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House Prices and Macroprudential Policies: Evidence from City-level Data in India

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Abstract

This paper examines the efficacy of macroprudential policies in addressing housing prices in a developing country while underscoring the importance of fundamental factors. The estimated models using city-level data for India suggest a strong influence of fundamental factors in driving housing prices. There is compelling evidence of the effectiveness of macroprudential tools viz., Loan-to-value (LTV) ratio, risk weights, and provisioning requirements, in influencing housing price movements. A granular analysis suggests an even stronger impact on housing prices of a change in the regulatory LTV ratio for large-sized vis-à-vis small-sized mortgages, which buttresses their potency in fighting house price speculations. A tightening of the risk weights on the housing assets of banks causes significant downward pressure on house prices. Similarly, regulatory changes in standard asset provisioning on housing loans also influence house prices.

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APPENDIX TABLES

I. INTRODUCTION

Housing asset is a key constituent of the household balance sheet, thus, the cyclical movements in house prices have a profound impact on the non-human wealth. Significant movements in house prices affect the stock of household wealth, which in turn, motivates the spending and borrowing decisions of households. Thus, from a macroeconomic perspective, house prices influence aggregate consumption and investment. The behavior of house prices also affects the stability of the financial system by impacting the profitability and balance sheet of banks and other financial intermediaries as mortgages constitute an important component of their asset portfolio.

In the housing market, demand shocks stemming from underlying macroeconomic factors can cause a surge in prices and create wealth effects given the relatively inelastic or sluggish supply curve. More specifically, a surge in speculative demand in a situation of inelastic short-run supply may lead to a rapid build-up of asset bubbles. Case and Shiller (2003) and Shiller (2005) highlighted the 'irrational exuberance' occurring in housing markets by revealing disparity between house prices and fundamental factors viz., population increases and building costs. Refinancing of mortgages available in developed markets also turns the wealth effect important in inducing the aggregate demand.[2] The procyclical increase in a household's ability to borrow may allow them to further augment housing spending, amplifying the collateral-based spending cycle (Almeida et al., 2006).

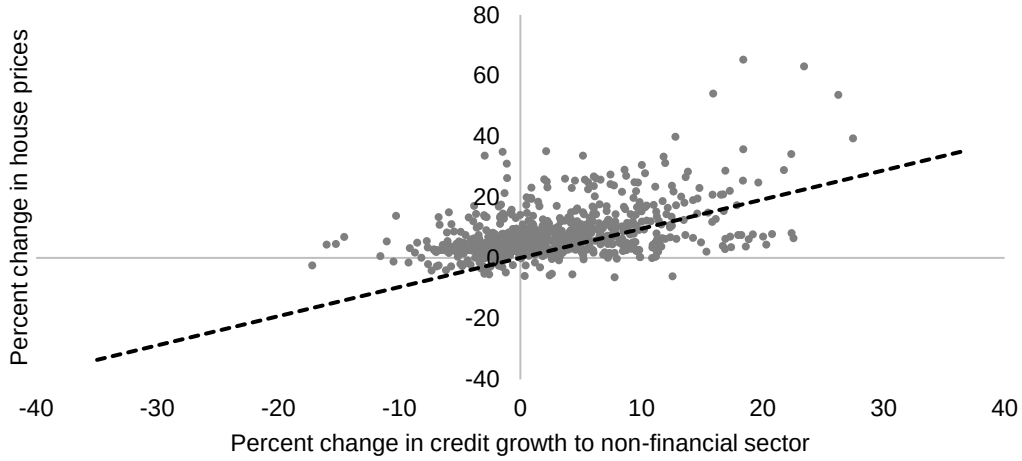
The last few decades have witnessed rapid urbanization and expansion of housing markets in developing countries. Urbanization leads to a higher rural-urban migration, which in turn leads to an outward shift in the demand curve for housing. In the low and middle-income countries, the share of urban population rose sharply from about 33 percent in the 1980s to 48 percent in the 2010s, exhibiting the largest rise in the urban population. The upper-middle-income countries experienced an even greater increase from 39 percent to 63 percent during the same period. The importance of asset prices in emerging market economies (EMEs) has significantly risen with the development of housing markets and greater participation of households. A comparison of house price movements in a few major EMEs before and after the global financial crisis reveals that significant growth in real house prices in the pre-financial crisis period was generally followed by sizeable deceleration or decline in the post-crisis period. This reinforces the belief of the existence of strong house price cycles in EMEs and the associated challenges for financial and macroeconomic stability.

The cross-country patterns provide important analytical foundations. A significant positive upward sloping curve in Figure 1, depicting the relationship between credit growth in the non-financial sector and house price growth across some large EMEs, underscores the importance of bank credit. Figure 2, more specifically, indicates a positive relationship

[2] Well-developed and liquid mortgage markets enable homeowners to withdraw equity against a rise in their property values and contribute to consumption booms in the economy.

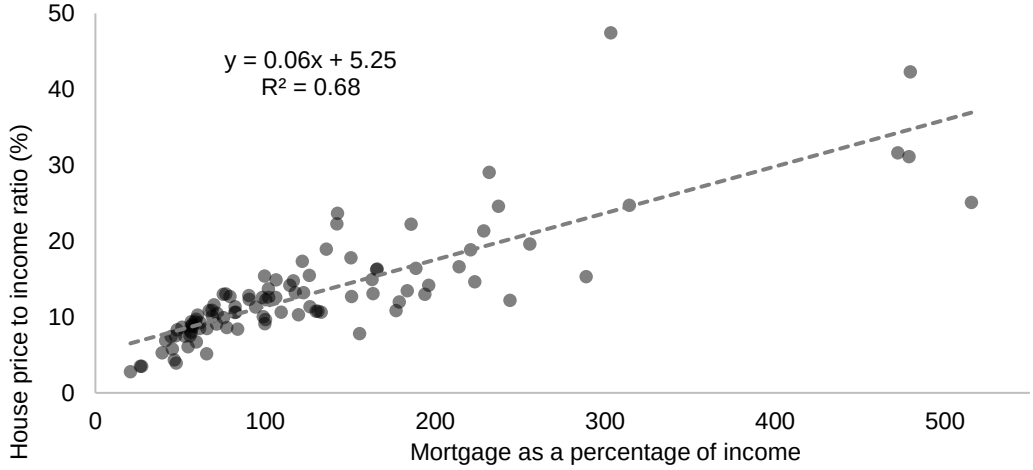
between housing prices and growth in mortgages across 101 advanced and developing countries. This suggests that greater access to mortgages raises household demand for housing assets, which in turn, may lead to higher prices.

Figure 1. Credit growth and house prices in emerging market economies
(15 major EMEs during the period 2000 Q1 to 2019:Q4)



Source: BIS database.

Figure 2. Access to mortgage and housing prices in advanced and developing countries
(Sample 101 countries)



Source: NUMBEO.

In this paper, we examine the effectiveness of macroprudential policies in influencing housing prices in a developing economy like India. Among the developing countries, India has been at the forefront in instituting countercyclical macroprudential tools to dampen the procyclicality in the financial system and addressing systemic risks. While giving due recognition to the long-run fundamental drivers of housing prices, our key motivation is to (a) explore the effectiveness of macroprudential policies in affecting house prices, after controlling for the fundamental drivers, and (b) examine the effectiveness of differential risk assigned on various mortgage sizes. This paper contributes to the empirical work by

utilizing granular city-level data on house prices and macroprudential tools. First, the novel databases of city-wise house prices in India are utilized to examine the effectiveness of macroprudential policies. Second, city-wise indicators viz., median LTV ratio, loan-to-income ratio and EMI ratio have also been utilized. Third, the paper uses granular data to examine the effectiveness of LTV ratio and risk weights prescribed for different sizes of mortgages on house prices. Section II assesses the theoretical literature to distill the role of major factors that influence the house price cycles as well as the relative efficacy of various macroprudential tools. An analytical framework has been formulated in Section III 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 IV. Section V analyses empirical results utilizing two separate novel databases on housing prices in India. Key findings are summarized in Section VI.

II. THEORY AND EMPIRICAL LITERATURE

The significance of housing and financial assets in macroeconomics and consumption theory is engrained in their role in influencing the lifetime wealth of households, which in turn, guides their consumption behavior, aggregate demand and business cycles. The household wealth and consumption relationship were articulated by the permanent income hypothesis (Friedman, 1957) and the life cycle hypothesis (Modigliani and Brumberg, 1954 and Ando and Modigliani, 1963). The life cycle theory assumes that households try to smooth out consumption over life-time based on the future expectations of income and wealth.[3] The asset pricing models, thus, have the central assumption that households engage in asset transactions for consumption smoothing and their decisions are guided by comparing the marginal benefit of current consumption against the expected asset returns. The main conduits of changes in household wealth are through changes in household preference for holding an asset and price movements.

As discussed earlier, housing wealth constitutes a predominant part of the households' asset portfolio and fluctuations in its value have implications for financial stability. Given the significance of asset prices in influencing household behaviour, increasing attention is being drawn to the related issue of understanding the sources of their fluctuations. In their pursuit to understand the factors driving the house price cycles, researchers have attempted to assess the role of macroeconomic fundamentals and some other plausible determinants. The early literature seems to generally focus on an assessment of house prices with the present value of rents, construction cost, and economic fundamentals viz., incomes, demography, labour market, bank credit, and mortgage cost. The co-movement of the housing market and the macroeconomy has been well documented (see Ito, 1993; Bowen, 1994; Green, 1997; Baffoe-Bonnie, 1998; Wen, 2001; Seko, 2003; Hwang and Quigley, 2004). Highlighting the intertwined nature and simultaneity in the relationship between

[3] The transmission from household wealth to consumption occurs mainly through two channels; first, drawing-down their assets to finance higher consumption and second, using housing collaterals to raises debt-financed consumption.

house prices and the macroeconomy, Jud and Winkler (2002) observe that real housing price appreciation is strongly influenced by macroeconomic variables, viz., population, real incomes, construction costs and interest rates. Case (2000) and Catte et al. (2004) also examine the transmission of macroeconomic shocks viz., unexpected changes in the credit supply and interest rate changes on house prices with a lag, conditional on the speed of the propagation mechanism. Adams and Fuss (2010) argue that given the short run inelastic house supply, an increase in economic activity leads to a rise in housing demand, which in turn leads to higher user costs and higher housing prices. Agnello and Schuknecht (2011) also find a higher probability of a housing boom associated with higher growth of personal income and conversely lower growth with a higher probability of a bust. Other factors highlighted are below-average long-run supply responsiveness, generous tax relief, and stricter rent control (Geng, 2018).

The demographic aspects viz., population, labour force, aging and migration, have, however, received lesser attention. The theoretical foundation of the relationship between demography and asset prices can be traced back to the celebrated permanent income hypothesis and life cycle hypothesis. The subsequent literature highlights a shift in demography as a key long-term determinant of house prices (Fitzpatrick and McQuinn, 2004; Terrones and Otrok, 2004; Ahearne et al, 2005; Egert and Mihaljek, 2007). Takáts (2012) also obtains a robust positive relationship between the size of the population and real housing prices. In developing countries, the phenomena of the rising working-age population may yield two types of demographic advantages. First, higher growth in the workforce relative to population growth may yield an improvement in per capita incomes and improve the affordability of housing assets. Second, greater workforce participation will directly result in reducing the high dependency ratio, generate greater savings, and consequently a higher pool of investible resources. For the emerging market and developing economies, Singh (2019) finds evidence of a strong positive impact of the increasing working-age population on real housing prices.

A widespread notion is that housing supply is highly elastic in the long run so that house price is determined by cost factors and housing quantity is determined by demand factors such as income and demographic characteristics (Blackely, 1999). Somerville (1999) find housing starts to be highly cost elastic. He observes that construction cost is endogenous in the housing supply function, and the cost shares of material and labour in the structure of new residences are approximately 65 and 35 percent, respectively. Blackely (1999) also finds strong long-run elasticity of about 0.8 of residential construction in response to changes in input prices.

Higher return on other substitutable assets in the household 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.

II.1 Credit, House Prices and Macroprudential Policies

While the macroeconomic factors largely shape the capacity of households and their housing purchase decisions, financial factors viz., credit conditions, and interest rate influence their access to mortgage markets to finance lumpy investments. Adams and Fuss (2010) argue that higher interest rates may turn the bond yields attractive thus, alter the opportunity cost of investing in real estate. Higher mortgage interest rates slow down the demand for housing credit and thus, adversely impact the house prices. Monetary policy changes influence the cost of wholesale funding for commercial banks, which in turn affects the cost of mortgage debt and the demand for housing credit. Taylor (2007) argues that the boom-bust in housing starts emanated from a significant deviation of the short-term interest rate path from the level thought to be appropriate.

