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Evidence from Major Cities in India

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Abstract: This study employed both univariate and panel Langrange Multiplier (LM) unit root tests with one and two structural breaks, developed by Lee and Strazicich (2003, 2004) and Im et al. (2005) to examine regional housing prices for nine urban cities (Ahmedabad, Bangalore, Chennai, Delhi, Jaipur, Kanpur, Kolkata, Lucknow and Mumbai) in India to test whether housing prices exhibit a random walk process. By using the quarterly data from 2008Q1 to 2014Q2 for nine urban cities located in various regions of India, the main findings emerging from both univariate and panel LM tests reveal that residential urban housing prices are stationary in levels for individual cities and in panels after taking into account of the structural breaks.

Key Words: Regional House Prices, India

1. Introduction

In the economics of housing literature, it has been documented that studying aggregative behaviour of the housing markets is a thorny issue as characteristic feature of each market are likely to differ depending on several factors[1]. In fact, there exists a great deal of studies in the empirical literature in the international context including few studies conducted in the Indian context. For instance, there are recent studies investigating the dynamics of the Indian housing market and understanding various determinants of housing prices at the national level (Mahalik and Mallick, 2011, 2014). Although very few literature are devoted towards examining the behaviour of aggregate housing market in the Indian context, but there is dearth of studies looking into the issue of the dynamics of regional house prices by studying their time series properties, such as their trend, cyclicality, seasonality and irregular

[1]Indeed it is noted that, in the U.S. and U.K., a national housing market has no real significance and a great deal of research carried out for these economies has concentrated at the sub-national levels (Meen, 2002).

behaviours. Therefore, studying the dynamic patterns in their movements of the regional housing prices would be more tempting issue for both the policymakers and researchers due to the major concern of its ‘‘ripple effect’’[2]. The house prices at the regional level are likely to exhibit considerable short-term volatility along with sharp differential patterns in their behaviour because of the rippling effects, but in the long run, they are likely to show trending behaviour with a likely chance of convergence considering their relativities in their movements. There are also some studies (Ashworth and Parker, 1997) which suggest that the differing properties of regional housing prices statistics arise for most of the economies on account of the structural differences in housing markets. These distinctive properties of the regional housing prices have made this a fertile research area for the test of unit root processes for various regions of India. Given the policy significance of studying the regional housing prices in an emerging economy for achieving the objectives of high growth and development the present study is primarily motivated to bridge up this research gap. This study while addressing this issue, it raises a very interesting research question- Do regional residential housing prices in India follow a random walk individually and also in panel? Motivated to answer this research question, the study investigates the time series properties of regional house prices for the Indian cities.

Given the above background, it is worth stressing the importance of housing in an economy in general and emerging economy in particular. Housing stock in developed economies is most often compared with commodities in the commodity market or an asset to hold among various physical and financial assets as it has its future value once sold by its owner, besides its use which provides shelters to the individual owners of houses or yields rents to the house owners who give it on rent like renting out a capital machine for any productive work purposes. In an emerging economy like India, housing is highly important property due to people’s belief in the traditional idea of ‘land is wealth’ and so also the housing which is constructed on land property[3]. Unlike developed maturing economies where housing stocks are frequently bought and sold, the market for housing is an emerging phenomenon in developing economies like India. From both welfare and consumption perspectives, housing provides shelter to the households and therefore it is noted from the literature that an almost 30% of the total income is spent on housing construction by the households of emerging economies (Tiwari and Parikh, 1997). An understanding of the properties of regional house prices and their inter-relationships is of further interest for a number of reasons given their implications on economic issues such as the distribution of wealth and labour market mobility (Alexander and Barrow, 1994). In addition, an analysis of housing markets at a regional level is of having great importance as it has been argued by Meen and Andrew (1998) that a more complete understanding of the housing market requires attention to be switched to the analysis of regional rather than the aggregate or national housing data. It is also practically experienced that the recent sub-prime crisis (2008-09) in the USA had its origin from the local housing market and in effect, it translated into affecting the global economies which in fact took the turn of a major global financial crisis or recession mainly on account of higher mortgage default related to land and housing assets (Cocco, 2004). Therefore, drawing the lessons from the boom and bust experiences in the housing asset

[2] Over successive cycles, house prices have risen first in some areas and then gradually spread out over the rest of the country (spill over or convergence) called as ripple effect. Chien (2010) also viewed the ‘‘ripple effect’’ differently in the sense that the house price shocks stemming from any region eventually ripple out to have the same effect on all regional house prices. In other words, shocks (real estate policies, financial crisis and natural disaster) to regional house prices have the tendency of ‘‘rippling out’’ to other regions.

