appendix Table A6). The results obtained both from the AB estimators and the system estimators suggest a very strong negative effect of tightening the LTV policy on house prices. Nevertheless, the impact of the loosening LTV policy seems to be stronger than the tightening policy. It seems to suggest that during an expansionary cycle of housing prices, though the tightening policy has a significant effect in arresting the rise in housing prices, the impact is relatively small. This could be attributed to the highly procyclical nature of stock prices.

[10] The monetary transmission to credit markets is impeded by factors viz., maturity mismatches and interest rate risk in the fixed-rate deposits against floating rate loans; rigidity in saving deposit interest rates; competition from other financial saving instruments; and deterioration in the loan portfolio (RBI, 2017).

Table 3
Arellano-Bond panel data estimators for real house prices.

Dependent variable: NHB's real house price index								
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log real house price(t-1)	0.25 * **	0.39 * **	0.13 * **	0.24 * **	0.21 * **	0.60 * **	0.15 * **	0.58 * **
	(5.39)	(4.71)	(4.59)	(5.37)	(5.88)	(15.74)	(4.91)	(3.75)
Log real per capita income(t-1)	0.31 * **	0.30 * **	0.25 * **	0.20 * **	0.27 * **		0.47 * **	0.24 * **
	(5.94)	(6.29)	(10.73)	(7.38)	(10.88)		(14.91)	(2.83)
Log city population		0.53 * **			0.79 * **	0.48 * **		
		(9.53)			(14.26)	(10.93)		
Log real construction cost					0.49 * **			
					(14.57)			
Log real construction cost(t-1)	0.77 * **	0.90 * **				0.21 * **		
	(5.74)	(6.52)				(4.88)		
Log real rental index	0.25 * **							
	(7.35)							
Log real stock price to real house price ratio	-0.49 * **	-0.48 * **	-0.56 * **	-0.45 * **	-0.55 * **	-0.48 * **	-0.67 * **	-0.46 * **
	(−21.81)	(−25.35)	(−32.05)	(−38.88)	(−43.26)	(−42.36)	(−17.06)	(−11.70)
Log real bank credit per account					0.11 * **			
					(11.07)			
Real interest rate on housing mortgages	-0.01 * **		-0.01 * **	-0.01 * **				
	(−10.22)		(−3.22)	(−13.58)				
Real interest rate on housing mortgages(t-1)							-0.01 * **	
							(−4.53)	
Real policy rate		-0.01 * **			-0.02 * **			-0.04 * **
		(−10.29)			(−14.72)			(−12.77)
Real policy rate(t-1)		-0.01 * **			-0.02 * **			
		(−8.84)			(−16.67)			
Log median LTV ratio for housing loans	0.64 * **	0.38 * **	0.69 * **			0.47 * **		
	(10.88)	(9.37)	(22.02)			(25.02)		
Log regulatory LTV ratio for large-size housing loans				0.43 * **				
				(2.94)				
Log regulatory LTV ratio for small-size housing loans					0.50 * **			
					(19.95)			
Log regulatory risk weight on housing loans			-0.12 * **	-0.10 * **				
			(−34.52)	(−4.94)				
Log regulatory risk weight on housing loans(t-1)						-0.13 * **		
						(−31.89)		
Log median housing loan-to-income ratio							0.18 * *	
							(1.96)	
Log median housing EMI-to-income ratio							-0.35 * *	-0.45 * **
							(−2.61)	(−10.04)
Log asset provisioning for banks' standard housing assets(t-1)								-0.10 * **
								(−3.30)
Wald χ2	13967.02(0.0)	6168.57	13000.0(0.0)	6097.6(0.0)	11673.9(0.0)	6056.1(0.0)	4093.6(0.0)	582.7(0.0)
Sargan test: chi2	2.05(0.04)	28.48(0.77)	29.79(0.72)	26.78(0.84)	29.41(0.73)	25.88(0.88)	9.02(0.99)	11.78(0.99)
Arellano-Bond test for AR(1): Z-stats	0-0.69(0.49)	-2.41(0.02)	-2.53(0.01)	-2.76(0.01)	-2.65(0.01)	3.45(0.00)	1.74(0.08)	-1.85(0.06)
Arellano-Bond test for AR(2): Z-stats	28.01(0.79)	-1.27(0.20)	1.74(0.08)	1.60(0.11)	0.95(0.34)	-1.23(0.22)	-0.52(0.60)	-0.72(0.47)
No. of instruments	42	43	41	41	44	41	31	41
No. of groups	33	33	33	33	33	33	13	13
T	8	8	8	8	8	8	4	8

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Table 4
Blundell-Bond system estimators for real house prices.