The credit channel plays an important role in influencing the supply of new housing stock, housing prices, and housing wealth. The increasing financialization of housing markets, the role of mortgage credit, and leverage in financing housing investment have been associated with housing price boom-bust cycles. The larger share of housing loans in the asset portfolio of financial institutions has reinforced the credit and housing market nexus and thus attracted greater attention from policymakers. The availability of bank credit is identified as an important factor in steering house prices (Collyns and Senhadji, 2002; Fitzpatrick and McQuinn, 2004; Tsatsaronis and Zhu, 2004). The boom in real house prices, according to Reinhart (2012) is fuelled by ample domestic credit availability, large capital inflows, and an easy liquidity environment. In developing countries, the credit constraint faced by households is an important factor influencing their decision to acquire housing assets, which require lumpy capital. For EMEs, Singh and Nadkarni (2020) observe that while both the real stock prices and house prices rise in response to an expansionary credit shock, the impact is significant and persistent for house prices.

In recent decades, a rising share of housing mortgage markets in developing countries has led to a greater regulatory interest in understanding the role of financial factors in causing house price bubbles, which 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. Thus, the alternate policy paradigm viz., macroprudential framework, has evolved to respond to the credit and asset price boom-bust cycles. These measures protect the bank's balance sheet both during the boom period by restraining them from excessive lending that may turn into non-performing loans (NPLs) and during downturns by minimizing their losses. Several regulatory tools have evolved viz., loan-to-value (LTV) ratio, risk weights on housing loans in the calculation of capital-asset ratio, provisioning, or dynamic provisioning for loan losses on standard or sub-standard assets, and debt-to-income (DTI) ratio. The most commonly deployed regulatory measure is the LTV ratio that operates on the underlying principle of imposing a hard-borrowing constraint on households in their decision to borrow from banks. This ratio, in effect, aims to limit the borrowing against the asset collateralization within certain prudential limits to work as a countercyclical tool in the face of inflated asset prices, easy borrowing constraints, and excessive credit expansion. The LTV ratio can work as a potent tool to limit the home buyer's access to bank funding

and hence significantly mitigate the credit-fed house price booms. 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 credit-fed residential properties. These tools are truly countercyclical in the sense that they can be easily unwound during a recession in the housing market and can significantly enhance household access to credit, although their somewhat asymmetric effectiveness during the boom and bust cycles could be a limiting constraint.

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; Claessens et al., 2013; Cerutti et al., 2015; Morgan et al., 2015; Ozge and Olmstead-Rumsey, 2015), with ample evidence of a strong pattern of the positive relationship between LTV limits and house price changes. The findings of Lim et al. (2011) on the role of LTV ratio in reducing growth in credit and asset prices are also reinforced by findings of Wong et al. (2011) and Crowe et al. (2011). Vandenbussche et al. (2012) provide evidence of the effectiveness of macroprudential measures like capital ratio requirements and non-standard liquidity measures in achieving a slowdown in house price inflation. Some other studies also reach similar empirical conclusions (Igan and Kang, 2011; Jiménez et al., 2012). Kuttner and Shim (2012), Arregui et al. (2013)and Tressel and Zhang (2016) and Richter et. al. (2018) also highlight the appeal of macroprudential measures in dampening growth in housing credit and house prices. Zhang and Zoli (2014) underscore the importance of LTV ratio, DTI ratio, risk weights, and loan loss provisions in containing mortgage loan growth in Asia. Ozge and Olmstead-Rumsey (2018) suggest that only housing-related macroprudential policies constrain housing credit growth and house price appreciation. Alam et. al. (2019) observe strong and nonlinear effects on household credit of LTV changes as the effects of LTV tightening diminishes with the size of the adjustment, possibly due to policy leakage effects.

The literature, thus, tends to suggest that various macroprudential tools have evolved in response to housing boom-bust episodes. The literature mostly, if not unequivocally, suggests that macroprudential tools for the housing market are effective in limiting the excessive expansion in mortgage credit and tackling the risks of housing price boom-busts.[4]

III. ANALYTICAL FRAMEWORK

The portfolio choice life cycle model of optimal household behaviour suggests that in each period, households receive labour income and decide to optimally allocate their available resources across a set of consumption goods, financial assets, and durable goods, such as houses. Households derive utility from housing services (w^H) and other non-housing

[4] The empirical findings of Vandenbussche, et.al. (2012) and Duffy (2012), however, do not provide conclusive evidence of the effectiveness of the LTV ratio on housing prices.

consumption (w^{NH}). Thus, the intertemporal utility obtained in period τ from housing and non-housing goods and services can be expressed as,

$$U\,[\gamma\,(w^{H}{}_{\tau},\, w^{NH}{}_{\tau})] \quad (1)$$

The equilibrium in the housing market is determined by the market-clearing prices which yield the intersection of demand (D^H) and supply (S^H) curves. Thus, the market equilibrium can be reached when,

$$D^H f(Zi) = S^H f(Xi,\ Yi) \quad (2)$$

where, D^H = demand function for housing stock, *Zi* is a vector of demand-side covariates, S^H = supply function of housing, *Xi* is a vector of macroeconomic covariates of housing supply and *Yi* represents a vector of institutional factors that affect the housing supply. The factors that affect the housing demand over the long run are household disposable income; demographic characteristics such as size and density of urban population and the workforce participation rates; tax exemptions for investment in residential housing to promote ownership of dwellings; interest rates on mortgages; flexibility of debt financing; returns on other competing physical or financial assets. Given that housing supply by its very nature tends to be sluggish, demand assumes importance in determining short-run fluctuations. Among the fundamental supply-side factors that influence house prices are availability and cost of land, construction cost, tax incentives for promoting the supply of housing and regulatory framework for the housing sector. The macroprudential policies in the mortgage market viz., LTV ratio, DTI ratio and risk weightage for capital requirements for banks, etc. also have an impact on the housing market by altering the cost and quantity of credit and thus impacting the housing demand. Thus, a simple reduced-form model of house prices can be posited as,

$$\sum_{i=1}^{n} pHi(t) = \varphi \sum_{i=1}^{n} Zi(t) + \frac{1}{\lambda}\sum_{t=1}^{T} Xi(t) + \frac{1}{\theta}\sum_{t=1}^{T} Yi(t) \quad (3)$$

The *Zi* represents a vector of the demand side fundamental determinates of house prices viz., income, population and labour market indicators, bank credit, mortgage cost, and monetary policy rates, that will exert upward pressure on asset 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,

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

where, *y* = household income, *pop* = size of the city population, which also captures the labour 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 et al., 2008). A higher concentration of households in a city generates greater demand for housing for a limited number 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,

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

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, tends 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 them to undertake housing investments, which in turn, may lead to some upward pressure on house prices.

The important macroprudential covariates in the model are the prudential ceilings on the LTV ratio (*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 on the current market value of the property, increases the sensitivity of credit to housing market conditions and could lead to positive momentum in the demand. 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. Typically, given the theoretical setting of the role of macroprudential policies in navigating credit and asset prices, the following elasticities can be conceived,

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

For empirical estimation, 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,[5]

$$P_{it} = \sum_{j=1}^{k} \delta y_{i,t-j} + \gamma X_{it} + \theta Z_{it} + \phi \Pi_{it} + \upsilon_i + \varepsilon_{it,} \quad i = 1, \ldots k \text{ and } t = 1, \ldots, n \qquad (4)$$

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

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 and 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}; and ε_{it} are *i.i.d.* that comes from a low-order moving-average process, with variance $\sigma^2\varepsilon$.

IV. DATA ISSUES

A rich analysis of the housing sector in developing countries is constrained by the availability of granular data on housing prices and housing stocks. In India, there are a few databases on city-level housing prices, all of which are of relatively recent origin.[6] Based on their coverage, cross-sectional and time-series dimensions, a credible methodology, and the official or semi-official characteristics, 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. See Annex A1 for the sample coverage of the study.

The RBI's HPI is a weighted average price index using 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.[7] First, the simple average of houses in each category, classified by small, medium, and large for each ward/administrative zone in each quarter based on the floor space area (FSA) is calculated. 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 the weights. Next, 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.[8]

The RBI also conducts a quarterly Residential Asset Price Monitoring Survey (RAPMS) since July 2010 for housing loans disbursed by select banks/housing finance companies

[6] Other databases on house price databases in India, include the Knight Frank residential property price index, which covers eight major cities viz., Mumbai, National Capital Region Delhi, Bengaluru, Pune, Chennai, Hyderabad, Kolkata and Ahmedabad. The index starts with the base 2013 and is compiled based on its market survey focusing on the property type. The other databases on housing prices based on market research or surveys are Liases Foras, Cushman and Wakefield, and Jones Lang Lasalle. A lack of adequate information on their methodology and coverage and their recent origin limits their use for a robust statistical analysis.

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

[8] The following formula is used for constructing the city-wise price indices for each category (small, medium and large) for t^{th} quarter: $HPItj = \Sigma(RPijt*wj)$, where i = category of the house (small/medium/ large) and n = number of ward/zone in each city. The city-wise price indices for each of the categories are averaged using the population proportion of the ten cities to its total to obtain the all-India index.

(HFCs) across 13 major cities.[9] The survey collects the following indicators on the housing market (i) loan to value (LTV) ratio;[10] (ii) EMI-to-income (ETI) ratio; (iii) house price to income (HPTI) ratio;[11] 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/UT capitals. Annex A.1 presents the list of cities used in the sample and their population size. Three indices viz. registered prices, assessment prices and market prices for under-construction properties use different sources to provide the entire spectrum of prevailing prices at the city level. The registration data are collected from the Sub-Registrar Offices (SROs) of States/UTs for registered prices; valuation data collected from primary lending institutions for the assessment prices; and primary and secondary data collected through a market survey for the market prices for under-construction properties.

The following variables have been used in this study. RBI's house price index for 10 major cities with 2010-11 as the base; NHB's house price index for 33 major cities with 2017-18 as the base; real district/state domestic product (SDP) per capita (SDP used for a particular city for which domestic product data are not available); real house price index (i.e., house price index of a city deflated by CPI index for the respective city/state);[12] city population size in millions; construction cost index with the base year 2011-12; state-wise CPI for housing to capture housing rent; average per account domestic commercial bank loans for residential housing; weighted average interest rate on housing loans of commercial banks; relative stock price index, i.e., index of stock prices relative to the RBI's HPI (i.e., BSE Sensex or Nifty ÷ HPI * 100); relative stock price index, i.e., index of stock prices relative to the NHB's Residex (i.e., BSE Sensex or Nifty ÷ Residex * 100); RBI's policy repo rate; median LTV ratio for housing loans in India; LTV ratio for large-size loans; LTV ratio for small size loans;[13] asset provisioning ratio on housing loans of commercial banks; median loan to income (LTI) ratio; 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 a select number of Indian cities for which CEIC releases the index. For the remaining cities in our sample, we construct a

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

[10] 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. Typically, this ratio is found to increase when the homeowner takes a second mortgage or home equity loan using the accumulated home equity as collateral. Thus, a ratio >1 indicates the negative equity of the homeowner.

[11] The house price to income ratio signifies the affordability of housing. It is generally represented as the ratio of median house prices to median disposable incomes of homebuyers, typically expressed as a percentage or as years of income. This forms a key component of mortgage lending decisions.

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

[13] In the 2017 guidelines of the Reserve Bank of India on LTV ratio for various loans categories, the small-sized loans corresponds to the lowest slab of loans up to Rs. 3 million and the large-sized loans relate to loans of Rs. 7.5 million or more.

construction cost index as a weighted index of materials used in construction viz., metallic mineral products, and non-metallic mineral products. A limitation of such an index is the lack of cost of land, information on which is scant. Nevertheless, the index provides the best available proxy for the construction cost. The nominal variables have been deflated using the CPI index.

The data used in the present study are annual data for the period 2008-09 to 2018-19. For some variables, the data are available at a monthly or quarterly frequency and 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. Annex A2 provides a detailed list of variables, definitions, cross-section and time dimensions.