[3] If anybody has more amounts of land, he or she is regarded as rich in the traditional society. Based on this status, they will be able to get status in the society.

market across the globe and recent business cycle phenomenon in the regional housing markets of the USA, it is pertinent to have a better understanding of the regional housing price movements in an emerging economy like India which is a prominent area of fundamental research for the policy.

Having discussed the importance of analysing housing market behaviour and its ultimate consequences and implications on the economy, it is vital to analyse the rationale behind the present analysis of examining the random walk property of the Indian regional housing markets for nine different important cities. This is because the Indian housing markets had been experiencing strong growth as reflected from the rising housing prices immediately prior to the Global Financial Crisis (Glindro et al. 2007). It is also natural to experience the fluctuating behaviour of the Indian housing market on account of the repurcussionary impact of the Global Financial Crisis (Lean and Smyth, 2013). There have been several ongoing discussions among the policymakers whether the movements in housing prices represent an asset price bubble. In this context, it is important to draw from Glindro et al. (2007)'s study which had stimulated the understanding of asset price bubble from two broader different viewpoints (pessimistic and optimistic). From a pessimistic viewpoint, housing price bubble refers to a situation where house prices are overvalued and will face downward corrections. In the extreme end, a rise in house price is an evidence of a speculative bubble and call for a monetary policy intervention to contain the asset price bubble. The optimistic view on the other hand reveals that surging house prices represent the recovery from previous crisis in which house prices fell too low relative to their fundamental equilibrium values. Moreover, there are several reasons for a surge in regional housing prices in emerging economies. First, a rise in income of the households can lead to rise in housing demand that might be reflected in the rising housing prices. Second, lower mortgage rate can facilitate higher chances of accessing housing loans from the financial institutions and in turn that can lead to higher demand for housing, given the supply of housing in the short run. Such temporary disturbances in the housing market from its equilibrium have the tendency of achieving the equilibrium in the long-run through the adjustment of its demand and supply. Third, credit availability could be another factor in the dynamics of housing markets. It is in the sense that if credit allocation will be higher towards housing sector, there can be higher demand for housing from the investor's and owner side which might lead to rising housing prices. Fourth, both the role of economic openness and urbanisation are likely to be important factors in the dynamics of housing markets. Finally, government policies can also play a vital role in encouraging or discouraging the foreign investors towards emerging housing markets like India.

2. Relevant literature review

One of the fundamental approaches of theoretical housing economics suggests that any positive demand shock given the low level of supply of housing would lead to a temporary increase in real house prices in the short-run. But in the long-run, house prices will change in line with the construction costs. If the cost of construction rises along with the rise in general prices in the economy, then it is widely believed that long-run real house prices would be expected to be constant or stationary as theory suggests that both house price and construction costs are cointegrated in the long-run, indicating that both prices and costs are major elements of the system property (Abraham and Hendershott, 1996). The long-run relationship between housing price and construction costs in a bivariate model is the basis of

Poterba (1984) model.[4] However, there is a possibility of housing prices becoming highly non-stationary due to the element of land market as housing economic theory emphasises the central role of land prices in the explanation of house price dynamics. Such situations could be largely attributed by conditions of the land market in terms of both price and land supply which in turn contributes to house price variation at the national, regional and international levels (Meen, 2002). Malpezzi (1999) also argued that differing real housing price movements across countries are often attributed to the strength of planning controls. For example, if the governments restrict the upward building of housing in the urban cities as part of their planning and policy towards the housing markets, that would ultimately reduce the housing supply. Therefore, a rise in housing demand will result in rising prices due to the inelasticity of increasing the housing stock. This reveals that non-stationary behaviour of house prices regionally and nationally could be attributed due to governments' planning and controls policy. Further, it is again documented that both supply responses and governments planning controls will determine the trend behaviour of house prices in the long-run. In this context, Meen (1999) indicates, the ripple effect implies a long-run constancy, or stationarity, in the ratio of house prices in different regions to the national figure. Using the ADF unit root test, Meen (1999) finds the evidence is supporting the stationarity in the regional-national house price ratios for UK. Meen (2002) further examined the house prices behaviour across two developed countries, such as U.S.A. and U.K. and found that behaviour of house prices has differed over time in the two countries at both the national and sub-national levels. In another study, Berg (2002), using the Granger causality test on the Swedish data from January 1981 to July 1997 finds that Stockholm region leads price changes in housing market, indicating the support for the ripple effect in the UK.

