What Causes Asset Price Bubble in an Emerging Economy? Some Empirical Evidence in the Housing Sector of India

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Abstract**:** *The study examines the dynamic causal relationships between house price and its five determinants; real income, short-run real interest rates, real stock price index, real effective exchange rate, and real non-food bank credit by using the quarterly data from 1996:Q1 to 2007:Q1 for India. Using cointegration test and vector error-correction model (VECM), the study finds that in the long run, real income significantly and positively influences the housing prices while real non-food bank credit adversely influences it. The net impact is a rise in housing prices on account of rising demand reflected in the increased income. The variance decomposition results suggest that it is the shocks to the non food bank credit which mainly explains the variability in housing prices besides its own shocks being the most influential while other factors are not significant. This suggests that the role of credit availability as a supply side determinant cannot be underestimated in the dynamic behaviour of housing prices in emerging economies.*

Keywords: Housing price; Stock price, Interest rate, Bank credit, & Exchange rate

JEL Classification Codes: R31; G12; E44; & F41

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Introduction

A variety of demand and supply side factors determine housing prices in an emerging economy. These factors could be quantitative as well as qualitative in nature. The size of population, its composition, urbanization, economic prosperity, role of speculative investors, government policy intervention and monetary policy etc. are among the host of factors that play dynamic role in the housing markets. It is difficult to capture all of these factors in the macro modeling of housing prices. Therefore, studies differ in modeling the factors influencing housing prices. Further, what explains at the micro level may not hold good at the macro level partly due to differences in location and other specific qualitative factors and partly due to the inherent data constraints at the macro level. Similarly, what holds in developed countries' context may not hold good for emerging economies context. For example, the intensity of speculation in housing market is not the same across the economies. The intensity of speculation in the developed economies is so significant, that could cause business cycles (Leamer, 2007), as is the resulting recent recession in US, an outcome of the sub prime crisis while this is rare instance in emerging economies.[1] The intensity of speculative impact differs according to the market demand conditions. With faster rise in growth of income, the emerging economies are witnessing structural changes with regard to their pattern of consumption and investments. There is an increasing demand for housing as an asset for future returns and an asset to live. This is backed up by increasing speculations by the foreign investors in the housing market of emerging economies depending on the degree of their entry restrictions in different markets.

Traditional models of housing market are based on the assumption that housing markets clear instantaneously. Prices are assumed to adjust almost immediately, so that the demand for housing equals the existing stock at any point in time. However, recent theoretical and empirical works have established that the market for owner-occupied housing is often inefficient and adjusts slowly to changes in market conditions (Case and

[1] Speculative impact of stock market on the economy is quite different from speculative impact of housing market. The impact of stock market on the economy is temporary in nature than the impact of housing market. The housing price buble takes time to occur.

Schiller 1989). DiPasquale and Wheaton (1994, 1995) find strong evidence that it takes several years for market changes to be fully incorporated into housing prices. The present study makes an attempt to understand the housing price behaviour in a dynamic emerging economy such as India, where the economy has undergone dramatic changes since the early 1990s and examine the rate of adjustment in the housing market for reaching to its long run equilibrium. Before the study embarks on the analytical framework to that end, it is imperative to study and identify various determinants of housing prices in various country cases (emerging and developed) by carrying out a comprehensive survey of literature.

There exists a great deal of studies in various developed and emerging economies on housing prices. Studying US data, Abraham and Hendershott (1994), found that the construction costs, employment growth and income growth are significant in predicting housing prices across the metropolitan housing markets. Similarly, examining housing price growth dynamics in a sample of 130 metropolitan areas across US during 1984-1998, Jud and Winkler (2002) found that real housing price appreciation positively responds to population growth, income, construction costs and negatively responds to real interest rate. The stock market appreciation is found to impart a strong current and lagged wealth effect on growth of housing prices. Miller and Peng (2004) examining the volatility of single-family home value appreciation in USA, for 277 metropolitan statistical areas (MSA) during 1990:q_1-2002:q_2, found a strong effect of exogenous change in population growth rate on the volatility of home value appreciation.

In an interesting attempt, using impulse response analysis for Greece during 1981–1990, Apergis and Rzitis (2004) found that housing loan rate is an important variable with highest explanatory power for the variation of housing prices, followed by inflation and employment. Chen and Patel (1998) in Taipei context found that household income,

short-run interest rate, stock price index, construction costs and housing completion Granger-cause house prices. Analysing the determinants of housing price for Australian during the period 1970-2003, Abelson et al.(2005) found that in long-run housing prices are related positively to real income and inflation rate and negatively to unemployment rate, mortgage rates, equity prices, exchange rate and housing stocks. Similar result was also evidenced by Egret and Mihaljek (2007) for eight transition economies of Central and Eastern Europe (CEE) and nineteen OECD countries. They strongly argued that rising housing prices is the result of increasing concentration of economic activities, especially due to booming of the service sector in urban areas. Allen et. al. (2006) investigating the relationship between city housing prices and city specific variables across eight metropolitan cities of Canada in 1981-2005, found that union wage level tends to positively influence city existing-housing prices.

Applying GLS procedure on the panel data from 1987 to 1999 for 71 Spanish province capitals and bigger cities, Paz (2000) observed that rising housing price is attributed to demand determinants such as wages of labour, migrants and productive structure. In addition, housing price in urban areas depends on the market characteristics such as vacancy level, land availability, costs of construction, economic growth, industry, and service sectors activities. Muellbauer and Murphy (1994) also stressed that shortage of supply factors, i.e., land on account of expansion of cities, increases the value of land, tensing the high housing prices.

Examining cross-sectional house price appreciation in the Boston metropolitan area during 1982–1994, Case and Mayer (1995) observed that results were consistent with many predictions of standard urban model. They found house prices in towns with a large share of residents working in the manufacturing sector in 1980 grew less quickly in the ensuing years when aggregate manufacturing employment fell. As baby boomers moved into middle age, house values appreciated faster in towns with a larger initial percentage of middle-aged residents.