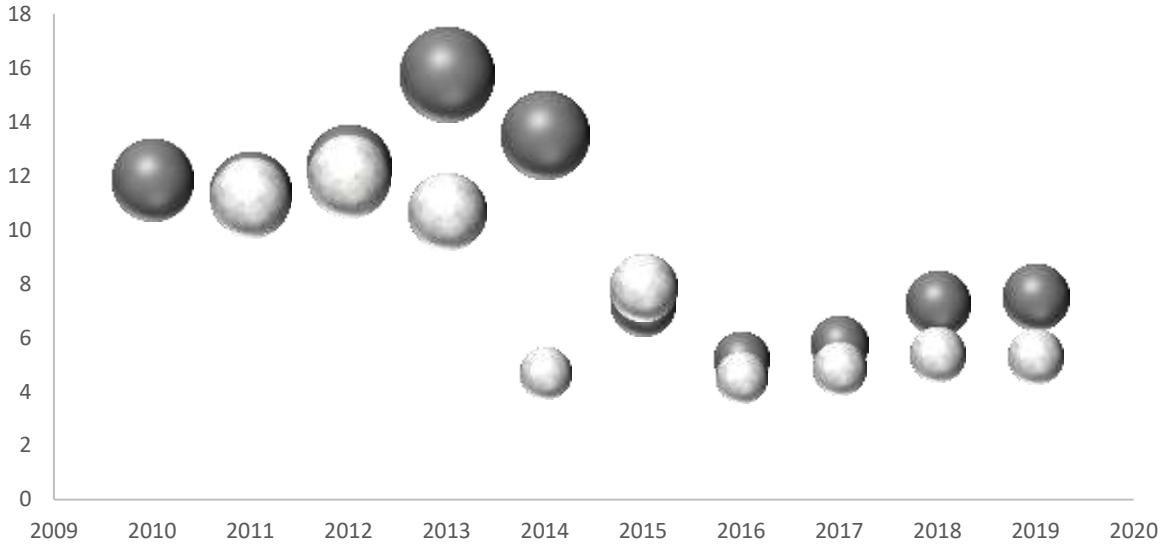
V. EMPIRICAL RESULTS

V.1 Stylized Facts

India, like many other EMEs, has also exhibited a significant rise in the degree of urbanization from 23 percent to 34 percent between 1980 and 2018. The portfolio allocation of households across asset categories in India, based on the National Sample Survey Office (2014) suggests that buildings and housing constitute about 45 percent of the total asset holdings of urban households. 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 would have much larger wealth effects and can cause greater business cycle fluctuations.

The importance of housing assets in India is evident from the household fixed investment in dwellings, buildings and structures, constituting a significant share (about 30 percent) of the real gross fixed capital formation in the economy during the last few years. Regarding the banking sector linkages, the housing loan portfolio of commercial banks in India constitutes about 15 percent of their total loan portfolio. In the post-global financial crisis period, nominal house price growth remained largely above the nominal income growth for the most part ending 2015-16, indicating a worsening of house price income ratio, i.e., affordability. A significant shift is evident thereafter with house price growth remaining below the growth rate of nominal income. The dispersion in house price growth across cities has significantly narrowed down over time for both the RBI and NHB house price indices, which could also be attributed to the convergence in the movement of underlying drivers of house prices across cities (Figure 3).

Figure 3. Dispersion in the growth of house prices across Indian cities
(Standard deviation of nominal house prices – period 20010 to 2019)



Source: Author's computation.

In recent decades, the rapid development of formal housing and mortgage markets is accompanied by greater participation of banks and non-banks, which has also drawn greater attention to the nexus between credit and house prices from the perspective of property boom-bust cycles. As an offshoot to these developments, 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 the housing sector (see Annex A4). In the Indian context, Sinha (2011) has argued that time-varying risk weights and provisioning norms on standard assets for specific sectors had the desired effect in moderating the credit boom both through signaling effect and the cost of credit.

V.2 Results from House Price Models based on the RBI's Housing Price Index

For the empirical estimation of various specifications of the panel estimators, we use panel data for a cross-section of cities in India spanning 2008-09 to 2018-19. The summary statistics of the variables used in the model are presented in Annex A3.

V.2.1 Nominal House Prices – Fundamental Drivers and the Macroprudential Policies

Goodhart and Hofmann (2008) underscore the importance of nominal shocks in explaining house price dynamics. Following this approach, we first estimate the nominal house price models. All the estimated models are found to be robust. The detailed results obtained from

dynamic panel data (DPD) estimators and the related diagnostics are provided in Appendix Tables A1 and A2. The unrestricted lag structures of the DPD estimators is 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 for zero autocorrelation in first-differenced errors does not reject the null hypothesis of no second-order serial correlation. The definitions of the variables used in the empirical models are presented in Annex A2.

For the sake of brevity, empirical results based on alternative specifications are summarized in Table 1. It is well understood that higher-income growth raises the lifetime wealth of individuals and enhances their capacity to undertake greater debt service payments and raises their ability to make fresh investments.[14] The finding 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 behaviour of house prices. The demographic impact captured through the size of the urban population of a city 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. 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 to a lower level of the housing stock. The relatively sizeable magnitude of the construction cost indicates that the housing market is supply-constrained and a small slowdown in the supply can lead to more than a proportionate increase in nominal house prices.

Given the increasing share of mortgage financing, bank credit plays an important role in influencing 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 and also the housing prices. Sutton (2002) and Tsatsaronis and Zhu (2004) argue that nominal interest rates perform better than real interest rates in explaining house prices, given that banks typically decide to grant a housing loan based on the ratio of debt servicing costs to income, which depends on the nominal and not the real rate.

Among the key macroprudential tools with the central banks or other regulatory authorities, loan-to-value (LTV) is used by lenders to determine the level of risk that can be taken for a secured loan. Our estimates suggest that a 10-percentage point loosening of the median LTV ratio leads to an average 4-7 percent increase in nominal house prices by way of a direct impact on the credit supply. The estimates for the US economy by Duca et al. (2010) suggest that a 10-percentage point increase in LTV ratio yields about an 8-11 percent increase in house prices. Similarly, Crowe et al. (2011), observe that a 10-

[14] Higher per capita income generates a perception of higher lifetime income growth and increases the capacity of households to spend a larger share of income on housing.

percentage point increase in maximum LTV allowed by regulations is associated with a 13 percent increase in nominal house prices for a cross-section of developed countries. It is interesting to note that the effect of a unit increase in the LTV ratio on large-sized loans is found to be significantly greater than the effect of an increase in the LTV ratio for small-sized loans. 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 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 has an important role in reinforcing the nexus between credit markets and house prices.

Table 1. Summary results of the panel data estimators for nominal house prices based on the RBI's House Price Index (HPI)

Variables	Arellano–Bond	Blundell–Bond
Log of nominal HPI(t-1)	0.29	0.30
Log of the city real per capita income(t-1)	0.33	0.16
Log of the city population (t-1)	0.53	0.16
Log of nominal construction cost Index	1.10	1.31
Log of nominal construction cost Index (t-1)	0.83	1.11
Log of housing rentals	0.46	0.36
Log of the ratio of BSE Sensex to nominal HPI	-0.63	-0.55
Log of per account nominal bank credit for residential housing	0.14	
Log of per account nominal bank credit for residential housing(t-1)	0.23	0.15
Real weighted average interest rate on banks' housing loans (t-1)	-0.07	-0.07
RBI's policy rate	-0.02	-0.04
Log of sample median LTV ratio on bank's housing loans	0.40	0.69
Log of regulatory LTV ratio on banks' large-sized housing loans	1.03	0.94
Log of regulatory LTV ratio on banks' small-sized housing loans	0.55	0.70
Log of regulatory risk weights on the banks' housing loans	-0.14	-0.14
Log of regulatory risk weights on the banks' housing loans (t-1)	-0.21	-0.21
Log of median housing loan-to-income (LTI) ratio	0.51	0.81
Log of housing EMI-to-income ratio	-0.40	-0.63
Log of asset provisioning for banks' standard housing assets	-0.20	-0.13

Note: Coefficients presented in the table represent the average of coefficients obtained from alternative specifications presented in Appendix Tables A1 and A2.
All coefficients are significant at the 5% level.

As a robustness check, alternative specifications based on the panel fixed-effects models are presented in Appendix Table A5. The conclusions are broadly similar to the dynamic panel data estimators.

V.2.2 Real House Price Dynamics and the Effectiveness of Macroprudential Policies

The constant real house prices do not necessarily signify constant nominal house prices as house prices and prices of goods and services may be rising at the same pace (Nakajima, 2011). The results from the estimated FE estimators summarized in Table 2 and the detailed results reported in Appendix Tables A3 and A4 reveal that all the demand-side variables are highly significant in driving real house prices. The lagged real house prices have a significant impact on real house prices, reemphasizing the role of backward-looking house price expectations. The liquidity effect, imbedded in personal incomes, is also found to be significant. The credit supply and mortgage interest rates also play an important role in driving real house prices. The relative return on housing prices over the stock prices – a demand-side variable indicating substitution effect – has a dominant effect on real 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.[15]

Table 2. Summary results of the panel data estimators for real house prices based on the RBI's House Price Index

Variables	Arellano–Bond	Blundell–Bond
Log of real HPI (t-1)	0.24	0.36
Log of city real per capita income (t-1)	0.25	0.25
Log of the city population (t-1)	0.40	0.12
Log of real construction cost Index		0.96
Log of real construction cost Index (t-1)	0.29	0.91
Log of real housing rentals	0.33	0.39
Log of the ratio of real BSE Sensex to real HPI	-0.57	-0.55
Log of real per account nominal bank credit for residential housing	0.15	0.14
Log of real per account nominal bank credit for residential housing (t-1)		0.18
Real weighted average interest rate on banks' housing loans	-0.01	-0.02
RBI's real policy rate	-0.03	-0.02
RBI's real policy rate (t-1)	-0.02	
Log of sample median LTV ratio on bank's housing loans	0.41	0.44
Log of sample median LTV ratio on bank's housing loans (t-1)	0.42	
Log of regulatory LTV ratio on banks' large-sized housing loans	1.10	1.14
Log of regulatory LTV ratio on banks' small-sized housing loans	0.40	0.59
Log of regulatory risk weights on the banks' housing loans	-0.15	-0.14
Log of regulatory risk weights on the banks' housing loans (t-1)		-0.15
Log of median housing loan-to-income (LTI) ratio	0.45	
Log of median housing loan-to-income (LTI) ratio (t-1)		0.56
Log of housing EMI-to-income ratio	-0.70	
Log of asset provisioning for banks' standard housing assets		-0.16
Log of asset provisioning for banks' standard housing assets	-0.10	

Note: Coefficients presented in the table represent the average of coefficients obtained from alternative specifications presented in Appendix Tables A3 and to A4.
All coefficients are significant at the 5% level.

[15] 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).

The macroprudential tools viz., LTV ratio, risk weights and asset provisioning had a strong impact on housing prices. The effect of an LTV policy with differentiating LTV ratio in driving real house prices is vividly reinforced by a relatively smaller impact of a change in LTV ratio for the small-sized loans (0.40-0.59) vis-à-vis large-seize loans (1.10-1.14). A tightening of other macroprudential measures, viz., risk weights, and asset provisioning, also have a significant moderating impact on house prices. A rise in loan leverage ratio also leads to significant movements in real house prices and so is the case with the affordability indicator, which is captured by the EMI ratio. Thus, empirical results vividly bring out the efficacy of macroprudential policies as a countercyclical tool.

The robustness checks carried out by estimating a suit of fixed effects estimators in Appendix Table A6, yield broadly similar results.

V.3 Results from Housing Price Models based on the NHB's Residex

To validate the above conclusions, we further examine the role of macroprudential policies, utilizing a broader dataset of house prices of the National Housing Bank for 33 cities for the period 2010-2019.

V.3.1 Nominal House Price Dynamics and the Role of Macroprudential Policies

In what follows, we discuss results obtained from alternative specifications of dynamic panel data estimators, utilizing one-step and two-step estimators. For testing overidentifying restrictions, we use the Sargan test statistics which validates our instruments. Detailed results based on alternative specifications with the diagnostic tests are presented in Appendix Tables A7 and A8 and the estimates from the robustness exercises, using fixed-effect models, are presented in Appendix Table A11.

The results indicate a significant lag effect of nominal house prices in shaping house price movements. The demand-side variables viz., per capita income, city population, bank credit, and mortgage rates are found to have a significant effect on house prices (Table 3). A relative increase in stock price ratio 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 rising 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.

Housing prices also respond significantly negatively to the slackening/tightening of macroprudential tools viz., LTV ratio, risk weights, and asset provisioning, with a strong lagged effect of changes in these tools. The estimators also reinforce the role of a differentiating LTV policy, with much higher effects of a change in the regulatory LTV ratio for the large-sized loans on housing prices vis-à-vis their small size counterparts. We

also observe a strong negative effect of a rise in EMI, i.e., worsening affordability, on house prices. Rising loan leverage in the housing market also tends to push up housing prices.