Similarly, research studies also have employed advanced econometric tools to examine the ripple effect of regional house prices. By employing the class of unit root tests of Elliot et al. (1996) and Ng and Perron (2001), Holmes and Grimes (2005) found support for the convergence in the regional house prices in the UK from the long-run equilibrium relationships. The study suggested that the house price shocks stemming from any region eventually ripple out to have the similar effect on all regional house prices. To test the stationarity of regional house price ratios using the MTAR test of Newbold et al. (2001), Cook (2003) found the existence of stationarity in a number of regions of the UK. Cook (2005) further detected long-run relationships in regional house prices in the UK covering the data period 1973Q4-2003Q1. By using Engle and Granger (1987) cointegration technique, their empirical results supported the existence of ripple effect underlying the asymmetric movements in regional house prices. Mikhed and Zemcik (2009) examined the bubbles in 23 metropolitan statistical areas (MSA) in the USA covering the data from 1975Q1-2006Q2. By using cointegration and Granger causality test, they also observed the evidence of bubbles in the housing markets, as the non-stationary nature of house price is suggestive of rational bubbles in the USA housing market of selected periods, mainly in the late 1980s and 1990s up to 2005. Larraz-Iribas and Alfaro-Navarro (2008) examined the asymmetric behaviour of regional house prices across 17 regions in Spain covering the quarterly data from 1995Q1-2006Q4. By employing Engle and Granger (1987) cointegration procedure, they found the

[4] It is worth stressing that conditioning variables are more central to the dynamic properties of housing prices. If the housing stock (conditioning variable) is not in the equation, then there is no feedback from construction costs to housing prices (Dipasquale and Wheaton, 1994; Meen, 2002). In more details, change in housing supply is backed by change in construction costs. For example, a rise in construction costs will reduce the housing construction and thereby will increase house price given the higher demand for housing and reverse holds true for both. If housing supply is fully elastic given the lower level of construction costs, output will increase to the point at which prices are unchanged.

evidence of cointegration, which suggests a broad grouping of regions based on proximity or similar economic characteristics. Moreover, there is evidence of a stable long term relationships among prices, even though the relationship among these regions is not so intuitive from an economic perspective. Cointegration test showed the asymmetric behaviour of regional house prices in Spain depending on spatial characteristics of regions.
Chien (2010) also examined the stationarity of house prices for three regional cities (Taipei city, Taichung city and Kaohsiung city) in Taiwan covering the quarterly time series data ranging from 1991Q1-2006Q4. The empirical result emanating from conventional ADF (1979) and PP (1988) tests shows that house prices across all the selected cities are non-stationary at levels and found to be non-stationary at their first differences. These tests evidence the presence of ripple effect across all the cities in Taiwan. Moreover, the empirical results of Lee and Strazicich (2003) indicate that ripple effect exists for each city in Taiwan except for Taipei city. These findings indicate that Taipei city is a regional global city which has resulted in higher prices, but does not affect the house prices of the entire area while ADF and PP tests reveal that the changes in Taipei city house price affect house prices of other neighbouring regions and the Taiwan as a whole. In this sense, Pelaez (2012) support the utilization of advance econometrics tool in prediction of changes in house price as the stylized facts of time series are an important part of research in economics (Harvey, 1989, 1997; Hodrick and Prescott, 1980; Cogley and Nason, 1995; Baxter and King, 1999). Therefore, by utilizing band-pass filter approach to business cycle component of house prices, Pelaez (2012) found that band-pass filter approach is capable of predicting the housing price bubble much before the sub-prime crisis happened in the US as this approach is mainly concerned with removing structural changes involved in the housing prices at lower and higher frequency, while Hodrick and Prescott (1980) was only dealing with the cyclical behaviour of housing prices near the sample end-periods. Lean and Smyth (2013) examined the housing prices for five different housing price indices (all housing, detached housing, semi-detached housing, terrace housing and high-rise housing) in 14 states of Malaysia covering the quarterly time series from 2000Q1-2010Q3 to test whether housing prices exhibit a random walk. The overall results from using univariate and panel langrage Multiplier (LM) unit root tests with one and two structural breaks proposed by Lee and Strazicich (2003, 2004) and Im et al. (2005) suggest that house prices are trend reverting. Further, LM univariate unit root test found stationarity in housing prices on a segmented trend for the vast majority of states, while panel LM unit root tests also reveal the stationary house prices where the segmented trends are reverting for the Malaysian housing markets.