In contrast, Bourne (1981) stressed rising housing price is the result of quality location, and preferences of households. Kundu et al. (1997) found that land price rise was observed in the polycentric Lucknow urban city of India where decentralization is occurring compared to the old main city centres and attributed the land price rise in urban city to macro and micro socio-economic factors such as availability of economic opportunities, level of urban services and state intervention through land acquisition. This is also commonly observed in different polycentric cities of India. The above literature reflects that various macro factors (quantitative and qualitative) influence house prices in different country situations although there are some common macro determinants and, when it comes to India there are dearth of studies at the macro level.

Analytical Framework

Housing markets, like other durable goods markets, can be viewed to have a flow dimension and stock dimension. Net investment, the flow dimension, is the sum of construction of new residential units and depreciation of existing units. The long-run supply or stock of housing is the accumulation of net investment. DiPasquale et. al.

(1994) and Riddle (2000, 2004) define the long-run equilibrium stock, S_t, to be a function of price, P_t, and a vector of cost shifting variables such as construction costs including material costs and labour cost, land cost and credit availability, $X_{s,t}$ so that, in functional form it can be written as:

$$S_t = S\left(P_t, X_{s,t}\right) \qquad (1)$$

The model can be specified in a linear form as:

$$S_t = \alpha_0 + \alpha_1 P_t + \alpha_2 X_{s,t} + \nu_t \qquad (2)$$

Similarly, housing demand theory defines equilibrium demand, 'D_t' for the current stock of housing as a function of price (P_t), and a set of demand variables such as income, mortgage interest rate, population growth, wealth, and overseas demand, $X_{d,t,}$ so that the long-run demand for housing in functional form may be written as:

$$D_t = D\left(P_t, X_{d,t}\right) \qquad (3)$$

This can be specified in a linear equation form as:

$$D_t = \beta_0 + \beta_1 P_t + \beta_2 X_{d,t} + \varepsilon_t \qquad (4)$$

Accordingly, in the economic literature (Hendry 1984; Meen 1990; Muellbauer and Murphy 1997) the housing price model most often takes an inverted demand equation of the following general kind:

$$P_t = f\left(X_{d,t}, X_{s,t} Z_t\right), \qquad (5)$$

where Z_t refers to qualitative variables influencing the housing price. However, economic theory does not provide a finite list of variables. It may be useful to make some observations about the main possible determinants of housing prices in Indian dwelling market as it is difficult to capture all the factors.

Given the above framework, the final estimable housing price equation can be specified as follows:

$$HPI_t = \theta_0 + \theta_1 DY_t + \theta_2 BSEI_t + \theta_3 NFC_t + \theta_4 REER_t + \theta_5 RIR_t , \quad (6)$$

where HPI_t refers to housing prices, DY_t refers to disposable income, BSE denotes Bombay Stock Exchange Index, NFC_t denotes non-food bank credit, $REER_t$ indicates real effective exchange rate and RIR_t denotes real interest rates. Before undertaking empirical analysis, it is important to analyse the relative importance of possible determinants of housing prices. Income is generally an important demand factor explaining the behaviour of housing prices. The preferred form of income variable is disposable income (DY_t) per household. The households with high disposable income have the high probability of demand for housing services (Abelson et.al., 2005, and Joshi 2006). When the real mortgage interest rate (*RIR*) rules at low level that can lead to housing prices rise.[2] The easy availability of credit for housing sector (non-food bank credit) at cheaper rates can push up the housing prices (Himmelberg et. al., 2005, Joshi 2006). Because, loans at cheaper rates enables the homebuyers to get loan from the financial and non-financial institutions against their asset backed securities (ABS). When borrowing cost is low, it helps the property holders to raise more finance from the banks against their assets, leading to increases in housing prices.

[2] See Abelson et al. (2005). Economic theory suggests that real rates are more important because nominal component of interest costs should be offset by nominal increase in housing price. The nominal interest rates can create a repayment problem in the early years for some borrowers and restrict their borrowings. An unregulated interest rate may reflect real borrowing costs better.

Indeed, in an open economy like India, the trade based weighted real effective exchange rate (*REER*) can influence housing prices (a low exchange rate for foreigners increases the attractiveness of housing assets) (Abelson et al., 2005). Wealth (value of asset) may also influence housing demand. However, a proper estimate of wealth is not available for many emerging economies like India. Equity is an important component of wealth (Bombay Stock Exchange 30 share index-*BSE*) and may positively be related to housing prices (Chen and Patel 1998, Egert and Mihaljek 2007). Also, when supply of equities is high, the returns on those assets plunge and investors substitute housing for their investment purposes. Alternatively, the investors apparently enter into housing market following crash in stock market. This is also observed in 21st Jan 2008 where Indian stock market witnessed historically a 4th biggest crash, called tsunami in the Indian stock market (*The Economic Times* 23rd Jan 2008).

Understanding Theoretical Relationships

In the preceding section a housing price equation is specified where different factors exert influence on housing prices. However, the relationship between housing price and its determinants are ambiguous depending upon country situations such as economic prosperity, openness of the economy to capital flows and housing markets etc. Theoretically and empirically in most studies, it is usually assumed that the determinants of housing price are exogenous and therefore are expected to cause housing price changes. However, in most cases, there could exist two-way relationship, meaning that housing prices may affect those determinants due to simultaneity relationship.

An increase in real disposable income makes household more affluent. This raises the demand for housing and consequently prices. On the other hand, there can also be a feedback effect from housing prices to income. This is due to the fact that a house represents an accumulation of wealth by households that increases with appreciation of returns on account of appreciation of housing prices. It gives rise to income in the form of increases in rent and appreciation of its value. Conversely, falling housing prices depresses homeowner's wealth and in turn, leads to reduction in consumption spending over and above that associated with current income. As a result, even a small percentage decline in the value of housing assets can generate wealth losses that are large in relation to national income.