Dependent variable: NHB's real house price index

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Log real house price(t-1)	0.43 * **	0.37 * **	0.39 * **	0.34 * **	0.48 * **	0.49 * **	0.42 * **	0.56 * **
	(7.78)	(11.72)	(28.49)	(14.42)	(13.36)	(7.40)	(2.01)	(10.96)
Log per capita income(t-1)	0.20 * **	0.18 * **	0.20 * **	0.24 * **				0.19 * **
	(18.80)	(18.25)	(13.04)	(33.91)				(11.21)
Log real construction cost	0.59 * **	0.75 * **	0.31 * **	0.49 * **			0.60 * **	0.79 * **
	(24.05)	(27.43)	(11.97)	(31.64)			(6.12)	(35.58)
Log real construction cost(t-1)					0.86 * **	0.44 * **		
					(9.87)	(16.72)		
Log real rental index	0.15 * **							
	(3.59)							
Log real stock price to house price ratio	-0.52 * **	-0.72 * **	-0.62 * **	-0.57 * **	-0.39 * **	-0.45 * **	-0.26 * **	-0.53 * **
	(−30.06)	(−17.25)	(−47.62)	(−46.39)	(−8.28)	(−10.35)	(−5.01)	(−42.87)
Log real credit per account					0.12 * **			
					(8.67)			
Real interest rate on housing mortgages		-0.01 * **						
		(−29.20)						
Real policy rate			-0.01 * **	-0.01 * **				
			(−15.90)	(−14.85)				
Real policy rate (t-1)	-0.02 * **				-0.02 * **	-0.01 * *	-0.03 * **	
	(−10.63)				(−6.63)	(−2.54)	-(4.46)	
Log median LTV ratio for housing loans		0.49 * **						
		(22.64)						
Log regulatory LTV ratio for large-size housing loans			0.80 * **					
			(13.14)					
Log regulatory LTV ratio for small-size housing loans				0.41 * **				
				(28.04)				
Log regulatory risk weight on housing loans		-0.17 * **			-0.06 * **	-0.24 * **		
		-(43.10)			(−4.40)	(−32.63)		
Log regulatory risk weight on housing loans(t-1)	-0.17 * **	-0.21 * **	-0.21 * **	-0.19 * **	-0.12			-0.20 * **
	(−50.03)	(−47.10)	(−45.92)	(−42.06)	(−7.73)			(−55.81)
Log median housing loan-to-income ratio						0.74 * **		
						(18.05)		
Log median housing EMI-to-income ratio(t-1)							-0.23 * **	
							(−3.73)	
Log asset provisioning for banks' standard housing assets								-0.12 * **
								(−37.54)
Wald χ2	14,765.4(0.0)	10,000.0(0.0)	11,900.0(0.00)	13,100.0(0.0)	36,557.3(0.0)	32,247.8(0.0)	229.63	9944.2(0.00)
Sargan test: chi2	30.15(0.93)	29.74(0.94)	28.02(0.96)	29.60(0.94)	28.46(0.98)	9.42(0.99)	12.06(0.99)	30.78(0.92)
Arellano-Bond test for AR(1): Z-stats	-2.66(0.01)	-2.95(0.00)	3.27(0.00)	3.02(0.00)	-3.49(0.00)	-1.11(0.27)	-1.56(0.12)	-3.08(0.00)
Arellano-Bond test for AR(2): Z-stats	-1.03(0.30)	-0.47(0.64)	-0.46(0.65)	-0.89(0.37)	0.65(0.52)	-1.22(0.22)	0.31(0.76)	-1.54(0.12)
No. of instruments	50	51	50	50	45	36	67	49
No. of groups	33	33	33	33	33	13	13	33
T	9	9	9	9	9	5	9	9

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Table 5
Blundell-Bond system estimators for real housing credit demand.

Dependent variable: Real bank credit to the housing sector			
Variables	[1]	[2]	[3]
Log real credit per account (t-1)	0.09 * *	0.20 * **	0.29 * **
	(2.90)	(15.28)	(28.21)
Log real credit per account (t-2)	0.06 * **		
	(3.79)		
Log real per capita income	0.46 * **	0.41 * **	0.51 * **
	(19.07)	(14.93)	(73.18)
Real policy rate	-0.02 * **	-0.03 * **	-0.02 * **
	(−8.95)	-(26.27)	-(19.12)
Real policy rate (t-1)		0.04 * **	0.04 * **
		(10.92)	(14.20)
Log regulatory LTV ratio for large-size housing loans	0.29 * **		
	(5.32)		
Log regulatory LTV ratio for small-size housing loans (t-1)		0.31 * **	
		(5.34)	
Log regulatory risk weight on housing loans	-0.10 * **		
	(−21.75)		
Log regulatory risk weight on housing loans(t-1)	-0.09 * **	-0.10 * **	
	(−16.26)	(−9.63)	
Log regulatory risk weight on small-size housing loans(t-1)			-0.18 * **
			(−35.84)
Log asset provisioning for banks' standard housing assets		-0.12 * **	-0.16 * **
		(−11.23)	(−20.27)
Wald χ2	46,664.1(0.0)	17,600.0(0.0)	7095.9(0.0)
Sargan test: chi2	32.25(0.98)	32.14(0.98)	32.00(0.99)
Arellano-Bond test for AR(1): Z-stats	2.99(0.00)	2.97(0.00)	2.94(0.00)
Arellano-Bond test for AR(2): Z-stats	-1.39(0.17)	0.15(0.88)	1.96(0.06)
No. of instruments	58	60	55
No. of groups	33	33	33
T	9	10	10

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Since all the macroprudential measures work through the bank balance sheet channel, we estimate a real housing credit demand function to gauge the operation of the credit channel. The empirical results presented in Table 5 indicate a strong effect of both the LTV ratio prescribed for large and small-size loans on the real housing credit demand. Similarly, we find a significant negative effect of an increase in both risk weights and asset provisioning on real housing credit demand.

6. Conclusions

The key objective of this paper is to examine the effectiveness of macroprudential policies in influencing house price cycles in a developing country, after controlling for the fundamental factors. We use two novel databases on city-level housing prices for India, which broadly yield similar conclusions. Among the key macroeconomic determinants, per capita income significantly influences house prices. We also find strong backward-looking house price expectations operating in the housing market. The conclusion about the role of long-run drivers is further strengthened by the impact of the demographic factors on house prices. The importance of the opportunity cost of housing investments is mirrored in a strong inverse effect of a positive shock to the stock relative to house prices. We find strong evidence of the role of bank credit channels in influencing movements in housing prices. Construction cost emerges as a dominant supply-side factor in driving the housing prices, given the usual sluggishness in supply response in the housing market.