Table 3. Summary results of the panel data estimators for nominal house prices based on the NHB's Residex

Variables	Arellano–Bond	Blundell–Bond
Log of nominal HPI(t-1)	0.29	0.42
Log of city real per capita income(t-1)	0.28	0.21
Log of city population (t-1)	0.29	
Log of nominal construction cost Index	0.59	0.67
Log of nominal construction cost Index (t-1)	0.49	0.59
Log of housing rentals	0.22	0.13
Log of the ratio of BSE Sensex to nominal HPI	-0.59	-0.41
Real weighted average interest rate on banks' housing loans	-0.05	-0.01
Real weighted average interest rate on banks' housing loans (t-1)	-0.02	
RBI's policy rate	-0.02	-0.04
Log of sample median LTV ratio on bank's housing loans	0.40	0.66
Log of regulatory LTV ratio on banks' large-sized housing loans	0.59	0.60
Log of regulatory LTV ratio on banks' small-sized housing loans	0.37	0.20
Log of regulatory risk weights on the banks' housing loans	-0.14	-0.14
Log of regulatory risk weights on the banks' housing loans (t-1)	-0.15	-0.11
Log of median housing loan-to-income (LTI) ratio	0.57	0.58
Log of housing EMI-to-income ratio	-0.75	
Log of housing EMI-to-income ratio(t-1)	-0.31	-0.25
Log of asset provisioning for banks' standard housing assets	-0.17	-0.11

Note: Coefficients presented in the table represent the average of coefficients obtained from alternative specifications presented in Appendix Tables A7 and A8.
All coefficients are significant at the 5% level.

V.3.2 Real House Price Dynamics and the Role of Macroprudential Policies

Based on a wider cross-section of the NHB Residex database, the alternative specifications are presented in Appendix Tables A9 to A10 and summarized in Table 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 lending. We also find evidence of a contemporaneous strong impact (-0.51) of a relative asset price shock (i.e., rise in stock price relative to house price) on house price movements, indicating the presence of a strong asset substitution effect. A rise in the construction cost, a measure of a supply shock, can influence the cost of housing and house supply, which in turn, has a strong positive impact on housing prices. The impact of a supply shock becomes more pronounced in markets where supply responds in a relatively sluggish manner to housing demand.

Table 4. Summary results of the panel data estimators for real house prices based on the NHB's Residex

Variables	Arellano–Bond	Blundell–Bond
Log of real house price(t-1)	0.31	0.42
Log of city real per capita income(t-1)	0.28	0.21
Log of the city population	0.60	
Log of real construction cost Index	0.37	0.55
Log of real construction cost Index(t-1)	0.63	0.65
Log of real housing rentals	0.25	0.15
Log of the ratio of real BSE Sensex to real house price	-0.51	-0.51
Log of real per account nominal bank credit for residential housing	0.12	0.12
Real weighted average interest rate on banks' housing loans	-0.01	-0.01
Real weighted average interest rate on banks' housing loans(t-1)	-0.01	
RBI's real policy rate	-0.02	-0.01
RBI's real policy rate(t-1)	-0.02	-0.02
Log of sample median LTV ratio on bank's housing loans	0.56	0.73
Log of regulatory LTV ratio on banks' large-sized housing loans	0.76	0.80
Log of regulatory LTV ratio on banks' small-sized housing loans	0.50	0.41
Log of regulatory risk weights on the banks' housing loans	-0.11	-0.16
Log of regulatory risk weights on the banks' housing loans(t-1)	-0.13	-0.17
Log of median housing loan-to-income (LTI) ratio	0.18	0.74
Log of housing EMI-to-income ratio	-0.40	
Log of housing EMI-to-income ratio(t-1)		-0.23
Log of asset provisioning for banks' standard housing assets		-0.12
Log of asset provisioning for banks' standard housing assets	-0.10	

Note: Coefficients presented in the table represent the average of coefficients obtained from alternative specifications presented in Appendix Tables A9 and A10.
All coefficients are significant at the 5% level.

A positive real monetary policy shock on house prices is found to be significant, though, the effect is relatively small as compared to other macroeconomic factors. Among the macroprudential tools, the impact of the LTV ratio is found to be most dominant. The results also reinforce the larger effect on real house prices of a unit increase in the maximum LTV ratio prescribed for the large-sized housing loans compared to the effect of the LTV ratio for 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. 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.

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 Appendix Table A11 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.

As part of the robustness exercise, we provide the results based on fixed effect estimators in Appendix Table A13, yielding broadly similar conclusions.

VI. 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 conduct the empirical investigation using two novel databases on city-level housing prices in India, which broadly reinforce similar conclusions. Among the key macroeconomic determinants, per capita income significantly influences house prices. Both the nominal and real 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. 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. Mortgage credit is also an important factor influencing movements in housing prices. Construction cost continues to be 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 ratio as the most potent tool to respond to housing price fluctuations. A theme emerging from all the estimators is that a change in the maximum LTV ratio for large-size loans has a much more dominant effect on house prices compared to a change in the LTV ratio 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. 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 both nominal and real housing prices. Similarly, standard asset provisioning on banks' housing loans also significantly affects house prices. Additionally, there is evidence of a robust effect of these regulatory measures on credit demand, which in turn, have impactions on housing prices. 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 lead to greater procyclicality in the housing market and hence opens up the scope for a larger role for 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.

References

Adams, Zeno and Roland Fuss (2010), "Macroeconomic determinants of international housing markets", *Journal of Housing Economics*, 2010, 19(1), pp. 38-50.

Agnello, Luca and Ludger Schuknecht (2011), "Booms and busts in housing markets: Determinants and implications," *Journal of Housing Economics*, 20(3), pp. 171-190, September.

Ahearne, Alan G., John Ammer, Brian M. Doyle, Linda S. Kole, and 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.

Almeida, Heitor, Murillo Campello and Crocker Liu (2006), "The Financial Accelerator: Evidence from International Housing Markets," *Review of Finance*, 10(3), pp. 321-352.

Ando, Albert and Franco Modigliani (1963), "The 'life-cycle' hypothesis of saving: aggregate implications and tests," *American Economic Review*, 53(1), pp. 55-84.

Arregui, Nicolas, Jaromír Benes, Ivo Krznar, Srobona Mitra and 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," *Journal of Real Estate Finance and Economics*, 17(2), pp. 179-97.

Blackley, Dixie M. (1999), "The Long-Run Elasticity of New Housing Supply in the United States: Empirical Evidence for 1950 to 1994," *The Journal of Real Estate Finance and Economics*, 18, pp. 25-42.

Bowen, Alex (1994), "Housing and the macroeconomy in the United Kingdom," *Housing Policy Debate*, 5(3), pp. 241-51.

Case, Karl E. (2000), "Real Estate and the macroeconomy," *Brookings Papers of Economic Activity*, 2, pp. 119-145.

Case, Karl E. and Robert J. Shiller (2003), "Is There a Bubble in the Housing Market?" *Brookings Papers on Economic Activity*, 34(2), pp. 299-362.

Catte, Pietro, Nathalie Girouard, Robert Price and Christophe André (2004), "Housing Markets, Wealth and the Business Cycle", OECD Economics Department Working Papers No. 394, Paris.

Cerutti, Eugenio M, Stijn Claessens and Luc Laeven (2015), "The Use and Effectiveness of Macroprudential Policies: New Evidence," IMF Working Paper No. 15/61.

Claessens, Stijn and Ayhan Kose (2013), "Financial Crises Explanations, Types, and Implications," IMF Working Papers 13/28, International Monetary Fund.

Collyns, Charles and 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 and Pau Rabanal (2011), "Policies for Macrofinancial Stability: Options to Deal with Real Estate Booms," IMF Staff Discussion Note, SDN/11/02.

Duca, John V., John Muellbauer, and Anthony Murphy (2010), "House Prices and Credit Constraints: Making Sense of the U.S. Experience," Oxford University Working Paper.

Duffy, David (2012), "Irish Housing: A Role for Loan-to-Value Limits?" Renewal Series Paper 7, The Economic and Social Research Institute, Dublin, February.

Egert, Balázs and Dubravko Mihaljek (2007), "Determinants of House Prices in Central and Eastern Europe," BIS Working Paper No. 236, September.

Fitzpatrick, Trevor and Kieran McQuinn (2004), "House Prices and Mortgage Credit: Empirical Evidence for Ireland," Research Technical Paper 5/RT/04, Central Bank and Financial Services Authority of Ireland.

Friedman, Milton (1957), A Theory of the Consumption Function. Princeton: Princeton University Press.

Geng, Nan (2018), "Fundamental Drivers of House Prices in Advanced Economies," International Monetary Fund WP/18/164 IMF Working Paper.

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

Green, Richard (1997), "Follow the leader: how changes in residential and nonresidential investment predict changes in GDP," *Real Estate Economics*, 25(2), 253-70.

Ho, Lok and Gary Wong (2008), "The Housing Ladder and Hong Kong Housing Market's Boom and Bust Cycle," Centre for Public Policy Studies, Lingnan University, Working Paper No. 190.

Jung, Hosung and Jieun Lee (2017), "The effects of macroprudential policies on house prices: Evidence from an event study using Korean real transaction data," *Journal of Financial Stability*, 31, pp. 167-185.

Igan, Deniz and 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 (2011), "Housing Finance and Financial Stability - Back to Basics?" Global Financial Stability Report, April 2011, IMF.

Ito, Takatoshi (1993), "The land/housing problem in Japan: a macroeconomic approach," *Journal of the Japanese and International Economies*, 7(1), pp. 1-31.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró and Jesús Saurina (2012), "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications," *American Economic Review*, 102(5), pp. 2301-2326.

Jud, Donald and Daniel Winkler (2002), "The Dynamics of Metropolitan Housing Prices," *Journal of Real Estate Research*, 23(1-2), pp. 29-45.

Kuttner, Kenneth and Ilhyock Shim (2012), "Taming the real estate beast: the effects of monetary and macroprudential policies on housing prices and credit", proceedings of the Reserve Bank of Australia-BIS conference on Property markets and financial stability, Sydney, Australia, 20–21 August 2012, pp. 231-259.

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.

Modigliani, Franco and Richard Brumberg (1954), "Utility analysis and the consumption function: an interpretation of cross-section data", pp. 388–436, in Kenneth K. Kurihara, edited, Post-Keynesian Economics, New Brunswick, NJ. Rutgers University Press.

Morgan, Peter J., Paulo José Regis and 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.

Nakajima, Makoto (2011), "Understanding house-price dynamics," *Business Review* (Federal Reserve Bank of Philadelphia), 2, pp. 20-28.

National Sample Survey Office (2014), Key Indicators of Debt and Investment in India, NSS 70th Round 2013 (January - December 2013).

Orsmond, David and Fiona Price (2016), "Macroprudential Policy Frameworks and Tools," RBA Bulletin, Reserve Bank of Australia, pages 75-86, December.

Ortalo-Magné, François and Sven Rady (1999), "Boom In, Bust Out: Young Households and the Housing Cycle," *European Economic Review*, 43(4-6), pp. 755–766.

Ortalo-Magné, François and Sven Rady (2006), "Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints." *Review of Economic Studies*, 73(2), pp. 459-485.

Ozge, Akinci, and Jane Olmstead-Rumsey (2018), "How effective are macroprudential policies? An empirical investigation," *Journal of Financial Intermediation*, 33(C), pp. 33-57.

Reserve Bank of India (2017), Report of the Internal Study Group to Review the Working of the Marginal Cost of Funds Based Lending Rate System, Reserve Bank of India.

Reinhart, Carmen M. (2012), "A Series of Unfortunate Events: Common Sequencing Patterns in Financial Crises," NBER Working Papers 17941, National Bureau of Economic Research.

Richter, Bjorn, Moritz Schularick, and 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 (2nd ed.), Princeton University Press, Princeton, New Jersey.

Singh, Bhupal (2019, "Demographic transition and asset prices: Evidence from developing countries," *International Finance*, 22, pp. 53-69.

Singh, Bhupal and Avadhoot R. Nadkarni (2020), "Role of credit and monetary policy in determining asset prices: Evidence from emerging market economies," *North American Journal of Economics and Finance*, 51, pp. 1-20.

Sinha, Anand (2011), "Macroprudential policies – Indian Experience," Address at Eleventh Annual International Seminar on Policy Challenges for the Financial Sector, Co-hosted by the Board of Governors of the Federal Reserve System, International Monetary Fund and the World Bank, Washington D.C., June 1-3, 2011.

Somerville, C. Tsuriel (1999), "Residential Construction Costs and the Supply of New Housing: Endogeneity and Bias in Construction Cost Indexes," *The Journal of Real Estate Finance and Economics*, 18, pp. 43–62.