Prices of financial assets, namely stock prices, may also have a two-way causality relationship with housing prices given that households' portfolios comprise both financial and physical assets. This bilateral causality relationship suggests that stocks and housing assets act as alternative investment avenues for households. Housing usually requires a large initial money capital compared to buying or investing in stocks/shares. It is also true that owner-occupiers cannot afford to sell and buy houses just following a small change in prices caused by economic circumstances because of relatively high cost associated with acquisition of housing and, the investment on it, is also long-term in nature[2]. It can therefore be, argued that stock and housing markets are two independent markets with no short-term causality in either direction. But, there could be a long-term

[2] Housing has a volume cycle, not a price cycle. Home prices are very sticky downward. When there is decline in price, house owners would not rush for selling the house expecting there would be a further decline in prices. Rather, they would hold it even at lower prices (Leamer, 2007).

relationship. When returns on stocks improve, it gives rise to wealth and that can be ustilised in holding house assets by individuals.

However, housing prices could have one-way causality relationship with monetary factors. Low interest rate (cost of borrowing) may lead to surge in housing prices when it is complemented with abundant credit availability. There may not exist a feedback relationship from house price to cost of credit. Housing prices could have two-way causality with trade variable. The trade-based low real effective exchange rate could increase the overseas demand for housing prices. On the other hand, low housing price can lead to appreciation of exchange rate. Apart from these, the policies related to the external sector can also influence housing prices in the domestic market. The factors such as stock market index and interest rates already considered are supposed to capture the aspects of financial liberalization. However, some of the external policies are of recent origin in emerging economies[3]; allowing the entry of foreign investors into domestic housing markets or issuing housing equity to the foreigners. This is likely to affect the housing prices in the recent and future periods in the Indian scenario which is beyond the scope of the present study. Since it is a very recent phenomenon, therefore, capturing the effect of this policy would be difficult in time series models.

Given the above relationship, the present study attempts to explain the housing price behaviour in India in a partial macroeconomic framework. The partial adjustment

[3] The Government of India (2005) took the bold steps in liberalizing the economy and the housing sector in particular. The Government has decided to allow FDI upto 100 percent under the automatic route in townships, housing, built-up infrastructure and construction development projects, which include commercial premises, hotels, hospital, recreational facilities, and regional level infrastructures.

housing-market model proposed by DiPasquale and Wheaton (1994) is considered. The framework is useful when an analysis could capture a few direct and indirect important determinants of housing prices, as it is difficult to obtain the information on all the quantitative and qualitative variables influencing housing prices in developing economies. Against this backdrop, the primary objective here is to establish the dynamic casual relationships between housing prices and its determinants, such as real income, real stock prices, real non-food bank credit, real interest rates and real effective exchange rate in India.

Data Sources and Description

To understand housing price behaviour in India, the study uses quarterly data. All the data are collected from Reserve Bank of India (RBI) Monthly Bulletin, Handbook of Statistics on Indian Economy, RBI and Central Statistical Organisation, Government of India. The choice of the data period for the empirical analysis is purely based on the availability of data series. The quarterly data with a higher frequency would establish the relation in a more liberalized regime where significant policy changes have taken place in the domestic financial environment and in the external environment. So**,** the quarterly data set used spans from 1996:1 to 2007:1. The data on variables include housing price index (HPI), real Gross Domestic Product (RGDP), real mortgage rate (RSBIR), non food bank credit (NFC), real effective exchange rate (REER), and Bombay stock exchange index (BSE). The housing price index is a based on monthly Consumer Price Index for the industrial workers estimated by the Reserve Bank of India. It is a general measure of housing price in India. Since data on determinants of housing prices including housing prices are available on a monthly basis, therefore, sum of monthly data for four consecutive periods in the series are averaged to produce quarterly observations. The same does not apply for GDP series as it is already available on quarterly basis. The

short-term 91-days Treasury bill rate is taken as a proxy for the real mortgage rate.[4] The non-food bank credit, real effective exchange rate and Bombay Stock Exchange have been considered as to represent credit availability for housing and other durables, overseas demand and stock prices respectively. The quarterly data on real GDP series is considered with a new base year 1999-2000=100. Since the data with the new base period is not available prior to 1999-2000, the real GDP data with base 1993-94 =100 is spliced forward into the new base year. Further, BSE Index is collected with base 1978-79 = 100. The 36-currency bilateral trade based weights real effective exchange rate is collected with 1993-94 =100 base year. The variables, measured in nominal terms such as interest rate, stock price index, and non-food bank credit are deflated by the Whole Sale Price Index (WPI) in order to consider their real values. All the variables are converted into natural logarithms, with the exception of real effective exchange rate, and real interest rate. The data on population characteristics and other qualitative variables are difficult to account for on a quarterly database.

Econometric Methodology

Time series procedures are employed to understand housing price behaviour in India. It assumes in the long-run, housing price adapt to economic fundamentals. However, in short-run, the housing price may deviate from long-run equilibrium; but continually readjust to the deviations through an error correction mechanism. Therefore, we use Johansen cointegration-vector error correction model (VECM) (1988, 1991) as a suitable strategy to examine the co-movement between housing price and economic fundamentals and their dynamic relationship both in the long and short-run. Engel Granger test suffers from low power and the usual problem of simultaneity biasedness is associated with single equation approach. Consequently, we choose to test for cointegration using Johansen method. This enables to know the housing market disequilibrium in short-run.

[4] The study also considers 364-day treasury bill rate in place of 91-day treasury bill rate for verification of results. However, it is subsequently seen that results remain unchanged.

As a check for robustness of results, the study utilises impulse response and variance decomposition of Vector Autoregression (VAR) method as proposed by Sims (1980).

Time Series Properties of Variables

To test for cointegration in housing price equation, first, one needs to ensure that the variables are integrated of same order. Therefore, we conduct unit root test for each variables in the model. Augmented Dickey Fuller (ADF, 1979) test is the most popular tests for stationarity, however, due to its limitations in correcting for heteroscedasticity, a non-parametric test devised by Phillips-Perron (PP, 1988) is performed for verifying ADF results.

Secondly, the result of the Multiple Cointegration test can be quite sensitive to the lag length. Therefore, it is imperative to check an optimal lag length. The study usually selects an appropriate lag according to Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). It usually prefers the latter as it selects longer lags. The logic of preferring a longer lag is that it can show the effects of housing price determinants, in the current period, over a longer time. There may persist lagged effects of determinants of housing price besides their immediate impacts.