On the role of macroprudential policies, which is the central theme of this paper, we find the LTV limit as the most potent tool to respond to housing price fluctuations. A theme emerging from all the estimators is that a change in the LTV limit for large-size loans has a much more dominant effect on house prices compared to a change in the LTV limit for small-size loans. This finding is intuitively appealing as the large-sized loans tend to be motivated more by investment motives, while the small-sized housing loans are less speculative as these are generally for owner-occupied housing. Additionally, we find evidence of asymmetry in the impact of loosening versus the tightening of the LTV ratio, which can be attributed to the procyclical behavior of the house prices. The conjecture of the speculative elements is also buttressed by the evidence of a strong asset substitution effect driven by relative asset returns. An increase in the risk weights on housing assets of commercial banks also causes significant downward pressure on housing prices, thus re-emphasizing the role of regulatory policies. Similarly, the standard asset provisioning on banks' housing loans also significantly influences house prices. Additionally, there is evidence of a robust effect of these regulatory measures on credit demand, which in turn, influences the demand for housing and vividly underscores the role of credit channels. The build-up of credit leverage (loan-to-income ratio) is found to have a substantial effect on house prices as the greater access to borrowed funds tends to fuel the demand. A worsening of housing affordability, captured by higher loan EMI, has a significant negative effect on house prices.

The broader policy implication of the above findings is that as a developing economy attains greater financial deepening and mortgage credit markets expand, it may exhibit greater procyclicality in the housing market and hence the greater scope for the regulatory policies like the macroprudential policies in containing systemic risks. The results on the efficacy of macroprudential tools in leaning against the wind in a mortgage market strengthens our belief about the efficacy of macroprudential policies in addressing the risks posed by the credit and housing boom-bust cycles.Acknowledgment

The author would like to thank Gaston Gelos and Machiko Narita of the Monetary and Capital Markets Department and Katharina Bergant of the Research Department of the International Monetary Fund for their valuable and insightful comments, which helped in revising the paper.

Disclaimer

The views expressed in this paper are those of the author and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Appendix

See Tables A1-A6 here.

Table A1
A brief history of implementation of macroprudential tools four housing in India.

Date	Asset provisioning ratio	Risk Weight	LTV ratio
Dec-04	0.25	75.00	100.00
Jul-05	0.25	75.00	100.00
Nov-05	0.40	75.00	100.00
May-06	1.00	75.00	100.00
Jan-07	1.00	75.00	100.00
May-07	1.00	50–75*	100.00
May-08	1.00	50–100*	≤ 75- > 75*
Nov-08	0.40	50–100*	≤ 75- > 75*
Nov-09	0.40	50–100*	≤ 75- > 75*
Dec-10	0.40–2.00*	50–125*	≤ 75–125*
Jun-13	0.40–2.00*	50–75*	75–90*
Oct-15	0.40–2.00*	35–75*	≤ 75 - ≤ 90*
Jun-17	0.25	35–50*	≤ 75 - ≤ 90*
Oct-20	0.25	35–50*	≤ 80 - ≤ 90*

Source: Reserve Bank of India and IMF's iMaPP database.
* regulatory requirements differing as per the loan sizes/categories.

Table A2
Summary statistics for housing price models.

Variable code	Variable name	No. of Obs.	Mean	Std. Dev.	Min	Max
asstprov	Standard asset provisioning ratio on the outstanding housing loans	363	0.37	0.06	0.25	0.40
rbse_rhpi10	Ratio of real BSE index to real HPI10 index	110	155.6	42.6	86.9	267.8
rbse_rhpi33	Ratio of real National Stock Exchange index to real HPI33 index	254	296.3	42.4	171.7	417.2
rnse_rhpi10	Ratio of real National Stock Exchange index to real HPI10 index	254	87.7	12.8	52.2	125.0
rnse_rhpi33	Ratio of real National Stock Exchange index to real HPI33 index	254	87.7	12.8	52.2	125.0
rhpi10	RBI's real HPI index for 10 cities	110	143.6	46.5	72.9	274.0
rhpi33	NHB's real house price index for 33 countries	254	36.9	5.2	25.3	62.0
rconsix	Real construction cost index	363	122.1	11.2	82.6	146.0
cpiix	CPI Index	363	226.7	51.6	131.7	360.8
cpiin	CPI inflation	363	7.7	3.7	0.1	19.0
rcrdpa	Real housing credit per account	363	846.1	342.5	228.3	2169.7
ddppc	District domestic product per capita	363	114,398.2	74,702.1	13,168.9	356,818.3
sdppc	Net state domestic product per capita	363	93,719.5	43,797.8	17,033.5	279,601.1
emiy	Housing EMI to Income ratio	130	36.2	4.4	24.3	59.3
hpiy	House price to income ratio	130	58.0	6.5	45.8	77.0
pop_city	City population in thousands	363	4394.3	5410.8	218.0	28,514.0
rrepo	Real policy rate of the central bank	363	-0.92	3.84	-14.10	6.23
rwarhg	Real weighted average interest rate on housing loans	363	2.48	3.31	-8.24	9.31
rwm	Regulatory maximum risk weights on housing loans	363	0.65	0.24	0.35	1.00
rws	Regulatory risk weights on small size housing loans	363	0.57	0.11	0.50	0.75
lti	Median housing loan-to-income ratio	65	3.12	0.37	2.30	3.98
ltvm	Median loan-to-value ratio of banks	330	0.69	0.04	0.49	0.79
ltvl	Regulatory loan-to-value ratio for large size housing loans	363	0.78	0.02	0.75	0.80
ltvs	Regulatory loan-to-value ratio for small size housing loans	363	0.83	0.07	0.75	0.90

Table A3
Panel fixed-effect models for real house prices based on the RBI's HPI.