Stein, Jeremy (1995), "Prices and Trading Volume in the Housing Market: A Model with Down payment Effects," *Quarterly Journal of Economics*, 110(2), pp. 379-406.

Sutton, Gregory D. (2002), "Explaining changes in house prices", BIS Quarterly Review, September.

Takats, Elod (2012), "Aging and house prices", *Journal of Housing Economics*, 21(2), pp. 131-141.

John B. Taylor (2007), "Housing and Monetary Policy," NBER Working Papers 13682, National Bureau of Economic Research.

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 and Haibin Zhu (2004), "What drives housing price dynamics: cross-country evidence", BIS Quarterly Review, March.

Vandenbussche, Jérôme, Ursula Vogel and 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," *Annals of Economics and Finance*, 2(2), pp. 437-44.

Wong, Eric, Tom Fong, Ka-fai Li and 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).

Zhang, Longmei and Edda Zoli (2014), "Leaning Against the Wind: Macroprudential Policy in Asia," IMF Working Paper, WP/14/22.

Annex A1. Sample of cities in house price database and their population

City	NHB House Price Index	RBI House Price Index	Population (in thousand)
Ahmedabad	√	√	7,681
Bangalore	√	√	11,440
Bhopal	√		2,278
Bhubaneshwar	√		1,100
Chandigarh	√		1,110
Chennai	√	√	10,456
Coimbatore	√		2,641
Dehradun	√		871
Delhi	√	√	28,514
Gandhinagar	√		356
Guwahati	√		1,083
Hyderabad	√	√	9,482
Indore	√		2,822
Jaipur	√	√	3,717
Kanpur	√	√	3,081
Kochi	√	√	2,858
Kolkata	√	√	14,681
Lucknow	√		3,505
Ludhiana	√		1,806
Meerut	√		1,636
Mumbai	√	√	19,980
Nagpur	√		2,808
Nashik	√		1,952
Patna	√		2,352
Pune	√		6,276
Raipur	√		1,521
Rajkot	√		1,767
Ranchi	√		1,370
Surat	√		6,564
Thiruvananthapuram	√		2,369
Vadodara	√		2,110
Vijayawada	√		1,911
Visakhapatnam	√		2,076

Source: RBI; NHB; UN Population Statistics database.

Annex A2. Definition of variables, sample period and data sources

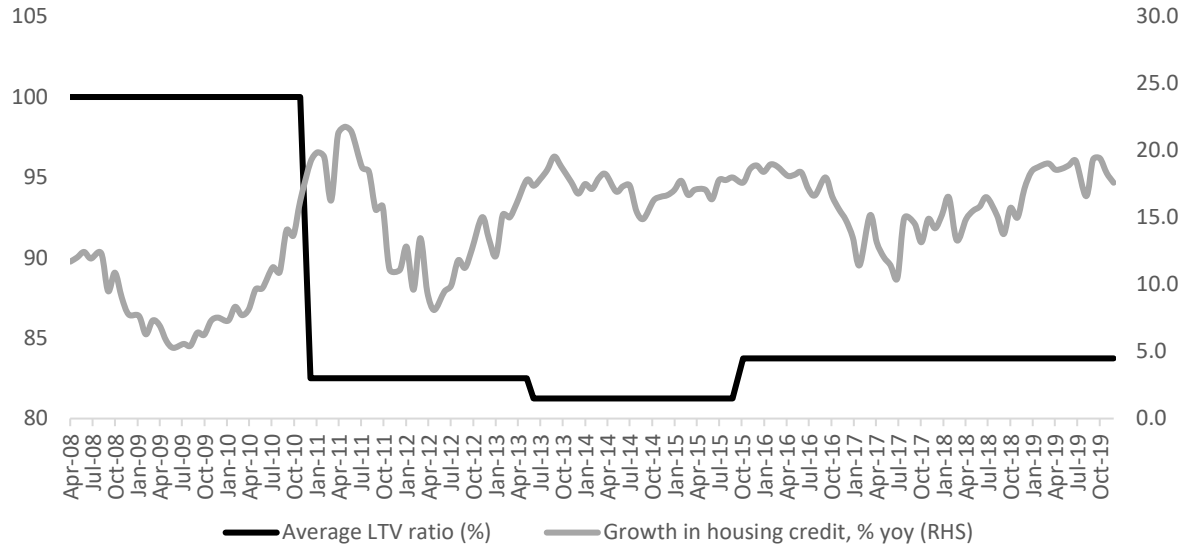
Variables	Definition	Sample period	No. of cities	Source
lnhpi10	Log of RBI's house price index with 2010-11 as the base	2009-2019	10	RBI
lnrhpi10	Log of RBI's real house price index with 2010-11 as the base (deflated by GDP deflator)	2009-2020	10	RBI
lnhpi33	Log of NHB's house price index with 2013 as the base	2010-2019	33	NHB
lnrhpi33	Log of NHB's house price index with 2012 as the base (deflated by GDP deflator)	2010-2019	33	NHB
lnsdppc	Log of real net state domestic product per capita	2009-2019	33	CSO, Govt. of India
lnddppc	Log of real district domestic product per capita	2009-2019	33	CSO, Govt. of India
lnpop_city	Log of the city population in millions	2009-2019	33	UN Population database
lnconcoix	Log of construction cost index with the base year 2011-12	2009-2019	33	CEIC & Author's computation
lnrconcoix	Log of construction cost index with the base year 2011-12, deflated by GDP deflator	2009-2019	33	Author's computation
lncrdpa	Log of average per account domestic commercial bank credit to the housing sector	2009-2019	33	RBI, Basic Statistical Returns
lnrcrdpa	Log of average per account domestic commercial bank credit to the housing sector deflated by GDP deflator	2009-2019	33	RBI, Basic Statistical Returns
warhg	The weighted average interest rate on housing loans by the commercial banks	2009-2019	All India	RBI, Basic Statistical Returns
rwarhg	The weighted average interest rate on housing loans by the commercial banks adjusted for CPI inflation	2009-2019	All India	RBI, Basic Statistical Returns
lnbse_hpi10	Relative asset price index, i.e., index of stock prices as a ratio to the house price index of RBI	2009-2019	10	Author's computation
lnrbse_rhpi10	Relative real asset price index, i.e., real index of stock prices as a ratio to the real house price index of RBI	2009-2019	10	Author's computation
lnbse_hpi33	Relative asset price index, i.e., index of stock prices (BSE/NSE) as a ratio to the house price index of NHB	2009-2019	33	Author's computation
lnrbse_rhpi33	Relative real asset price index, i.e., real index of stock prices (BSE/NSE) as a ratio to the real house price index of NHB	2009-2019	33	Author's computation
repo	RBI's policy repo rate	2009-2019	All India	RBI
rrepo	RBI's policy repo rate deflated by CPI inflation rate	2009-2019	All India	Author's computation
lnltvm	Log of sample median loan-to-value ratio of commercial banks housing loans in India	2009-2019	13	RBI's Residential Asset Price Monitoring Survey (RAPMS)
lnltvl	Log of regulatory loan-to-value ratio for large size loans of commercial banks in India	2009-2019	All India	RBI
lnltvs	Log of regulatory loan-to-value ratio for small size loans of commercial banks in India	2009-2019	All India	RBI
lnrwm	Log of the regulatory maximum risk weights ratio of commercial banks in India	2009-2019	All India	RBI
lnrws	Log of the regulatory risk weights in respect of small loans of commercial banks in India	2009-2019	All India	RBI
lnasstprov	Log of regulatory asset provisioning ratio on housing loans of commercial banks	2009-2019	All India	RBI
lnlti	Log of sample median of loan to income (LTI) ratio of commercial banks in India	2009-2019	13	RBI's Residential Asset Price Monitoring Survey (RAPMS)
lnemiy	Log of sample median of equal monthly loan installment (EMI) to income ratio of commercial banks in India	2009-2019	13	RBI
lnhpiy	Log of sample median of house price to income ratio of commercial banks in India	2009-2019	13	RBI's Residential Asset Price Monitoring Survey (RAPMS)

Annex A3. 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
bse_hpi10	Ratio of BSE index to HPI10 index	110	160.3	43.8	89.5	275.8
rbse_rhpi10	Ratio of real BSE index to real HPI10 index	110	155.6	42.6	86.9	267.8
bse_hpi33	Ratio of real Bombay Stock Exchange index to real HPI33 index	254	296.3	42.4	171.7	417.2
rbse_rhpi33	Ratio of real National Stock Exchange index to real HPI33 index	254	296.3	42.4	171.7	417.2
nse_hpi10	Ratio of National Stock Exchange index to HPI10 index	110	46.4	12.6	26.2	8019.4
rnse_rhpi10	Ratio of real National Stock Exchange index to real HPI10 index	254	87.7	12.8	52.2	125.0
nse_hpi33	Ratio of National Stock Exchange index to HPI33 index	254	8771.0	1284.5	5223.3	12495.1
rnse_rhpi33	Ratio of real National Stock Exchange index to real HPI33 index	254	87.7	12.8	52.2	125.0
hpi10	RBI's nominal HPI index for 10 cities	110	163.0	73.5	63.3	371.8
rhpi10	RBI's real HPI index for 10 cities	110	143.6	46.5	72.9	274.0
hpi33	NHB's nominal house price index for 33 countries	254	90.8	14.8	42.0	117.3
rhpi33	NHB's real house price index for 33 countries	254	36.9	5.2	25.3	62.0
consix	Nominal construction cost index	363	132.0	13.6	88.3	149.4
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
crdpa	Nominal per account bank credit to households	363	949.9	467.1	178.3	2944.0
rcrdpa	Real housing credit per account	363	846.1	342.5	228.3	2169.7
ddppc	District domestic product per capita	363	114398.2	74702.1	13168.9	356818.3
sdppc	Net state domestic product per capita	363	93719.5	43797.8	17033.5	279601.1
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	28514.0
repo	RBI's repo rate	363	6.78	0.94	4.88	7.90
rrepo	RBI's real repo rate	363	-0.92	3.84	-14.10	6.23
warhg	Weighted average interest rate on housing loans	363	10.17	0.70	8.88	11.11
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 of banking sector	65	3.12	0.37	2.30	3.98
ltvm	Median loan-to-value ratio of banks for the housing sector	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
ydef	GDP deflator	363	1.10	0.18	0.78	1.36

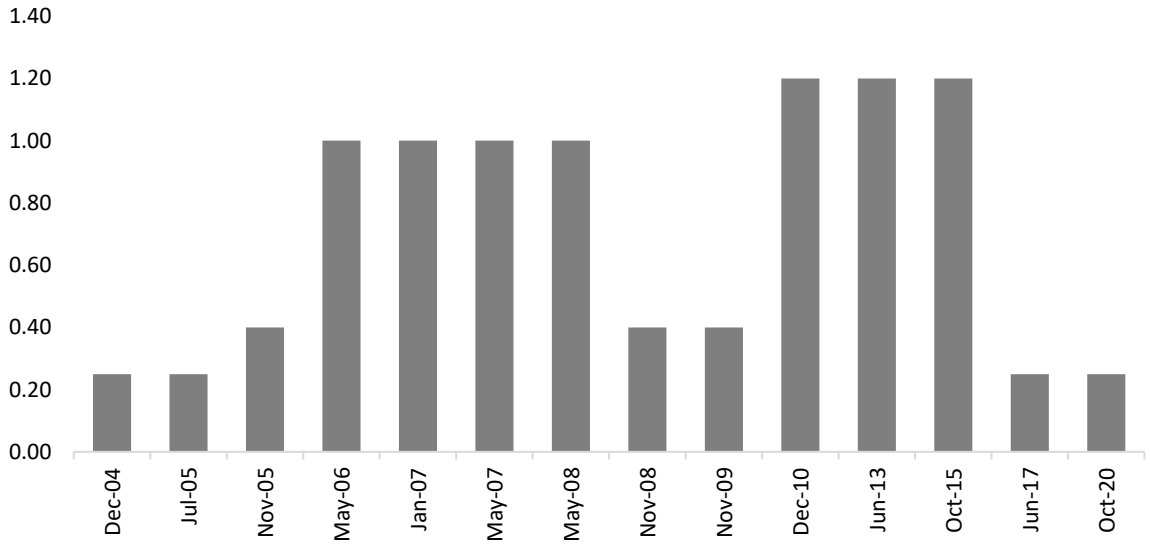
Annex A4. Evolution of macroprudential tools in India

a. LTV ratio for personal housing loans in India and housing credit growth



Source: IMF's iMaPP database and Reserve Bank of India.

b. Asset provisioning ratio for personal housing loans in India



The ratio represents the average.
Source: Reserve Bank of India and Sinha (2011).