Cointegration and Vector Error Correction Model

The aim was to analyse housing price dynamics. Therefore, as a check for robustness, the study applies VAR model. However, one area of controversy for estimating in VAR models is whether the variables included in the model should be stationary or not. Some

argue that if the time series is non-stationary, regression of one time series variable on one or more variables can often give rise to spurious results due to the effect of a common trend. Sims (1980) and others, though, recommend against differencing even if the variables have a unit root. The main argument against differencing is that "it throws away" information concerning the co-movement in the data, which in general, leads to poor forecasting. However, econometricians use stationary variables for stability and robustness in VAR results. Therefore, wherever endogenous variables are found to be non-stationary, we consider differencing the series for stationarity. The VAR model can be represented as follows:

$$\Delta Y_t = \gamma_y \, \mu_{t-1} + \sum_{i=1}^{\eta} \alpha_i \, \Delta Y_{t-i} + \sum_{j=1}^{\eta} \beta_j \, \Delta X_{t-j} + \varepsilon_{1t} \qquad (7)$$

$$\Delta X_t = \gamma_x \, \mu_{t-1} + \sum_{i=1}^{\eta} \delta_i \, \Delta Y_{t-i} + \sum_{j=1}^{\eta} \phi_j \, \Delta X_{t-j} + \varepsilon_{2t} \qquad (8)$$

The above two equations constitute a vector autoregression model (VAR) in first differences. In equation (7) and (8), if γ_x and γ_y equal to zero, it is a traditional VAR in first difference. If γ_y differs from zero, ΔY_t responds to the previous period's deviation from long-run equilibrium. Hence, estimating Y_t as a VAR in first differences is inappropriate if Y_t has an error correction representation. Therefore, if the variables are non-stationary and cointegrated in the same order, correct method is to estimate the Vector Error Correction Model (VECM), which is VAR in first-differences with the addition of a vector of cointegrating residuals. Thus, with this procedure, the model does not lose long-run information. Therefore, the study does not estimate VAR model in differences. However, for checking the dynamic relationship among the variables, it uses impulse response and variance decomposition procedures in differences of variables.

Impulse response function and variance (forecast error) decomposition are two procedures for characterising the dynamic behaviour of the VAR model. Equations (7) and (8) are rather difficult to describe in terms of α_i and ϕ_j coefficients; the impulse response functions and variance decomposition techniques are useful devices in the VAR framework for testing the sources of variability. The impulse response traces the response of the endogenous variables to a shock in another variable in the system. The variance decomposition splits the variance of the forecast error for each variable into components shocks that can be attributed to each endogenous variables.

Following Sims' (1980) seminal paper, dynamic analysis of VAR model is routinely carried out using ''orthogonalized'' impulse responses, where the underlying shocks to VAR model are orthogonalized using Cholesky decomposition method. This method assumes the system is recursive. In other words, all the determinants are influencing housing prices simultaneously and the estimations of impulse response and variance decomposition are orthogonalized so that the covariance matrix of the resulting innovations is a lower triangular matrix.

Empirical Results and Discussion

The empirical analysis reported here is based on a two-stage estimation. In the first stage, cointegration analysis is used to identify cointegrating relationship among the variables. This is important because if two non-stationary variables are cointegrated, a VAR model in the first difference is misspecified. If cointegration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic Vector Error Correction Model (VECM).

Table 1: Results of Unit Root Test

Variables	Levels		Ist Difference		
	ADF	PP	ADF	PP	Inference on Integration
LHPI	$-1.716^{C}(4)$	$-0.40^{T}(4)$	$-5.36^{T}(1)$	$-4.06^{N}(1)$	1
LGDP	$4.95^{C}(3)$	$-6.50^{T}(1)$	$-15.98^{C}(1)$	$-7.22^{C}(1)$	1
LBSE	$-1.53^{T}(1)$	$-1.40^{T}(1)$	$-4.42^{N}(1)$	$-4.99^{N}(3)$	1
LNFC	$3.03^{C}(1)$	$3.88^{C}(1)$	$-6.48^{T}(1)$	$-6.24^{T}(1)$	1
RT91	$-3.78^{T}(1)$	$-13.32^{T}(1)$			0
REER	$-2.64^{C}(1)$	$-3.02^{C}(1)$			0

Note: L stands for Logarithm of the respective variables, and the optimal lag length for the ADF and PP tests is based on the AIC and SBC Criteria. The McKinnon critical values for ADF and PP tests at 1%, 5% and 10% are –3.59, -2.93 and -2.60 respectively for without trend but intercept (denoted by superscript C) and -4.18, -3.51 and -3.18 respectively for with trend and intercept (denoted by superscript T) and - 2.61, -1.94 and -1.61 respectively for no trend and intercept (denoted by N). For PP tests at 1%, 5% and 10% are –3.69, -2.97 and -2.62 respectively for without trend but intercept and -4.33, -3.58 and -3.22 respectively for with trend and intercept and - 2.65, -1.95 and -1.62 respectively for no trend and intercept.

As discussed in previous section, it is necessary to check the order of integration of the level variables for an appropriate econometrics method. Therefore, unit root tests of each variable at their levels as well as first difference of non-stationary level variables were conducted. The result from Table 1 shows that all the variables are non-stationary at their levels except RT91 (short-term 91-day Treasury bill rate) and REER. However, all the non-stationary variables are found to be stationary at their first differences, and therefore, are integrated of order one.

Cointegration -Vector Error Correction Model

The cointegration model used here has total six variables; four non-stationary variables viz house price Index (LHPI), Per capita real GDP (LPRGDP), Real Bombay Stock Index (LRBSE), Real Non-food Bank credit (LRNFC) and two stationary variables viz Real Effective Exchange rate (REER), and Real State Bank of India advance rate (RSBIR). Two stationary variables have been assumed to be exogenous in the

cointegration framework as they are likely to exert their influence on house price in the long-run rather than getting influenced by other variables. Studies also show that their behaviour is quite independent of movement of other monetary, fiscal and real influences (Nachane, Karnik and Hatekar 1997; Mallick and Agarwal 2007). Since they are found to be stationary, the study assumes them as exogenous in the cointegration model. However, in the error correction equation, they are treated as endogenous, the constant, and an error correction term being exogenous to the model.