Dependent variable: RBI's real house price index

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
constant	-0.77 (−0.80)	-3.60 -(2.53)	5.53 (4.86)	2.79 (2.71)	2.72 (2.49)	-8.62 (−4.58)	-4.06(−3.3-5)	-2.68 (−1.23)	0.79 (0.66)	3.62 (4.01)	0.14 (5.23)
Log real per capita income	0.22 * * (2.42)	0.29 * ** (3.5-0)	0.14 * * (2.58)	0.19 * ** (3.-07)	0.18 * ** (2.-87)	0.58 * * (6.62)	0.58 * ** (6.-62)	0.41 * ** (6.-00)	0.39 * ** (6.-00)	0.32 * ** (3.-21)	0.23 * ** (5.72)
Log city population		0.43 * * (2.44)									
Log real construction cost index						0.46 * (1.85)	0.46 * (1.85)				
Log real stock price to real house price ratio	-0.77 * ** (−-14.98)	-0.75 * ** (−-16.24)	-0.91 * ** (−26.98)	-0.90 * * (−13.23)	-0.86 * ** (−20.38)	-0.56 * ** (−6.22)	-0.56 * ** (−6.22)	-0.75 * ** (−10.86)	-0.75 * ** (−10.01)	-0.42 * ** (−5.65)	-0.97 * ** (−40.43)
Log real rental index	0.62 * ** (7.1-1)				0.26 * (1.81)						
Log real credit per account				0.11 * * (2.19)							
Real interest rate on housing mortgages					-0.01 * * (−2.53)						
Real policy rate		-0.06 * ** (−-6.33)	-0.05 * ** (−12.29)			-0.01 * * (−2.15)	-0.01 * * (−2.10)	-0.06 * ** (−8.68)	-0.06 * ** (−8.61)		-0.05 * ** (−14.37)
Log median LTV ratio for housing loans	0.73 * ** (3.7-4)	0.89 * * (2.18)	0.26 * * (2.58)	0.86 * ** (3.-16)	0.63 * ** (4.-00)						0.34 * ** (3.01)
Log regulatory LTV ratio for large size housing loans						1.63 * (−3.-39)		1.25 * * (2.86)			
Log regulatory LTV ratio for small size housing loans							0.58 * ** (3.-39)		0.44 * * (2.86)		
Log regulatory risk weight on housing loans			-0.20 * ** (−12.90)	-0.24 * ** (−10.22)	-0.22 * ** (−7.43)						-0.19 * ** (−17.45)
Log median housing loan-to-income ratio										0.61 * ** (3.-41)	
Log median housing EMI-to-income ratio										-0.68 * ** (−2.97)	
Log asset provisioning for banks' standard housing assets											-0.10 * ** (−9.43)
R2 (within)	0.92	0.92	0.96	0.96	0.95	0.87	0.87	0.91	0.91	0.87	0.87
F-stats.	232.14(0.0)	206.07(0.0)	299.30(0.0)	262.96(0.0)	254.32(0.0)	44.79(0.0)	44.79(0.0)	145.87(0.0)	145.87(0.0)	45.78(0.0)	65.39(0.0-)
No. of groups	10	10	10	10	10	10	10	10	10	10	10
T	9	11	10	10	9	11	11	11	11	11	11

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Table A4
Panel fixed-effect estimators for real house prices based on the NHB's Residex.

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
constant	-1.69	-2.51	1.03	-6.56	-3.96	-5.98	2.88	-4.95	0.91	5.01
	(−1.03)	(−1.60)	(0.76)	-(2.55)	-(2.00)	(2.51)	(5.37)	(−1.69)	(1.28)	(4.84)
Log real per capita income	0.34 * **	0.45 * **	0.27 * **	0.51 * **	0.51 * **	0.37	0.17 * *	0.41 * **		
	(3.33)	(5.90)	(3.88)	(6.54)	(6.54)	(0.09)	(2.04)	(2.90)		
Log city population									0.71 * **	0.23 *
									(7.05)	(1.93)
Log real construction cost	0.86 * **	0.50 * *	0.33 * *	0.86 * **	0.86 * **	0.80 * *		1.53 * **		
	(3.40)	(2.60)	(2.15)	(4.53)	(4.53)	(2.18)		(5.82)		
Log real rental index		0.40 * **					0.24 * *			
		(3.88)					(2.09)			
Log real stock price to real house price ratio	-0.59 * **	-0.63 * **	-0.72 * **	-0.63 * **	-0.63 * **	-0.64 * **	-0.86 * **	-0.88 * **	-0.65 * **	-0.60 * **
	(−18.57)	(−11.00)	(−21.89)	(−20.51)	(−20.51)	(20.03)	(−12.70)	(−14.71)	(−15.23)	(−16.02)
Log real credit per account						0.08			0.12 * **	0.19 * **
						(0.12)			(3.31)	(6.17)
Real interest rate on housing mortgages	-0.01 * **							-0.05 * **		
	(−3.04)							(−5.11)		
Real policy rate		-0.02 * **	-0.01 * **	-0.02 * **	-0.02 * **	-0.02 * *	-0.01 * **		-0.03 * **	-0.01 *
		(−3.11)	(−3.02)	(−6.14)	(−6.14)	(−2.00)	(−4.60)		(−3.15)	(1.87)
Log median LTV ratio for housing loans			0.60 * **				0.73			
			(5.54)				(−3.27)			
Log regulatory LTV ratio for large size housing loans				0.93 * **		0.92 * *				
				(3.36)		(2.27)				
Log regulatory LTV ratio for small size housing loans					0.33 * **					
					(3.36)					
Log regulatory risk weight on housing loans			-0.11 * **				-0.22 * **			
			(−5.16)				(−8.59)			
Log median housing loan-to-income ratio								0.44 * **		
								(3.06)		
Log median housing EMI-to-income ratio (t-1)								-0.37 * *	-0.22 * *	-0.20 * *
								(−2.08)	(−2.13)	(−2.31)
Log asset provisioning for banks' standard housing assets										-0.17 * **
										(−4.48)
R2 (within)	0.65	0.69	0.72	0.68	0.68	0.70	0.94	0.85	0.79	0.79
F-stats.	80.38(0.0)	45.85(0.0)	92.54(0.0)	92.11(0.0)	92.11(0.0)	83.10(0.0)	214.79(0.0)	43.94(0.0)	63.93(0.0)	65.92(0.0)
No. of groups	33	33	33	33	33	33	10	33	33	33
T	10	9	10	10	10	10	9	10	10	10