Appendix Table A1. Arellano-Bond panel data estimators for nominal house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
lnhpi10(t-1)	0.36***	0.50***	0.31***	0.40***	0.19***	0.48***	0.19**	0.20***	0.20***	0.19**	0.20***
	(5.27)	(8.27)	(5.50)	(9.94)	(4.97)	(4.69)	(2.12)	(2.87)	(2.87)	(2.35)	(4.47)
lnddppc(t-1)	0.26*	0.27**	0.17*	0.33***		0.37***	0.69***	0.40***	0.40***	0.14**	0.24*
	(1.80)	(2.07)	(1.78)	(3.37)		(2.74)	(4.37)	(3.19)	(3.19)	(1.96)	(1.89)
lnpop_city(t-1)	0.56**	0.66**	0.39**								
	(2.74)	(2.91)	(2.31)								
lnconcoix	1.49***			0.44***	1.31***		0.87***				1.40***
	(5.89)			(4.34)	(11.42)		(3.00)				(12.03)
lnconcoix(t-1)		1.15***	0.81***			0.54***					
		(4.34)	(4.33)			(3.34)					
lnrentix					0.46***						
					(5.30)						
lnbse_hpi10			-0.63***	-0.46***	-0.72***	-0.50***	-0.45***	-0.82***	-0.82***	-0.70***	-0.54***
			(-9.97)	(-9.71)	(-28.14)	(-8.11)	(-3.69)	(-15.50)	(-15.50)	(-7.69)	(-4.15)
lncrdpa								0.14***	0.14***		
								(3.43)	(3.43)		
lncrdpa(t-1)				0.23***							
				(6.10)							
warhg(t-1)	-0.04*		-0.11***								
	(-1.71)		(-5.32)								
repo		-0.02			-0.05***			-0.02***	-0.02***	-0.01***	
		(-1.58)			(-9.25)			(-5.29)	(-5.29)	(-3.22)	
lnltvm						0.52***					0.28**
						(8.10)					(2.14)
lnltvl							0.70**	1.35***			
							(2.48)	(11.66)			
lnltvs									0.55***		
									(11.66)		
lnrwm						-0.11***		-0.14***	-0.14***	-0.15***	-0.18***
						(-4.08)		(-15.37)	(-15.37)	(-3.98)	(-4.96)
lnrwm(t-1)					-0.26***		-0.14***			-0.22***	
					(-19.24)		(-5.55)			(-5.57)	
lnlti										0.51***	
										(3.64)	
lnemiy										-0.40**	
										(-2.39)	
lnasstprov											-0.20***
											(-3.59)
Wald $\chi 2$	2940.9(0.0)	2289.1(0.0)	4678.5(0.0)	12758.3(0.0)	11196.0(0.0)	3605.2(0.0)	4269.2(0.0)	8382.88(0.0)	8171.76(0.0)	1617.0(0.0)	13789.2(0.0)
Sargan test: chi2	46.35(0.38)	46.99(0.35)	57.83(0.20)	8.09(0.99)	9.36(0.99)	8.27(0.99)	6.79(0.99)	12.48(0.99)	12.48(0.99)	24.31(0.44)	6.85(0.0)
Arellano-Bond test for AR(1): Z-stats	2.63(0.01)	-3.69(0.00)	-4.46(0.00)	-2.21(0.03)	-2.76(0.01)	-2.25(0.02)	-1.29(0.20)	2.06(0.04)	2.06(0.04)	3.02(0.00)	2.31(0.02)
Arellano-Bond test for AR(2): Z-stats	1.12(0.26)	1.37(0.17)	0.70(0.48)	1.42(0.16)	-1.87(0.06)	1.59(0.12)	0.82(0.41)	0.61(0.54)	0.61(0.54)	1.10(0.27)	-1.28(0.20)
No. of instruments	49	49	50	49	50	50	50	51	51	32	50
No. of groups	10	10	10	10	10	10	10	10	10	8	10
T	9	9	9	9	9	9	9	9	9	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A2. Blundell-Bond system estimators for nominal house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
lnhpi10(t-1)	0.36*** (12.28)	0.32*** (3.23)	0.23** (2.36)	0.29*** (8.35)	0.51*** (9.48)	0.45*** (8.42)	0.26*** (5.44)	0.23** (2.48)	0.22** (2.34)	0.24** (2.59)	0.20** (2.27)
lnddppc(t-1)		0.27** (2.19)			0.15*** (3.48)	0.18*** (5.74)			0.12** (2.38)	0.12** (2.39)	0.11** (2.27)
lnpop_city(t-1)	0.16** (2.02)							0.17** (2.43)			
lnconcoix	1.34*** (16.12)		1.38*** (6.82)		0.62*** (10.1)		1.90*** (7.90)				
lnconcoix(t-1)		1.32*** (7.88)						0.96*** (3.06)	1.07*** (3.98)		
lnrentix			0.36* (1.91)								
lnbse_hpi10	-0.54*** (-10.04)	-0.39*** (-5.83)	-0.76*** (-14.90)	-0.72** (-16.61)	-0.62*** (-8.85)	-0.58*** (-9.64)	-0.68*** (-7.49)	-0.35*** (-3.53)	-0.44*** (-4.98)	-0.51*** (-5.28)	-0.50*** (-5.61)
lncrdpa(t-1)				0.15** (5.89)							
warhg(t-1)	-0.07*** (-15.01)										
repo			-0.08*** (-13.21)		-0.02*** -9.95	-0.03*** -11.18	-0.04*** (-7.36)				
lnltvm			0.61*** (2.77)				0.76*** (3.54)			0.69*** (3.53)	
lnltvl				0.95*** (5.45)	0.99*** 7.11						0.86*** (3.77)
lnltvs						0.74*** 10.26					
lnrwm			-0.11* (-1.97)		-0.13*** (-5.66)	-0.08*** (-3.55)	-0.17*** (-4.86)	-0.17*** (-3.85)			
lnrwm(t-1)	-0.18*** (-7.71)	-0.24*** (-5.18)		-0.22*** (-11.56)							-0.21*** (-4.45)
lnlti								0.86*** (5.48)	0.79*** (5.11)	0.69*** (4.22)	0.88*** (5.76)
lnemiy								-0.84*** (-4.35)	-0.67*** (-3.43)	-0.32* (-1.76)	-0.70*** (-3.73)
lnasstprov							-0.12*** (-8.43)		-0.12*** (-3.70)	-0.14*** (-4.02)	
Wald $\chi 2$	7144.5(0.0)	11241.2(0.0)	24760.2(0.0)	24824.1(0.0)	20039.22	23468.22	18158.8(0.0)	13600.1(0.0)	13800.1(0.0)	12800.0(0.0)	15000.0(0.0)
Sargan test: chi2	9.45(0.99)	7.4(0.99)	7.16(0.99)	9.82(0.99)	9.90(0.99)	8.91(0.99)	7.10(0.99)	35.50(0.23)	36.00(0.21)	28.48(0.54)	34.33(0.27)
Arellano-Bond test for AR(1): Z-stats	-2.18(0.03)	-1.66(0.10)	-1.32(0.19)	2.49(0.01)	1.67(0.10)	-1.95(0.05)	-2.13(0.03)				
Arellano-Bond test for AR(2): Z-stats	-0.55(0.58)	-0.05(0.96)	-1.46(0.15)	0.09(0.93)	0.26(0.79)	1.42(0.16)	-1.87(0.06)				
No. of instruments	59	58	59	59	59	59	60	37	37	37	37
No. of groups	10	10	10	10	10	10	10	8	8	8	8
T	10	10	9	10	10	10	10	5	5	5	5

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 A2 for the definition of the variables.

*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A3. Arellano-Bond panel data estimators for real house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
lnhpi10(t-1)	0.38***	0.23**	0.29***	0.30***	0.16***	0.24***	0.23**	0.23**	0.16*	0.26***	0.16***
	(6.89)	(2.20)	(2.71)	(5.36)	(3.59)	(3.67)	(2.17)	(2.17)	(1.89)	(2.74)	(2.79)
lnddppc(t-1)	0.20**	0.42***	0.17***	0.15**		0.22***	0.38***	0.38**	0.20**	0.17*	0.16**
	(2.11)	(3.64)	(6.11)	(2.41)		(3.17)	(2.84)	(2.84)	(2.18)	(1.93)	(2.54)
lnpop_city(t-1)				0.40**							
				(2.15)							
lnrconcoix(t-1)		0.40***	0.32***				0.21*	0.21*			
		(3.42)	(4.09)				(1.66)	(1.66)			
lnrentix			0.33								
			(4.16)								
lnrbse_rhpi10	-0.53***	-0.16*	-0.53***	-0.61***	-0.86***	-0.52***	-0.58***	-0.58***	-0.82***	-0.27***	-0.84***
	(-7.74)	(-1.91)	(-7.13)	(-7.97)	(-16.07)	(-10.19)	(-7.18)	(-7.18)	(-9.74)	(-3.87)	(-13.08)
lnrcrdpa	0.15***				0.14**						
	(3.01)				(2.45)						
rwarhg(t-1)		-0.01***	-0.01***								
		(-6.14)	-(4.84)								
rrepo	-0.02**				-0.02**		-0.04***	-0.04***			-0.04***
	(-2.20)				(-2.55)		(-4.24)	(-4.24)			(-5.18)
rrepo(t-1)				-0.03***	-0.02***	-0.01*					
				(-3.64)	(-5.63)	(-1.93)					
lnltvm				0.28***	0.44***	0.32**			0.59***		
				(2.95)	(3.14)	(1.98)			(3.34)		
lnltvm(t-1)											0.42***
											(2.75)
lnltvl							1.10***				
							(3.29)				
lnltvs								0.40***			
								(3.29)			
lnrwm					-0.18***	-0.10***			-0.16***		-0.17***
					(-12.07)	(-3.45)			(-8.63)		(-6.50)
lnlti										0.45**	
										(2.66)	
lnemiy										-0.70***	
										(-3.41)	
lnasstprov(t-1)									-0.09***		-0.10*
									(-3.50)		(-1.72)
Wald $\chi 2$	1576.8(0.0)	3158.38	2765.13(0.0)	2402.8(0.0)	5930.1(0.0)	2109.0(0.0)	10235.3(0.0)	10235.3(0.0)	4054.74(0.0)	239.9(0.0)	2472.5(0.0)
Sargan test: chi2	56.48(0.09)	4.94(0.99)	64.71(0.09)	60.1(0.09)	9.98(0.99)	60.15(0.09)	9.68(0.99)	9.75(0.99)	9.90(0.99)	28.59(0.38)	58.21(0.09)
Arellano-Bond test for AR(1): Z-stats	-3.10(0.00)	1.79(0.07)	-2.27(0.02)	-2.21(0.03)	2.73(0.01)	3.57(0.00)	-1.88(0.06)	-1.89(0.06)	-2.91(0.00)	-2.87(0.01)	-4.39(0.00)
Arellano-Bond test for AR(2): Z-stats	-0.38(0.70)	1.17(0.24)	-0.90(0.37)	-1.58(0.12)	1.62(0.11)	1.03(0.30)	-0.63(0.53)	-0.61(0.53)	-1.91(0.06)	1.43(0.15)	1.47(0.14)
No. of instruments	49	58	58	50	51	49	50	50	51	32	51
No. of groups	9	10	10	10	10	8	10	10	10	8	10
T	9	10	9	9	9	5	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A4. Blundell-Bond system estimators for real house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
lnrhpi10(t-1)	0.19**	0.47***	0.41***	0.38***	0.27***	0.27***	0.30***	0.36***	0.39**	0.53***
	(2.49)	(3.64)	(6.52)	(7.99)	(4.14)	(7.89)	(5.21)	(3.15)	(2.12)	(11.46)
lnddppc(t-1)	0.17***				0.25**	0.34*	0.37*	0.16*	0.24**	
	(7.69)				(2.48)	(1.83)	(1.90)	(1.89)	(2.28)	
lnpop_city(t-1)			0.12***							0.13***
			(3.06)							(4.67)
lnrconcoix			1.46***			0.24*	0.48***			1.68*
			(8.26)			(1.79)	(4.22)			(8.85)
lnrconcoix(t-1)	0.78***	0.59*						0.98***	1.28**	
	(4.23)	(1.85)						(5.94)	(2.95)	
lnrentix	0.16**			0.63***						
	(1.96)			(6.92)						
lnrbse_rhpi10	-0.59***	-0.57***	-0.68***	-0.62***	-0.42***	-0.46***	-0.44***	-0.56***	-0.60***	-0.57***
	(-5.55)	(-5.09)	(-7.10)	(-10.82)	(-5.87)	(-7.38)	(-7.13)	(-6.04)	(-3.29)	(-9.70)
lnrcrdpa				0.14***						
				(4.03)						
lnrcrdpa(t-1)		0.18**								
		(2.11)								
rwarhg			-0.02***		-0.02***					
			(-4.17)		(-3.06)					
rrepo1	-0.03**	-0.01***		-0.03***				-0.01**		-0.03***
	(-2.04)	(-3.81)		(-2.94)				(-2.02)		(-3.24)
lnltvm				0.43***						
				(3.48)						
lnltvl					1.04***	1.23***				
					(8.69)	(7.57)				
lnltvs							0.59***			
							(9.34)			
lnrwm			-0.18***							-0.10***
			(-4.32)							(-3.42)
lnrwm(t-1)	-0.10***	-0.13***	-0.29***		-0.12***				-0.12***	-0.17***
	(-3.77)	(-5.54)	(-7.51)		(-4.89)				(-3.50)	(-5.95)
lnlti(t-1)								0.56***		
								(3.78)		
lnemiy										
lnasstprov						-0.13**	-0.14**	-0.17***	-0.23***	-0.14***
						(-2.37)	(-2.24)	(-4.34)	(-3.22)	(-3.02)
Wald $\chi 2$	23839.87	3661.67	19522.5(0.0)	12246.5(0.0)	3342.2(0.0)	17041.1(0.0)	21229.4(0.0)	10000.0(0.0)	24964.1(0.0)	32615.1(0.0)
Sargan test: chi2					6.69(0.99)	7.03(0.99)	6.58(0.99)	16.33(0.75)	7.58(0.99)	70.15(0.07)
Arellano-Bond test for AR(1): Z-stats	2.36(0.02)	1.84(0.07)	1.68(0.09)	-2.11(0.04)	1.91(0.06)	1.73(0.08)	1.71(0.09)		-1.37(0.17)	
Arellano-Bond test for AR(2): Z-stats	-1.25(0.21)	1.44(0.15)	0.67(0.50)	-0.42(0.67)	1.13(0.26)	1.39(0.16)	1.43(0.15)		0.72(0.47)	
No. of instruments	59	59	60	58	59	59	59	28	59	61
No. of groups	10	10	10	10	10	10	10	8	10	10
T	9	10	10	9	10	10	10	4	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A5. Panel fixed-effect models for nominal house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
constant	-2.04	-7.79	-7.59	3.99	1.80	-7.33	-8.65	-6.60	-1.25
	(-1.10)	(-6.00)	(-6.88)	(1.86)	(0.94)	(-6.22)	(-6.36)	(-3.46)	(-0.60)
lnddppc	0.33**	0.31***	0.59***	0.41***	0.46***	0.39**	0.39**	0.32***	0.27***
	(2.43)	(3.17)	(6.13)	(4.77)	(2.96)	(2.41)	(2.41)	(3.74)	(5.27)
lnpop_city		0.39**						0.53***	
		(1.95)						(3.06)	
lnconcoix	0.71***	2.59***	1.56***	0.59***		2.19***	2.19***	1.19***	0.97***
	(4.17)	(13.59)	(5.53)	(2.37)		(6.36)	(6.36)	(4.09)	(6.02)
lnrentix	0.70***								
	(6.05)								
lnbse_hpi10	-0.84***	-0.75***	-0.95***	-0.81***	-0.41***	-0.63***	-0.63***	-0.91***	-0.98***
	(-15.39)	(-14.98)	(-16.06)	(-10.25)	(-3.53)	(-11.99)	(-11.99)	(-18.22)	(-27.25)
lncrdpa		0.08**	0.11**	0.16***	0.18**				0.21***
		(2.34)	(2.40)	(3.40)	(1.92)				(5.28)
warhg						-0.14***	-0.14***		
						(-4.74)	(-4.74)		
repo	-0.07***	-0.11***	-0.08***					-0.04***	
	(-9.14)	(-8.65)	(-7.57)					(-3.26)	
lltvm			0.55**					0.47**	0.67**
			(2.21)					(-2.09)	(2.43)
lnltvl						1.68***			
						(3.05)			
lnltvs							0.59***		
							(3.05)		
lnrwm				-0.26***				-0.22***	-0.22***
				(-6.13)				(-5.59)	-(9.11)
lnlti					0.62**				
					(2.45)				
lnemiy				0.26*	-0.85**				
				(1.75)	(-2.37)				
lnasstprov									-0.36***
									-(11.08)
R2 (within)	0.98	0.96	0.98	0.97	0.91	0.95	0.95	0.98	0.98
F-stats.	830.58(0.0)	492.16(0.0)	516.43(0.0)	419.26(0.0)	56.70(0.0)	333.85(0.0)	333.85(0.0)	477.03(0.0)	605.09(0.0)
No. of groups	10	10	10	10	10	10	10	10	10
T	9	10	10	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A6. Panel fixed-effect models for real house prices based on the RBI's HPI