The VECM involves selection of appropriate lag length. An inappropriate lag selection may give rise to problems of overparametrization or underparameterization. The objective of estimation is to ensure that there is no serial correlation in the residuals. Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn criterion (HQ) are used to select optimal lag lengths. Up to three lags are tested in the present study. The resulting lag structures are reported in Table 2. All the criteria such as LR, FPE, AIC, SC, and HQ select for second lag. Hence, the second period is considered to be optimal lag here.

Table 2: Selection of Lag Length in VAR

Lags	Log L	LR	FPE	AIC	SC	HQ
0	18.57	NA	5.87	-0.69	-0.52	-0.63
1	220.80	356.30	8.30	-9.56	-8.73	-9.25
2	266.54	71.87*	2.06*	-10.97*	-9.48*	-10.43*
3	278.21	16.11	2.68	-10.77	-8.62	-9.98

Note: * Indicates lag order selected by the criterion, NA shows not available.

Results from Cointegration Tests

Cointegrating relationship is tested with equation (6). The relationship is estimated by the Johansen (1988) multivariate cointegration test.[7] Table 3 presents the trace and maximum eigenvalue statistics for the sample period: 1996:1 to 2007:1. The test statistics and asymptotic critical values at 1% and 5% are also shown in the Table 3. Both the tests reject the hypothesis of no cointegration **($\delta = 0$)** at the 1% and 5% level, where as they do not reject the hypothesis that **$\delta \leq 1$.** This suggests that there exists at least one cointegrating vector in the model. Therefore, the conclusion is that **$\delta = 1$**, that is, there is one stationary relationship among the variables.

Table 3: Johansen Co-integration Rank Test

Null Hypothesis	Alternative Hypothesis	Trace Statistic	5% Critical Value	1% Critical Value
$\delta = 0$	$\delta \geq 1$	56.10*(**)	47.21	54.46
$\delta \leq 1$	$\delta \geq 2$	13.01	29.68	35.65
$\delta \leq 2$	$\delta \geq 3$	3.65	15.41	20.04
Null Hypothesis	Alternative Hypothesis	Maximum Eigen Statistic	5% Critical Value	1% Critical Value
$\delta = 0$	$\delta = 1$	43.08*(**)	27.07	32.24
$\delta \leq 1$	$\delta = 2$	9.35	20.97	25.52
$\delta \leq 2$	$\delta = 3$	3.65	14.07	18.63

Note: * and ** shows significant at 5 % and 1 % level.

Long Run Estimates of Housing Price Equation

The long run coefficients obtained from cointegrating equation shows that the real income measured from real *GDP* has a significant and positive influence on the housing

[7] In Johansen Test, we can calculate the trace statistic, i.e., λ_i (0) = -T [ln (1-λ_1) + ln (1-λ_2) + ln (1-λ_3). Where T is the total number of observation less the lags and λ_i are the characteristics roots of Coefficient matrix of independent variables. Similarly, the same formula can be used in the calculation of maximum Eigen value statistic. See Ender et al. (2004) for more details.

price while the real *BSE* index does not have any influence on housing price. In addition, the real non-food credit has a significant and surprisingly negative influence on housing price. The housing price responding negatively to the bank credit availability in the long run may arise for the reason that when more credit is available from the banks, it rapidly give rise to construction of number of new houses and thereby it suppresses the price of housing. In this case the supply force dominates over the demand forces consequent upon availability of bank credit. The credit has more of supply force than its demand force. It gives rise to increased supply of houses as credit gets utilized in the construction process than utilization of bank credit just in buying number of new houses. There might also be houses constructed but there may not be economic demand because of affordability problem on the part of individuals. Once an income factor comes in, it gives rise to economic demand and thereby leading to rise in prices. Otherwise, new arrival of houses arising from credit availability could put downward pressure on house prices or keeps the housing markets dampen. It could be seen in equation (11) that increased demand arising due to increased income has a dominant impact on housing prices than the supply force due to availability of bank credit. In overall, it leads to rise in housing prices.

$$\underset{}{HPI_t} = \underset{(7.29)^*}{14.86\ RGDP_t} - \underset{(-0.85)}{0.21\ RBSE_t} - \underset{(-7.46)^*}{7.54\ RNFC_t} \qquad (11)$$

Short Run Estimates of Housing Price from VECM Model

The coefficients of error correction term in the VECM shows that it is significant and possesses correct sign (negative sign) implying that there is partial adjustment of housing prices in the short run to its deviations from its long run equilibrium path. The adjustment is around 10 per cent per quarter. This implies that any disequilibrium in the housing market from its the long run equilibrium takes around 2 and half years for correcting the disequilibrium. Looking at the short-run parameters, it suggests that surprisingly both real GDP and real interest rate have significant and negative influence on housing prices. Other variables do not play significant role in the short run. Some literature argues that housing investment is long term in nature. It needs enhanced permanent income for

housing investment. Even if there is a change in transitory income in the short run, the housing investment will not be stimulated unless there is an increase in the permanent income. This is the reason why a short run rise in income does not encourage to invest/construct on housing, thereby putting downward pressure on the housing prices. It is also found that about 52 per cent ($R^2 = 0.52$) of housing price variations is explained by its controlled determinants. The remaining (48 per cent) of housing price variations is explained by the other qualitative factors, which is implicitly incorporated in the residual of the system equation.