Figures in brackets are t-statistics or z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Table A5
Dynamic panel-data estimation for real house prices based on the RBI's HPI: Arellano–Bond estimators and Arellano–Bover/Blundell–Bond.

	Arellano–Bond estimators			Arellano–Bover/Blundell–Bond system estimators		
Variables	[1]	[2]	[3]	[4]	[5]	[6]
Log house price(t-1)	0.25 * **	0.19 * *	0.30 * **	-0.26	0.16 * **	0.28 * **
	(4.87)	(1.95)	(12.28)	-(1.19)	(3.18)	(5.98)
Log real per capita income(t-1)	0.12 *	0.21 * *		0.64 * *	0.11 * **	
	(1.82)	(2.05)		(2.46)	(5.54)	
Log city population	0.30 * *					0.09 * **
	(2.17)					(3.96)
Log constructions cost(t-1)				0.40 *	1.19 * **	1.55 * **
				(1.77)	(9.16)	(12.40)
Log real rental index						
Log ratio of real stock price to real house price	-0.64 * **	-0.75 * **	-0.56 * **	-0.45 * **	-0.72 * **	-0.75 * **
	(−11.05)	(−5.53)	(−19.66)	(−2.91)	(−16.05)	(−13.63)
Log real credit per account(t-1)			0.12 * **			
			(6.53)			
Real interest rate on housing mortgages (t-1)		-0.04 * **				
		(−6.41)				
Real policy rate	-0.03 * **					
	(−4.38)					
Real policy rate (t-1)						-0.01 * *
						(−1.98)
Log median LTV ratio	0.46 * **	0.35 * *		0.26		
	(3.16)	(2.24)		(0.91)		
Log regulatory LTV ratio for large-size loans						
Log regulatory LTV ratio for small-size loans					0.29 * **	
					(3.56)	
Log regulatory risk weights on the banks' housing loans		-0.07 * *	-0.08 * **		-0.11 * **	-0.10 * *
		(−2.12)	(−7.61)		(−4.13)	(−2.63)
Log median housing loan-to-income (LTI) ratio						
Log median housing EMI to income ratio						
Log of asset provisioning for banks' standard housing assets(t-1)		-0.09 * **		-0.19 * *	-0.37 * **	-0.25 * **
		(−3.38)		(−2.19)	(−10.51)	(−7.04)
Dum LTV tightening	-0.09 * **	-0.10 * **	-0.10 * **	-0.08 * **	-0.10 * **	-0.11 * **
	(−3.19)	(−8.87)	(−6.82)	(−6.95)	(−3.40)	(−5.01)
Dum LTV tightening (t-1)				-0.14 * **		-0.10 * *
				(−6.92)		(−2.49)
Wald $\chi 2$	2507.6(0.0)	4419.9(0.0)	4164.9(0.0)	43,843.0(0.0)	6651.5(0.0)	5930.1(0.0)
Sargan test: chi2	70.57(0.01)	9.39(0.99)	9.02(0.99)	4.53(0.99)	9.75(0.99)	9.98(0.99)
Arellano-Bond test for AR(1): Z-stats	3.48(0.00)	-2.67(0.01)	-2.18(0.03)	0.71(0.48)	-1.89(0.06)	2.73(0.01)
Arellano-Bond test for AR(2): Z-stats	-0.30(0.76)	1.30(0.19)	1.61(0.10)	1.81(0.08)	-0.61(0.53)	1.62(0.11)
No. of instruments	51	52	49	61	61	51
No. of groups	10	10	10	10	10	10
T	9	9	9	9	9	9

Figures in brackets are z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

Table A6
Dynamic panel-data estimation for real house prices based on the NHB's Residex: Arellano–Bond estimators and Arellano–Bover/Blundell–Bond.