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
constant	-0.77	-3.60	5.53	2.79	2.72	-8.62	-4.06	-2.68	0.79	3.62	0.14
	(-0.80)	(-2.53)	(4.86)	(2.71)	(2.49)	(-4.58)	(-3.35)	(-1.23)	(0.66)	(4.01)	(5.23)
lnddppc	0.22**	0.29***	0.14**	0.19***	0.18***	0.58**	0.58***	0.41***	0.39***	0.32***	0.23***
	(2.42)	(3.50)	(2.58)	(3.07)	(2.87)	(6.62)	(6.62)	(6.00)	(6.00)	(3.21)	(5.72)
lnpop_city		0.43**									
		(2.44)									
lnrconcoix						0.46*	0.46*				
						(1.85)	(1.85)				
lnrbse_rhpi10	-0.77***	-0.75***	-0.91***	-0.90**	-0.86***	-0.56***	-0.56***	-0.75***	-0.75***	-0.42***	-0.97***
	(-14.98)	(-16.24)	(-26.98)	(-13.23)	(-20.38)	(-6.22)	(-6.22)	(-10.86)	(-10.86)	(-5.65)	(-40.43)
lnrent_inx	0.62***				0.26*						
	(7.11)				(1.81)						
lnrcrdpa				0.11**							
				(2.19)							
rwarhg					-0.01**						
					(-2.53)						
rrepo		-0.06***	-0.05***			-0.01**	-0.01**	-0.06***	-0.06***		-0.05***
		-(6.33)	(-12.29)			(-2.15)	(-2.15)	(-8.68)	(-8.68)		(-14.37)
lnltvm	0.73***	0.89**	0.26**	0.86***	0.63***						0.34***
	(3.74)	(2.18)	(2.58)	(3.16)	(4.00)						(3.01)
lnltvl						1.63*		1.25**			
						(-3.39)		(2.86)			
lnltvs							0.58***		0.44**		
							(-3.39)		(2.86)		
lnrwm			-0.20***	-0.24***	-0.22***						-0.19***
			(-12.90)	(-10.22)	(-7.43)						(-17.45)
lnlti										0.61***	
										(3.41)	
lnemiy										-0.68***	
										(-2.97)	
lnasstprov											-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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A7. Arellano-Bond panel data estimators for nominal house prices based on the NHB's Residex

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
lnhpi33(t-1)	0.10***	0.16***	0.31***	0.35***	0.44***	0.24***	0.21***	0.34***	0.50***
	(3.17)	(8.67)	(5.48)	(5.94)	(13.49)	(2.70)	(25.71)	(3.70)	(3.34)
lnddppc(t-1)	0.22***	0.37***	0.24***	0.41***			0.18***	0.29***	0.26**
	(9.04)	(45.57)	(4.54)	(8.90)			(20.06)	(3.24)	(2.01)
lnpop_city(t-1)					0.24***	0.34***			
					(4.93)	(2.92)			
lnconcoix	1.00***	0.59***	0.21***	0.19*	0.28***		1.26***		
	(28.24)	(16.58)	(3.04)	(1.98)	(4.68)		(34.49)		
lnconcoix(t-1)									0.49**
									(2.35)
lnrentix						0.22**			
						(2.67)			
lncrdpa							0.10***		
							(6.49)		
warhg	-0.07***	-0.05***	-0.05***	-0.03***	-0.07***				
	(-33.99)	(-36.86)	(-16.48)	(-7.11)	(-34.93)				
warhg(t-1)	-0.03***		-0.01**						
	(-14.81)		(-2.58)						
lnbse_hpi33	-0.54***	-0.60***	-0.60***	-0.55***	-0.57***	-0.76***	-0.74***	-0.44***	-0.51***
	(-55.74)	(-64.57)	(-49.95)	(-38.48)	(-31.99)	(-21.04)	(-51.13)	(-10.86)	(-12.75)
repo						-0.03***			-0.05***
						(-7.42)			(-12.79)
repo(t-1)							-0.07***		
							(-29.00)		
lnltvm		0.37***				0.30**	0.52***		
		(18.50)				(2.58)	(19.91)		
lnltvl			0.84***		0.34***				
			(16.53)		(7.27)				
lnltvs				0.37***					
				(19.83)					
lnrwm		-0.10***	-0.12***	-0.11***		-0.18***	-0.18***		
		(-32.85)	(-29.39)	(-28.08)		(-10.02)	(-54.20)		
lnrwm(t-1)					-0.13***	-0.13***		-0.20***	
					(-70.41)	(-21.04)		(-11.90)	
lnlti								0.57***	
								(7.77)	
lnemiy								-0.75***	
								(-3.54)	
lnemiy(t-1)									-0.31***
									(-3.93)
lnasstprov(t-1)									-0.17***
									(-6.95)
Wald $\chi 2$	13100.1(0.0)	42566.5(0.0)	26900.0(0.0)	18100.0(0.0)	34400.0(0.0)	3672.4(0.0)	44300.0(0.0)	4287.1(0.0)	37909.3(0.0)
Sargan test: chi2	31.84(0.62)	30.82(0.67)	31.41(0.64)	29.46(0.73)	27.17(0.83)		31.30(0.65)	10.08(0.99)	12.11(0.99)
Arellano-Bond test for AR(1): Z-stats	-2.45(0.02)	3.81(0.00)	-3.50(0.00)	-3.95(0.00)	3.87(0.00)	3.83(0.00)	3.20(0.00)	1.20(0.23)	-2.15(0.03)
Arellano-Bond test for AR(2): Z-stats	0.36(0.72)	1.84(0.07)	1.81(0.06)	-0.79(0.43)	0.23(0.82)	1.33(0.18)	-1.85(0.06)	-1.21(0.23)	-0.78(0.44)
No. of instruments	41	42	43	42	42	43	44	31	42
No. of groups	33	33	33	33	33	33	33	13	13
T	8	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A8. Blundell-Bond system estimators for nominal house prices based on the NHB's Residex

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
lnhpi33(t-1)	0.24***	0.37***	0.51***	0.33***	0.63***	0.49***	0.44***	0.35***
	(5.62)	(33.06)	(27.22)	(13.61)	(12.00)	(7.65)	(6.99)	(4.54)
lnddppc(t-1)	0.13***	0.11***	0.11***	0.19***			0.38***	0.32***
	(6.91)	(11.20)	(9.00)	(7.62)			(2.80)	(3.40)
lpop_city					0.46**			
					(2.18)			
lnconcoix	0.86***	0.59***	0.17***		0.55**	1.21***		
	(15.46)	(34.40)	(9.60)		(2.29)	(13.99)		
lnconcoix(t-1)				0.74***			0.44***	
				(12.28)			(2.84)	
lnrentix	0.13***							
	(6.59)							
lnbse_hpi33	-0.40***	-0.61***	-0.40***	-0.47***	-0.35***	-0.36***	-0.31***	-0.41***
	(-28.54)	(-38.66)	(-61.26)	(-24.33)	(-4.36)	(-9.91)	(-7.05)	(-14.99)
lncrdpa						0.17***		
						(6.29)		
warhg	-0.01***							
	(-4.30)							
repo		-0.03***	-0.03***	-0.03***			-0.04***	0.05***
		(-37.24)	(-21.43)	(-24.17)			(-5.05)	(7.37)
repo(t-1)					-0.02***	-0.04***		
					(-4.03)	(-6.18)		
lnltvm		0.66***						
		(29.33)						
lnltvl			0.60***					
			(25.91)					
lnltvs				0.19***				
				(4.62)				
lnrwm		-0.14***						
		(-33.51)						
lnrwm(t-1)	-0.14***	-0.11***	-0.12***	-0.13***	-0.09***	-0.05***		
	(-25.23)	(-27.11)	(-34.11)	(-27.99)	(-4.31)	(-3.10)		
lnlti								0.58***
								(5.05)
lnemiy(t-1)					-0.26***	-0.23***	-0.25**	
					(-2.93)	(-3.42)	(-2.15)	
lnasstprov(t-1)								-0.11***
								(-9.36)
Wald $\chi 2$	12100.0(0.0)	15300.0(0.0)	16400.0(0.0)	2150.0(0.0)	2229.8(0.0)	13785.7(0.0)	2514.7(0.0)	17934.9(0.0)
Sargan test: chi2	32.08(0.89)	30.96(0.92)	31.32(0.91)	30.78(0.92)	5.50(0.99)	11.48(0.99)	17.88(0.99)	17.52(0.99)
Arellano-Bond test for AR(1): Z-stats	-1.81(0.07)	-3.48(0.00)	-2.55(0.01)	-3.65(0.00)	2.56(0.01)	-1.80(0.07)	-2.02(0.04)	1.17(0.24)
Arellano-Bond test for AR(2): Z-stats	-1.73(0.08)	0.03(0.98)	-0.39(0.70)	0.77(0.43)	-1.07(0.29)	-1.09(0.27)	-.03(0.97)	-0.37(0.71)
No. of instruments	50	51	50	50	50	50	49	36
No. of groups	33	33	33	33	13	13	13	13
T	9	9	9	9	9	9	9	5

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 A2 for the definition of the variables.