$$
\begin{aligned}
DHPI_t = {} & 0.14 + 0.62\ DHPI_{t-1} - 0.35\ DHPI_{t-2} - 1.04\ DRGDP_{t-1} \\
& (0.150) \quad (3.744)^{*} \qquad (-2.268)^{*} \qquad (-1.963)^{*} \\
& - 1.09\ DRGDP_{t-2} - 0.02\ DRBSE_{t-1} - 0.13\ DRBSE_{t-2} + 0.43\ DRNFC_{t-1} \\
& (-2.100)^{*} \qquad (-0.027) \qquad (-0.573) \qquad (0.388) \\
& - 1.02\ DRNFC_{t-2} - 0.01\ RT91_t + 0.01\ REER_t - 0.10\ ECM_{t-1} \qquad (12) \\
& (-0.719) \qquad (-1.305)^{*} \quad (0.014) \qquad (-1.386)^{*} \\
& R^2 = 0.52\ , \quad \bar{R}^2 = 0.35
\end{aligned}
$$

Table 4: Bivariate Granger Causality Test

Null Hypothesis: No Causality	Lags	Obs	F-Statistic	Probability
DRGDP → DHPI	4	40	2.09	0.10
DHPI → DRGDP			0.14	0.96
DRBSE → DHPI	1	43	3.18	0.08
DHPI → DRBSE			0.17	0.68
DRNFC → DHPI	5	39	3.58	0.01
DHPI → DRNFC			0.42	0.83
RT91 → DHPI	1	43	0.13	0.71
DHPI → RT91			3.06	0.08
REER → DHPI	1	43	1.95	0.17
DHPI → REER			2.98	0.09

As a prelude to estimating in a multivariate set up of VAR, the study conducts Granger causality test between housing prices and its determinants. If there exists some causality relationship among the variables in the bi-variate model, then only it makes meaningful to test their relationship in a multivariate framework. The estimated *F*-statistics of the causality test are reported in Table 4. The results of F-statistic suggest that all determinants including national income, Bombay stock exchange, and non-food bank credit granger cause housing prices, except real interest rate (RT91) and real effective exchange rate (REER). Although no causality is observed from real interest rate and the trade based real effective exchange rate to house price, but the reverse causality exists

A number of points also emerge from causality test results. Saravanan, Ramamoorthy, and Nagarajan (2007) have indicated that there is some evidence of inertia with short-term interest rate, implying a decrease in short-term interest rate causes rising housing prices in Indian economy and vice versa. Because the buyers enjoy short-term floating interest rate rather than the long-term interest rate. The main effect of interest rate on housing prices is likely to come through its effect on builders' funding cost and buyers' borrowing cost. The feedback effect, however, is not observed in our result. The results indicate that real effective exchange rate Granger causes housing prices as expected, but the reverse causality effect is not observed. Although, the theory suggests that depreciation in exchange rate could push up housing prices, this may not be the case in the short run.[8] However, given these results, it makes sense to include all of these variables in a VAR framework to understand the true dynamic relationship among the variables.[9]

[8] Abelson et al. (2005), 'In an open economy, the exchange rate could influence house prices i.e., a low exchange rate increases the attractiveness of housing assets to foreigners. As a result, the increasing housing investment on housing will lead to rising housing prices in an economy''.

[9] The causality test results may show that there may be a bi-directional causality relationship among two variables, but that could be due to a third common factor with which two variables are related without having true causality relations among the tested variables. Similarly, test result may show that there does not exist any causality relationship, but there could be causality between two variables once the intermediate link between the two variables is established through other variables in a multivariate framework. Therefore, it necessitates a multivariate modelling in order to discover the true direct and indirect relationship among the variables.

To provide further insight on the relationship of housing prices and its determinants, the variance decomposition and impulse response function are computed. These two approaches give an indication of the dynamic properties of the system and allow us to gauge the relative importance of the variables beyond the sample period. Before estimating Variance Decomposition and Impulse Response functions, one needs to ensure the model adequacy by using the required diagnostic checking procedures.

The results reported in Table 5 points out that VAR estimated with lag two satisfies the stability test, normality test as well as no serial correlations among the residuals in the VAR model. Therefore, it leads us to take the position that our model fulfils the model adequacy tests for the statistical analysis.

Table 5: Diagnostic Checking Criterion

Adequacy Test for VAR model	Critical Values	Lags
Stability Test	0.93, 0.93, 0.85, 0.73, 0.61, 0.19	2*.
Normality (Chi-Square values)	0.50, 0.41	2*
Serial Correlation (LM-stat)	68.35, 43.06	2*

Note: * Indicates lag length.

Variance Decomposition Results

The variance decomposition measures the percentage of variation in housing prices induced by shocks emanating from its relevant determinants. The estimates of variance decomposition are shown in Table 6 for a period of 20-quarter time horizon. The results indicate that disturbance originating from housing price itself inflicted the greatest variability to future prices. It contributes 89 per cent variability one quarter ahead, approximately 54 per cent fifth quarters ahead. The proportion of variance remains high (56 per cent) even till (20th quarter). This result indicates that current change in housing prices heavily influences people's expectation of future price changes. Despite an average of 56 per cent variability contributed by current price changes, there remains 44 per cent

of variability, which is being explained by other five factors.[10] Total real non-food bank credit availability prevails over all other four housing price determinants in influencing house prices. This accounts for approximately 30 per cent of the total variance contributed by five determinants (i.e., 13 per cent of the total variance) as shown in the Table 6. This variable captures the amount of bank credit availability to households for house purchase or for taking rented houses as well as funds available to the builders for house constructions. A relatively high proportion of housing price variance induced by credit availability confirms its importance in the dynamic behaviour of house prices.

The third largest source of housing price variance appears to be from real BSE index, which accounts for approximately 21 per cent of the total variance among four determinants contributed by five determinants (i.e, 9 per cent of the total house price variance). This indicates a very significant relationship between the two markets. Clearly, during the past ten years of rapid economic growth and financial reforms in India the values of both real assets and financial assets have appreciated enormously. Thus, this implies that stock market and housing markets are perfectly integrated. Stock market, which is highly liquid with relatively low transactions costs, is characterized by high degree of speculative activity. It is possible that the stock market may have some influence on speculative house building and investment but this is likely to be temporary in nature.