	Arellano–Bond estimators			Arellano–Bover/Blundell–Bond system estimators		
Variables	[1]	[2]	[3]	[4]	[5]	[6]
Log real house price(t-1)	0.36 * **	0.25 * **	0.28 * **	0.34 * **	0.53 * **	0.37 * **
	(11.31)	(3.53)	(4.65)	(7.90)	(17.17)	(6.27)
Log per capita income(t-1)		0.25 * **	0.28 * **	0.16 * **	0.22 * **	0.17 * **
		(4.01)	(4.88)	(11.67)	(9.49)	(6.56)
Log real construction cost		0.19 * **	0.50 * **		0.21 * **	
		(3.30)	(8.34)		(13.84)	
Log city population			0.75 * **			
			(7.43)			
Log real stock price to house price ratio	-0.71 * **	-0.53 * **	-0.59 * **	-0.59 * **	-0.41 * **	-0.61 * **
	(−50.71)	(−14.61)	(−18.68)	(−47.69)	(−18.70)	(−15.16)
Log real credit per account		0.12 * **	0.11 * **			
		(3.60)	(3.76)			
Real interest rate on housing mortgages(t-1)	-0.04 * **			-0.03 * **	-0.03 * **	-0.02 * **
	(−25.03)			(−18.08)	(−8.28)	(−6.30)
Real policy rate					-0.01 * **	
					(−13.11)	
Real policy rate (t-1)					0.01 * **	
					(4.03)	
Log median LTV ratio for housing loans		0.37 * **	0.20 * **	0.41 * **		0.87 * **
		(2.82)	(1.71)	(10.49)		(13.03)
Log median LTV ratio for housing loans(t-1)			-0.14 * **	0.44 * **		
			(−1.50)	(9.38)		
Log regulatory risk weight on housing loans				-0.08 * **		
				(−7.26)		
Log regulatory risk weight on housing loans(t-1)					-0.10 * **	
					(−9.77)	
Log asset provisioning for banks' standard housing assets						-0.03
						(−1.49)
Dum LTV tightening	-0.10 * **	-0.12 * **	-0.09 * **	-0.28 * **	-0.15 * **	-0.15 * **
	(−6.89)	(−5.00)	(−4.34)	(−17.88)	(−23.91)	(−7.13)
Dum LTV tightening(t-1)	-0.24 * **		-0.08 * **	-0.21 * **		-0.15 * **
	(−32.09)		(−4.93)	(−23.87)		(−8.03)
Wald χ2	35,227.34(0.0)	460.0(0.0)	725.7(0.00)	8630.0(0.0)	15,362.3(0.0)	32,247.8(0.0)
Sargan test: chi2	30.31(0.69)	29.74(0.94)	81.42(0.01)	24.46(0.95)	30.51(0.92)	31.81(0.89)
Arellano-Bond test for AR(1): Z-stats	-2.49(0.01)	-2.38(0.02)	-1.45(0.15)	-3.45(0.00)	-3.49(0.00)	-3.50(0.01)
Arellano-Bond test for AR(2): Z-stats	-0.71(0.48)	0.62(0.53)	0-0.73(0.46)	0.36(0.71)	0.65(0.52)	0.39(0.69)
No. of instruments	41	44	50	52	52	51
No. of groups	33	33	33	33	33	33
T	9	9	9	9	9	9

Figures in brackets are z-statistics. For F-stats, Wald Chi2 and Sargan test, figures in brackets are p-values.
Please see Annex A1 for the definition of the variables.
* , * *, * ** : represent significance level of 10 %, 5 % and 1 %, respectively.

References

Abraham, Jesse M., Hendershott, Patric H., 1996. Bubbles in metropolitan housing markets. J. Hous. Res. 7 (2), 191–207.

Adams, Z., Fuss, R., 2010. Macroeconomic determinants of international housing markets. J. Hous. Econ. 19 (1), 38–50.

Adelino, M., Schoar, A., Severino, F., 2015. House prices, collateral, and self-employment. J. Financ. Econ. 117 (2), 288–306.

Ahearne, Alan G. , John Ammer , Brian M. Doyle , Linda S. Kole , Robert F. Martin , 2005. House prices and monetary policy: a cross-country study, International Finance Discussion Papers 841 (Washington: Board of Governors of the Federal Reserve System, September).

Alam, Zohair Adrian Alter, Jesse Eiseman, Gaston Gelos, Heedon Kang, Machiko Narita, Erlend Nier, and Naixi Wang , 2019, Digging deeper—Evidence on the effects of macroprudential policies from a new database", IMF Working Paper, WP/19/66.

Andrews, Dan , 2010. Real house prices in OECD countries: the role of demand shocks and structural and policy factors, OECD Economics Department Working Paper 831.

Aoki, Kosuke, Proudman, James, Vlieghe, Gertjan, 2004. House prices, consumption, and monetary policy: a financial accelerator approach. J. Financ. Intermed. 13 (4), 414–435.

Arregui, Nicolas , Jaromír Benes , Ivo Krznar , Srobona Mitra , Andre Oliveira Santos , 2013. "Evaluating the net benefits of macroprudential policy: a cookbook", IMF Working Paper, WP/13/167.

Baffoe-Bonnie, John, 1998. The dynamic impact of macroeconomic aggregates on housing prices and stock of houses: a national and regional analysis. J. Real. Estate Financ. Econ. 17 (2), 179–197.

Bodman, P., Crosby, M., 2004. Can macroeconomic factors explain high house prices in Australia? Aust. Prop. J. 38 (3), 174–179.

Bourassa, S.C., Hendershott, P.H., 1995. Australian capital city real house prices, 1979-93. Aust. Econ. Rev. 16–26.

Bowen, Alex, 1994. Housing and the macroeconomy in the United Kingdom. Hous. Policy Debate 5 (3), 241–251.

Capozza, Dennis R., Green, Richard K., Hendershott, Patric H., 1996. Taxes, mortgage borrowing, and residential land prices. In: Aaron, Gale (Eds.), Economic Effects of Fundamental Tax Reform. Brookings Institution, Washington, DC, pp. 171–198.