*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A9. Arellano-Bond panel data estimators for real house prices based on the NHB's Residex

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
lnhpi33(t-1)	0.33***	0.25***	0.39***	0.13***	0.22***	0.24***	0.21***	0.60***	0.15***	0.58***
	(4.67)	(5.39)	(4.71)	(4.59)	(5.28)	(5.37)	(5.88)	(15.74)	(4.91)	(3.75)
lnddppc(t-1)	0.16***	0.31***	0.30***	0.25***	0.30***	0.20***	0.27***		0.47***	0.24***
	(8.92)	(5.94)	(6.29)	(10.73)	(12.94)	(7.38)	(10.88)		(14.91)	(2.83)
lnpop_city			0.53***				0.79***	0.48***		
			(9.53)				(14.26)	(10.93)		
lnrconcoix					0.25***		0.49***			
					(11.48)		(14.57)			
lnrconcoix(t-1)		0.77***	0.90***					0.21***		
		(5.74)	(6.52)					(4.88)		
lnrentix		0.25***								
		(7.35)								
lnrbse_rhpi33	-0.48***	-0.49***	-0.48***	-0.56***	-0.52***	-0.45***	-0.55***	-0.48***	-0.67***	-0.46***
	(-34.32)	(-21.81)	(-25.35)	(-32.05)	(-37.53)	(-38.88)	(-43.26)	(-42.36)	(-17.06)	(-11.70)
lnrcrdpa	0.13***				0.11***		0.11***			
	(15.99)				(9.56)		(11.07)			
rwarhg		-0.01***		-0.01***		-0.01***				
		(-10.22)		(-3.22)		(-13.58)				
rwarhg1									-0.01***	
									(-4.53)	
rrepo			-0.01***		-0.02***		-0.02***			-0.04***
			(-10.29)		(-9.79)		(-14.72)			(-12.77)
rrepo1	-0.01***		-0.01***		-0.02***		-0.02***			
	(-7.87)		(-8.84)		(-14.60)		(-16.67)			
lnltvm	0.61***	0.64***	0.38***	0.69***				0.47***		
	(10.24)	(10.88)	(9.37)	(22.02)				(25.02)		
lnltvl					1.09***	0.43***				
					(15.96)	(2.94)				
lnltvs							0.50***			
							(19.95)			
lnrwm				-0.12***		-0.10***				
				(-34.52)		(-4.94)				
lnrwm(t-1)								-0.13***		
								(-31.89)		
lnlti									0.18*	
									(1.90)	
lnemiy									-0.35**	-0.45***
									(-2.61)	(-10.04)
lnasstprov(t-1)										-0.10***
										(-3.30)
Wald $\chi 2$	8637.9(0.0)	13967.0(0.0)	6168.57	13000.0(0.0)	3300.5(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	27.52(0.82)	2.05(0.04)	28.48(0.77)	29.79(0.72)	29.82(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	2.07(0.04)	0-.69(0.49)	-2.41(0.02)	-2.53(0.01)	2.36(0.02)	-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	-1.59(0.11)	28.01(0.79)	-1.27(0.20)	1.74(0.08)	0.87(0.38)	1.60(0.11)	0.95(0.34)	-1.23(0.22)	-0.52(0.60)	-0.72(0.47)
No. of instruments	41	42	43	41	43	41	44	41	31	41
No. of groups	33	33	33	33	33	33	33	33	13	13
T	8	8	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A10. Blundell-Bond system estimators for real house prices based on the NHB's Residex

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
lnhpi33(t-1)	0.43***	0.37***	0.39***	0.30***	0.39***	0.34***	0.48***	0.49***	0.42***	0.56***
	(7.78)	(11.72)	(16.80)	(12.41)	(28.49)	(14.42)	(13.36)	(7.40)	(2.01)	(10.96)
lnddppc(t-1)	0.20***	0.18***	0.27***		0.20***	0.24***				0.19***
	(18.80)	(18.25)	(32.13)		(13.04)	(33.91)				(11.21)
lnrconcoix	0.59***	0.75***	0.53***	0.33***	0.31***	0.49***			0.60***	0.79***
	(24.05)	(27.43)	(42.11)	(26.25)	(11.97)	(31.64)			(6.12)	(35.58)
lnrconcoix(t-1)							0.86***	0.44***		
							(9.87)	(16.72)		
lnrentix	0.15***									
	(3.59)									
lnrbse_rhpi33	-0.52***	-0.72***	-0.50***	-0.58***	-0.62***	-0.57***	-0.39***	-0.45***	-0.26***	-0.53***
	(-30.06)	(-17.25)	(-38.70)	(-18.18)	(-47.62)	(-46.39)	(-8.28)	(-10.35)	(-5.01)	(-42.87)
lnrcrdpa							0.12***			
							(8.67)			
rwarhg		-0.01***								
		(-29.20)								
rrepo				-0.02***	-0.01***	-0.01***				
				(-28.19)	(-15.90)	(-14.85)				
rrepo(t-1)	-0.02***		-0.03***				-0.02***	-0.01**	-0.03***	
	(-10.63)		(-20.13)				(-6.63)	(-2.54)	-(4.46)	
lnltvm		0.49***		0.97***						
		(22.64)		(52.61)						
lnltvl					0.80***					
					(13.14)					
lnltvs						0.41***				
						(28.04)				
lnrwm		-0.17***					-0.06***	-0.24***		
		-(43.10)					(-4.40)	(-32.63)		
lnrwm(t-1)	-0.17***	-0.21***	-0.16***	-0.11***	-0.21***	-0.19***	-0.12***			-0.20***
	(-50.03)	(-47.10)	(-51.86)	(-25.52)	(-45.92)	(-42.06)	(-7.73)			(-55.81)
lnlti								0.74***		
								(18.05)		
lnemiy(t-1)									-0.23***	
									(-3.73)	
lnasstprov										-0.12***
										(-37.54)
Wald $\chi 2$	14765.4(0.0)	10000.0(0.0)	7360.0(0.0)	3552.7(0.0)	11900.0(0.00)	13100.0(0.0)	36557.3(0.0)	32247.8(0.0)	229.63(0.0)	9944.2(0.00)
Sargan test: chi2	30.15(0.93)	29.74(0.94)	29.91(0.93)	29.29(0.95)	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)	2.97(0.00)	-2.50(0.01)	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)	-0.49(0.62)	0.62(0.53)	-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	49	94	50	50	45	36	67	49
No. of groups	33	33	33	33	33	33	33	13	13	33
T	9	9	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 A2 for the definition of the variables.

*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A11. Blundell-Bond system estimators for real housing credit demand

Variables	[1]	[2]	[3]
lnrcrdpa(t-1)	0.09**	0.20***	0.29***
	(2.90)	(15.28)	(28.21)
lnrcrdpa(t-2)	0.06***		
	(3.79)		
lnddppc	0.46***	0.41***	0.51***
	(19.07)	(14.93)	(73.18)
rrepo	-0.02***	-0.03***	-0.02***
	(-8.95)	-(26.27)	-(19.12)
rrepo(t-1)		0.04***	0.04***
		(10.92)	(14.20)
lnltvl	0.29***		
	(5.32)		
lnltvs(t-1)		0.31***	
		(5.34)	
lnrwm	-0.10***		
	(-21.75)		
lnrwm(t-1)	-0.09***	-0.10***	
	(-16.26)	(-9.63)	
lnrws(t-1)			-0.18***
			(-35.84)
lnasstprov		-0.12***	-0.16***
		(-11.23)	(-20.27)
Wald $\chi 2$	46664.1(0.0)	17600.0(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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A12. Panel fixed-effect estimators for nominal house prices based on the NHB's Residex

Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
constant	-2.40	-3.02	2.88	-3.54	-0.90	-2.34	0.18	-4.18	5.58	1.71
	(-5.07)	(-4.66)	(2.90)	(-4.66)	(-0.65)	(-1.77)	(0.19)	(-4.79)	(7.01)	(1.84)
lnddppc	0.50***	0.40***	0.19**	0.49***				0.18**		0.33***
	(8.34)	(6.23)	(2.22)	(7.88)				(2.65)		(6.54)
lnpop_city				1.27***	0.49***	0.31***	0.54***	0.79***		0.75***
				(9.61)	(3.56)	(3.38)	(3.56)	(4.95)		(6.77)
lnconcoix	1.62***	0.50**	1.01***		0.50**	1.17***	0.86***	1.38***	0.92***	0.31***
	(11.08)	(2.45)	(5.37)		(2.77)	(18.09)	(4.99)	(7.39)	(6.04)	(2.99)
lnrentix					0.44***					
					(4.39)					
lnbse_hpi33	-0.65***	-0.66***	-0.72***	-0.70***	-0.67***	-0.82***	-0.87***	-0.92***	-0.65***	-0.81***
	(-13.76)	(-11.09)	(-11.70)	(-16.28)	(-16.33)	(-22.44)	(-18.48)	(-19.30)	(-15.70)	(-21.68)
lncrdpa		0.25***							0.29***	
		(8.34)							(9.72)	
warhg			-0.10***		-0.05***	-0.15***	-0.11***			
			(-7.09)		(-3.51)	(-23.48)	(-10.55)			
repo	-0.06***	-0.03**							-0.02**	
	(-6.54)	(-2.39)							(-2.38)	
lltvm					0.37**		0.35***			
					(2.65)		(3.14)			
lnltvl	1.04***					1.02***				
	(3.46)					(6.20)				
lnltvs		0.37***								
		(3.46)								
lnrwm			-0.15***	-0.23***	-0.11***	-0.10***	-0.19***	-0.24***	-0.11***	-0.22***
			(-4.85)	(-5.76)	(-3.33)	(-3.90)	(-10.39)	(-5.56)	(-3.47)	(-10.02)
lnlti								0.39***		
								(4.77)		
lnasstprov									-0.11***	-0.12***
									(-3.57)	(-4.39)
R2 (within)	0.81	0.87	0.71	0.88	0.85	0.95	0.93	0.95	0.87	0.90
F-stats.	235.03(0.0)	102.43(0.0)	129.77(0.0)	298.09(0.0)	165.52(0.0)	842.54(0.0)	298.79(0.0)	164.57(0.0)	242.96(0.0)	322.47(0.0)
No. of groups	33	33	33	33	33	33	33	13	33	33
T	10	6	10	10	9	10	10	5	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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.

Appendix Table A13. 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)
lnddppc	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)		
lnpop_city									0.71***	0.23*
									(7.05)	(1.93)
lnrconcoix	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)		
lnrentix		0.40***					0.24**			
		(3.88)					(2.09)			
lnrbse_rhpi33	-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)
lnrcrdpa						0.08			0.12***	0.19***
						(0.12)			(3.31)	(6.17)
rwarhg	-0.01***							-0.05***		
	(-3.04)							(-5.11)		
rrepo		-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)
lnltvm			0.60***				0.73***			
			(5.54)				(-3.27)			
lnltvl				0.93***		0.92**				
				(3.36)		(2.27)				
lnltvs					0.33***					
					(3.36)					
lnrwm			-0.11***				-0.22***			
			(-5.16)				(-8.59)			
lnlti								0.44***		
								(3.06)		
lnemiy								-0.37**	-0.22**	-0.20**
								(-2.08)	(-2.13)	(-2.31)
lhpiy									0.25**	
									(2.08)	
lnasstprov										-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 A2 for the definition of the variables.
*, **, ***: represent significance level of 10%, 5% and 1%, respectively.