Table 6: Variance Decomposition of Housing Prices

Horizon	REER	RT91	DRNFC	DRBSE	DRGDP	DHPI
1	0.73	2.68	3.01	1.49	2.09	89.97
	(-0.24)	(-0.46)	(-0.57)	(-0.35)	(-0.45)	(-10.52)
4	7.17	9.92	12.42	9.54	4.86	56.07
	(-0.84)	(-1.24)	(-1.51)	(-1.29)	(-1.40)	(-5.10)

[10] It can be emphasized that the current housing price variance (56 per cent) is accounted for by its own house prices in India. This implies housing price is a sufficient statistics for the homebuyers, thereby past rise in house prices leads to present rise in demand for housing with an expectation of future rise in house prices and in turn results in current rise in house prices. In contrast, for the house builders, the house price may not be a sufficient statistics due to increasing costs of production and in turn which limits the housing unit production.

5	7.72 (-0.82)	9.56 (-1.25)	14.64 (-1.68)	9.67 (-1.36)	4.64 (-1.38)	53.74 (-4.92)
7	8.22 (-0.84)	9.40 (-1.26)	14.56 (-1.68)	9.79 (-1.38)	4.88 (-1.41)	53.12 (-4.82)
10	8.67 (-0.84)	9.35 (-1.25)	14.68 (-1.72)	9.94 (-1.43)	4.95 (-1.37)	52.38 (-4.72)
14	8.81 (-0.79)	9.40 (-1.18)	14.62 (-1.68)	9.94 (-1.48)	5.22 (-1.31)	51.98 (-4.57)
18	8.86 (-0.73)	9.43 (-1.10)	14.58 (-1.59)	9.94 (-1.50)	5.37 (-1.24)	51.79 (-4.38)
20	8.87 (-0.71)	9.44 (-1.07)	14.57 (-1.57)	9.95 (-1.52)	5.41 (-1.22)	51.73 (-4.29)
Average1	7.58%	9.27%	13.12%	9.50%	4.71%	55.79%
Average 2	17.15%	20.98%	29.68%	21.49%	10.67%	

Note: Average 1 shows the average of total housing price variation and Average 2 shows the housing price variance from its individual determinant. The values in parentheses show *t*-statistic.

The fourth largest source of housing price variance appears to be from real short-term interest rate, which accounts for approximately 21 per cent of the total variance contributed by five determinants (i.e., 9 per cent of the total house price variance). This variable captures the cost of borrowing to household for house purchase as well as builder's development funding cost. A relatively high proportion of housing price variance induced by interest rate confirms its importance in the dynamic behaviour of house prices. It is, therefore, not surprising that it contributes a significant proportion of house price volatility.

Apart from these three determinants, two remaining variables account for less than 8 percent of total housing price variance. Real Effective Exchange Rate accounts for approximately 7 per cent of total house price variance (that is, approx. 17 per cent of the total variance among five determinants). However, the result indicates it is not significant. The final variable in the model, real GDP, contributes very little to housing

price variance (5 per cent of total housing price variance). The result suggests that the demand factor for housing market have more long-term impact than a short-run impact, which is being modelled in the above VECM.

Results from Impulse Response Function

Although the variance decomposition estimates the proportion of housing price variance accounted by its determinants, it cannot indicate whether the impact is positive or negative, or whether it is a temporary jump or long-run persistence. Thus, impulse response analyses are carried out to indicate system's dynamic behaviour. It predicts the responses of housing price to various shocks in its determinants. In other words, an impulse response function shows how a variable in the VAR system responds to one standard deviation shock in another variable of interest.

Figure 1 (a) to (f) illustrate the estimated impulse response functions for twenty-quarter time horizons. Real effective exchange rate is expected to have a negative influence on housing prices. In Figure 1(a), however, we find surprisingly that real effective exchange rate results in 0.01 per cent increase in housing prices during the first two quarters and there is a negative response only after third quarter. The results suggest that the appreciation of exchange rate discourages the foreign investors not to take any investment project in the economy where the exchange rate is overvalued against their currency, which subsequently leads to reduction of housing prices in an economy.

A one standard deviation disturbance originating from real interest rate in Figure 1(b) results in an approximately -0.02 per cent decline in housing prices in the first quarter; the price adjustment, however, undergoes a reversal (-0.01 to 0.01 per cent) between second to fourth quarter. Given that interest rate is often used by the monetary policy to dampen housing price inflation, higher interest cost could do both raise housing prices and also reduce demand and, consequently, causes decline in the house price. As seen in the Figure 1, interest rate has a negative relationship mostly in first year, implying that the chief determinant of housing prices is from the demand side in the short-run. But the

positive sign after fourth quarter suggests that the rise in interest rate increases builders' cost of capital, which is subsequently reflected in higher house prices in the long run.

Real non-food bank credit in Figure 1(c) has positive effect on housing prices as expected. It has a greater positive effect (0.03 per cent) in the first quarter, implying that buyers demand for housing increase rapidly due to easy availability of credit from public and private financial institutions in India. However, in the second quarter there is negative response in house price to one standard deviation shock in noon food credit. This is almost similar to the previous results obtained from VECM.