Case, Karl E., 2000. Real Estate and the macroeconomy. Brook. Pap. Econ. Act. 2, 119–145.

Catte, Pietro , Nathalie Girouard , Robert Price, Christophe André , 2004. Housing markets, wealth and the business cycle. OECD Economics Department Working Papers No. 394, Paris.

Cerutti, Eugenio, Dagher, Jihad, Dell'Ariccia, Giovanni, 2017. Housing finance and real estate booms: a cross-country perspective. J. Hous. Econ. 38, 1–13.

Cerutti, Eugenio M. , Stijn Claessens, Luc Laeven , 2015. The use and effectiveness of macroprudential policies: new evidence. IMF Working Paper No. 15/61.

Claessens, S., Kose, M.A., Terrones, M.E., 2012. How do business and financial cycles interact? J. Int. Econ. 87 (1), 178–190.

Collyns, Charles , Abdelhak Senhadji , 2002. Lending booms, real estate bubbles, and the asian crisis. IMF Working Paper 02/20, Washington, DC.

Crowe, Christopher, Giovanni Dell'Ariccia, Deniz Igan , Pau Rabanal , 2011. Policies for macrofinancial stability: options to deal with real estate booms. IMF Staff Discussion Note, SDN/11/02.

Davis, M., Heathcote, J., 2005. Housing and the business cycle. Int. Econ. Rev. 46 (3), 751–784.

De Wit, I., Van Dijk, R., 2003. The global determinants of direct office real estate returns. J. Real. Estate Financ. Econ. 26 (1), 27–45.

Doorn, V.L., Arnold, A., Rapoport, E., 2019. In the age of cities: the impact of urbanisation on house prices and affordability. In: Nijskens, R., Lohuis, M., Hilbers, P., Heeringa, W. (Eds.), Hot Property. Springer, Cham.

Duca, John V. , John Muellbauer , Anthony Murphy , 2010. House prices and credit constraints: making sense of the U.S. experience", Oxford University Working Paper.

Egert, Balázs, Dubravko Mihaljek , 2007., "Determinants of house prices in central and eastern Europe", BIS Working Paper No. 236, September.

Engsted, T., Pedersen, T.Q., 2015. Predicting returns and rent growth in the housing market using the rent-price ratio: evidence from the OECD countries. J. Int. Money Financ. 53, 257–275.

Fitzpatrick, Trevor, McQuinn, Kieran, 2004. House Prices and Mortgage Credit: Empirical Evidence for Ireland. Central Bank and Financial Services Authority of Ireland,.

Gertler, Mark, Gilchrist, Simon, 2018. What happened: financial factors in the great recession. J. Econ. Perspect. 32 (3), 3–30.

Goodhart, Charles , Boris Hofmann , 2008. "House Prices, Money, Credit and the Macroeconomy", ECB Working Paper No. 888.

Green, Richard, 1997. Follow the leader: how changes in residential and nonresidential investment predict changes in GDP. Real. Estate Econ. 25 (2), 253–270.

Green, Richard K., Vandell, Kerry D., 1999. Giving households credit: how changes in the U.S. tax code could promote homeownership. Reg. Sci. Urban Econ. 29 (4), 419–444.

Hendry, David F., 1984. Econometric modelling of house prices in the United Kingdom. In: Hendry, David F., Wallis, Kenneth F. (Eds.), Econometrics and Quantitative Economics. Basil Blackwell, Oxford, pp. 211–252.

Herring, R., Wachter, S., 2003. Bubbles in real estate markets. In: Hunter, William C., Kaufman, George G., Pomerleano, Michael (Eds.), Asset Price Bubbles: The Implications for Monetary, Regulatory, and International Policies. MIT Press, Cambridge.

Ho, Lok, Wong, Gary, 2008. The housing ladder and Hong Kong housing market's boom and bust cycle. Cent. Public Policy Stud Working Paper No. 190.

Hwang, Min, Quigley, John M., 2004. Selectivity, quality adjustment and mean reversion in the measurement of house values. J. Real. Estate Financ. Econ. 28, 161–178.

Iacoviello, M., 2005. House prices, borrowing constraints, and monetary policy in the business cycle. Am. Econ. Rev. 95 (3), 739–764.

Iacoviello, Matteo, Neri, Stefano, 2010. Housing market spillovers: evidence from an estimated dsge model. Am. Econ. J.: Macroecon. 2 (2), 125–164.

Igan, Deniz , Heedon Kang ,2011. "Do Loan-to-Value and Debt-to-Income Limits Work? Evidence from Korea", IMF Working Paper, WP/11/297.

International Monetary Fund, 2003. When the bubbles burst. World Economic Outlook. IMF,.

International Monetary Fund, 2011. Housing Finance and Financial Stability - Back to Basics? IMF, (Global Financial Stability Report, April 2011).

Ito, Takatoshi, 1993. The land/housing problem in Japan: a macroeconomic approach. J. Jpn. Int. Econ. 7 (1), 1–31.

Jiménez, Gabriel, Ongena, Steven, Peydró, José-Luis, Saurina, Jesús, 2012. Credit supply and monetary policy: identifying the bank balance-sheet channel with loan applications. Am. Econ. Rev. 102 (5), 2301–2326.

Jud, Donald, Winkler, Daniel, 2002. The dynamics of metropolitan housing prices. J. Real. Estate Res. 23 (1–2), 29–45.