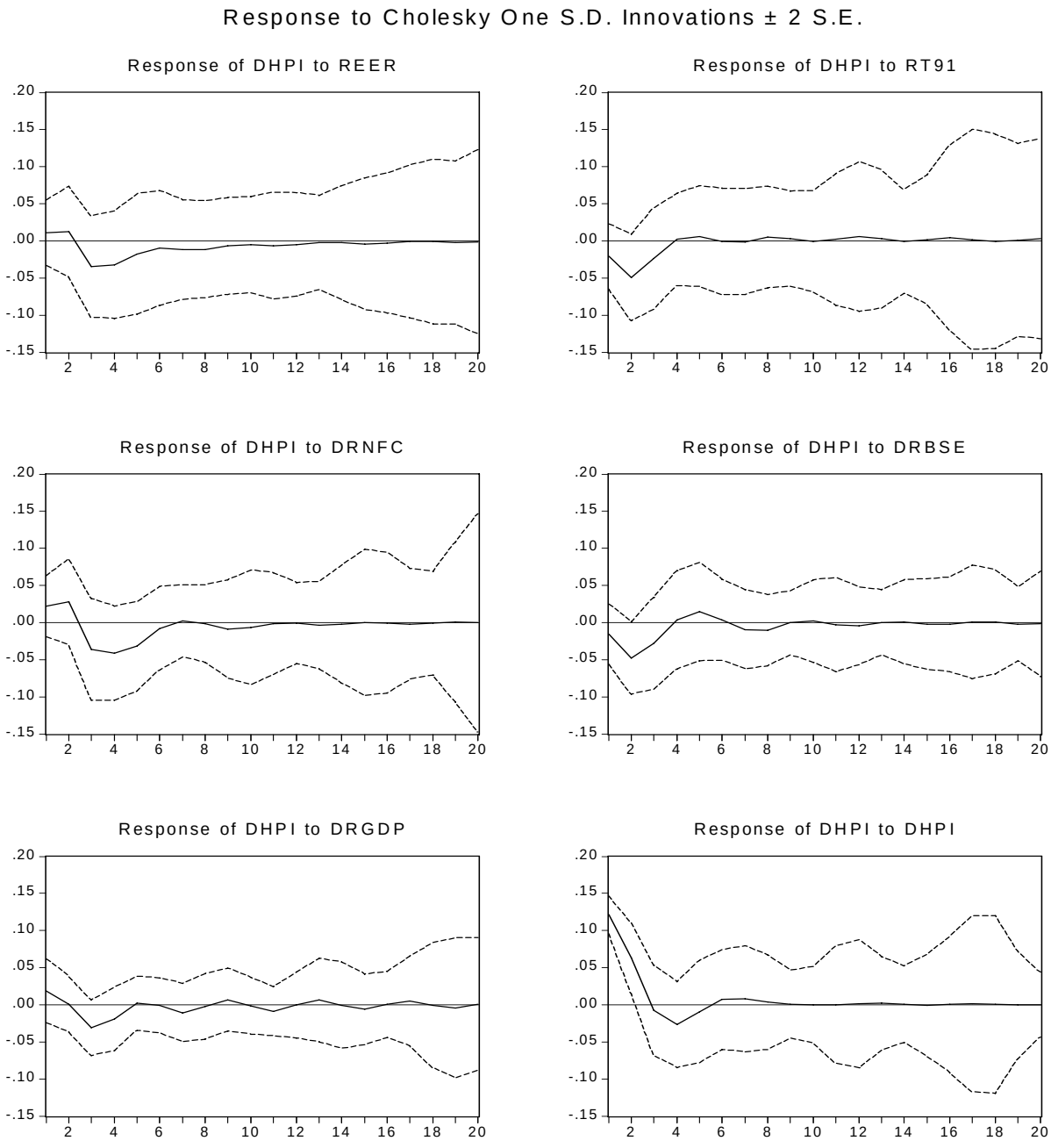
A one standard deviation disturbance originating from real stock price index in Figure 1(d) results in an approximately –0.01 per cent change in housing prices. It initially produces a negative impact on housing prices in first two quarters and has a large positive impact in third quarter. The possible explanation for the positive and negative impacts could be the influence of speculative activity in the stock market spilling over to investment in housing market. It is also feasible that wealth created in the stock market has a positive effect on the housing market in the long run.

A one standard deviation disturbance originating from real GDP in Figure 1(e) produces 0.02 per cent of increasing housing prices in the first quarter; the speed of adjustment is fairly rapid and it declines after the second quarter. In response to a one standard deviation disturbance in its own house price in Figure 1(f), house price increase by 0.12 per cent in the first quarter. This appears to die out very quickly, implying that the current price change has a greater influence on people's expectation of next quarter's price rather than over longer-term horizon.

This shows that result could vary depending on the methods employed for estimating the relationship as the study finds that there are factors which could not explain in the VECM in the short run, however, found to explain with variance decomposition and impulse response function of VAR model for future years. However, there are some consistencies in the results obtained by employing different time series econometrics

making the study most interesting for further analysis in other developing and emerging economies.

Figure 1(a) to (f): Impulse Response Functions



Conclusion

The overall aim of the paper is to investigate the long and short run determinants of housing prices and examine the sources and the extent of housing price variability due to relevant determinants within the context of a partial macroeconomic framework. The techniques employed for analysis include Johansen's cointegration test and VECM model and variance decomposition and impulse response techniques in the VAR.

The findings using quarterly data for the period from 1996:1 to 2007:1 indicate that there is a long-run equilibrium relationship between housing price and its determinants including real GDP, and real non-food bank credit. The long run coefficients obtained from cointegrating equation shows that the real *GDP* has a significant and positive influence on the housing price while the real *BSE* index does not have any influence on housing price. In addition, the real non-food credit has a significant and surprisingly negative influence on housing price. The increased demand arising due to increased income is higher than the supply of houses due to increased availability of bank credit leading to an overall rise in house prices in the economy over the long-run. The coefficients of error correction term in the VECM shows that it is significant and possesses correct sign (negative sign) implying that there is partial adjustment of housing prices in the short run to its deviations from its long run equilibrium path. The adjustment is around 10 per cent per quarter implying it takes about two and half years for fully adjusting to the deviations from its long run equilibrium. Looking at the short-run parameters, it suggests that surprisingly both real GDP and real interest rate have significant and negative influence on housing prices. Other variables do not play significant role in the short run

In order to test the sources of variability and identify the responses of housing prices to its determinants, the study decomposed the housing price variance. The results indicate that a disturbance originating from its own housing prices induces greatest variability in house prices: it accounts for 89 per cent of the variability one period ahead, approximately 54 per cent four quarters ahead and 56 per cent six years ahead. The

remaining (44 per cent) variance is accounted for by the five determinants. The supply side factor (credit availability alone) accounts for 13 per cent of the housing price variance and demand side factors (real GDP, real interest rate, real stock prices, and real effective exchange rate) explain another 31 per cent.

These results have significant policy bearing. Therefore, the findings in this study suggest that the supply side factor, credit availability in particular should not be underestimated in the dwellings market of Indian economy, which plays an important role for the dynamic behaviour of housing prices.

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