Justiniano, Alejandro, Primiceri, Giorgio, E., Tambalotti, Andrea, 2019. Credit supply and the housing boom. J. Political Econ., vol. 127 (3), 1317–1350.

Kearl, James R., 1979. Inflation, mortgages, and housing. J. Political Econ. 87 (5), 1115–1138.

Kiyotaki, N., Moore, J., 1997. Credit cycles. J. Political Econ. 105 (2), 211–248.

Korinek, Anton, Simsek, Alp, 2016. Liquidity trap and excessive leverage. Am. Econ. Rev. 106 (3), 699–738.

Kuttner, Kenneth , Ilhyock Shim ,2012. Taming the real estate beast: the effects of monetary and macroprudential policies on housing prices and credit. Reserve Bank of Australia-BIS conference on property markets & financial stability, Sydney, August.

Lim, C.H. , F. Columba , A. Costa , P. Kongsamut , A. Otani , M. Saiyid , T. Wezel and X. Wu , 2011. Macroprudential policy: what instruments and how to use them? Lessons from country experiences. IMF Working Paper 11/238.

Loutskina, E., Strahan, P.E., 2015. Financial integration, housing, and economic volatility. J. Financ. Econ. 115 (1), 25–41.

Madsen, J., 2012. A behavioural model of house prices. J. Econ. Behav. Organ. 82 (1), 21–38.

Mankiw, N.G., Weil, D.N., 1989. The baby boom, the baby bust, and the housing market. Reg. Sci. Urban Econ. 19 (2), 235–258.

McCarthy, Jonathan, Peach, Richard, 2002. Monetary Policy Transmission to Residential Investment 8. Economic Policy Review, Federal Reserve Bank of New York,, pp. 139–158.

Mian, Atif, Sufi, Amir, 2009. The consequences of mortgage credit expansion: evidence from the U.S. mortgage default crisis. Q. J. Econ. 124 (4), 1449–1496.

Mian, Atif, Sufi, Amir, 2018. Finance and business cycles: the credit-driven household demand channel. J. Econ. Perspect. 32 (3), 31–58.

Morgan, Peter J. , Paulo José Regis , Nimesh Salike ,2015. Loan-to-value policy as a macroprudential tool: the case of residential mortgage loans in Asia", ADBI Working Paper Series, No. 528, May.
Orsmond, David , Fiona Price , 2016. "Macroprudential policy frameworks and tools", RBA Bulletin, Reserve Bank of Australia, pages 75–86, December.
Ortalo-Magné, François, Rady, Sven, 1999. Boom in, bust out: young households and the housing cycle. Eur. Econ. Rev. 43 (4–6), 755–766.
Ortalo-Magné, François, Rady, Sven, 2006. Housing market dynamics: on the contribution of income shocks and credit constraints. Rev. Econ. Stud. 73 (2), 459–485.
Ozge, Akinci, Olmstead-Rumsey, Jane, 2018. How effective are macroprudential policies? An empirical investigation. J. Financ. Inter. 33 (C), 33–57.
Poterba, James M., 1984. Tax subsidies to owner-occupied housing: an asset-market approach. Q. J. Econ. 99, 729–752.
Reinhart, C.M., Rogoff, K.S., 2009. This Time is Different: Eight Centuries of Financial Folly. Princeton University Press,, Princeton.
Reinhart, Carmen M., 2012. A Series of Unfortunate Events: Common Sequencing Patterns in Financial Crises. National Bureau of Economic Research,.
Richter, Bjorn , Moritz Schularick , Ilhyock Shim ,2018. The costs of macroprudential policy. NBER Working Paper 24989.
Seko, Miki, 2003. House-price dynamics and effects on the macro economy in housing markets and household behavior in Japan, pp. 7–31.
Shiller, Robert J., 2005. Irrational Exuberance, second ed. Princeton University Press,, Princeton, New Jersey.
Shiller, Robert J., 2008. The Subprime Solution. Princeton University Press, Princeton.
Stein, Jeremy, 1995. Prices and trading volume in the housing market: a model with down payment effects. Q. J. Econ. 110, 379–406.
Takats, Elod, 2012. Aging and house prices. J. Hous. Econ. 21 (2), 131–141.
Terrones, Marco E. ,Otrok, Christopher , 2004. The global house price boom", World Economic Outlook, September, pp.71–89.
Tressel, Thierry and Yuanyan S. Zhang , 2016. "Effectiveness and channels of macroprudential instruments: lessons from the Euro Area", IMF Working Papers 16/4.
Tsatsaronis, Kostas, Zhu, Haibin, 2004. What drives housing price dynamics: cross-country evidence". BIS Q. Rev.
Vandenbussche, J.érôme, Ursula Vogel, Enrica Detragiache ,2012. "Macroprudential policies and housing prices - a new database and empirical evidence for central, Eastern, and South-Eastern Europe", IMF Working Paper, WP/12/303, December.
Wen, Yi, 2001. Residential investment and economic growth. Ann. Econ. Financ. 2 (2), 437–444.
Wong, Eric , Tom Fong , Ka-fai Li , Henry Choi , 2011. Loan-to-value ratio as a macroprudential tools - Hong-Kong's experience and cross-country evidence. HKMA Working Paper, 01/2011 (Hong Kong: Hong Kong Monetary Authority).
Zan, Y., Wang, S., 2012. Permanent and transitory shocks in owner-occupied housing: a common trend model of price dynamics. J. Hous. Econ. 21 (4), 336–346.
Zhang, Longmei , Edda Zoli , 2014. Leaning against the wind: macroprudential policy in Asia", IMF Working Paper, WP/14/22.