From the above comprehensive discussion on listed literature, the study derives the inference that most of the studies highlighted are mainly dealing with an empirical examination of time series properties and ripple effect of regional house prices in developed as well as developed economies by using the conventional ADF (1979) and PP (1988) unit root tests. Although ADF and PP unit root tests were popular tests, but Cochrane (1991) and others warned about drawing strong inferences from those tests due to their low power and higher distortion. Maddala and Kim (2000) also vehemently contested it and concluded that both the ADF and PP tests should not be used any more when it comes to examining the stationarity of macroeconomic variables or housing prices. Moreover, a related critique is that the ADF test often fails to reject the unit root null hypothesis when the time series is fractionally integrated (see e.g. Diebold and Rudebusch, 1991; Hassler and Wolters, 1994; and Lee and Schmidt, 1996). The recent study by Chien (2010) also agrees with these critics' views and viewed that it is important to check structural breaks if the empirical breaks cover an unstable time of social and economic development. In this case, without allowing structural breaks, ADF and PP type of tests may lead to wrong decision when the null hypothesis is not rejected. He further states that a potential problem common to ADF and PP tests is that they derive their critical values assuming no breaks under the null. Nunes et al. (1997) and Lee and Strazicich (2001) find that this assumption causes size distortions in the presence of a unit root with breaks.[5]

Moreover, it is being observed that little attention has been paid on testing the random walk property of regional housing prices in the Indian dwelling markets. Only few studies (Mahalik and Mallick, 2011; 2014) have examined the determinants of house prices at the aggregate level. In addition, Mallick and Mahalik (2014) also have also investigated the dynamic impact of macroeconomic variables on regional house prices for India covering the quarterly data from 2010Q1-2013Q4. From their study, they concluded that there is a lesser role of speculative factors in the Indian regional housing markets due to the lack of market integration among various assets markets. However, these studies have not explored the random walk property of city-wise house prices across nine emerging cities in India. The study used the quarterly data ranging from 2008Q4 to 2013Q4 for nine urban cities (Ahemadabad, Bangalore, Chennai, Delhi, Jaipur, Kanpur, Kolkata, Lucknow and Mumbai) in India. Since the study used the quarterly data, it has the high tendency of being affected greatly by the real estate polices, the recent global financial and economic crisis, and natural disaster. These events are likely to produce structural shifts in the data of housing prices across the cities belonging to different regions of India, which ultimately might have driven their results. In this context, the present study will be using univariate and panel Lagrange Multiplier (LM) unit root tests with one and two structural breaks developed by Lee and Strazicich (2003, 2004) and Im et al. (2005) to examine the regional housing prices for nine urban cities in India to test whether housing prices exhibit a random walk. This study for the first time makes an empirical attempt of testing random walk property of house prices across nine different urban cities in India with the help of advanced univariate and multivariate unit root tests tools. This is the innovation of our study to the existing housing economics literature in the Indian context.

The above section based on a thorough review of literature also highlights the fact that there are several attempts which have been made in the literature over time by applying different methodologies to investigate the random walk property of housing prices across different regions of different countries using different methodologies (see, e.g. Englund et al. 1999; Hill et al. 1999; Lean and Smyth, 2013). And there are several implications which are derived and can be generalised from the study of random walk behaviour of the regional house prices. The implications are - firstly, if the house prices follow a random walk, then it has the tendency of producing price bubbles. This is also consistent with a divergent path in its movement over time which is also considered as rational bubbles. If house prices, on the other hand, are trend reverting that excludes the possibility of rational bubbles (Canarella et al. 2012), indicating that trend reversion in house prices is also consistent with long-run competitive market adjustments. As a result, trend reverting house prices would provide a better real market situation, suggesting that a positive demand shock would lead to a temporary increase in house prices, because supply is always inelastic in the short-run. However, allowing inflation in the long run, house prices may return to their equilibrium path due to possible adjustment of supply with respect to demand for housing. The second interesting implication of whether house prices exhibit a random walk which is quite related

[5]Size properties of Lee and Strazicich (2003) are not affected by breaks under the null, which is contrary to ADF and PP types tests endogenous break tests. Further, Lee and Strazicich (2003) state that it has higher power, with two structural breaks, and is unaffected by spurious rejections of the null when the series has a unit root with breaks (see for more details, Chien, 2010; Pelaez, 2012).

to the ability of the investors in forecasting future movements in housing prices. For example, if house prices are trend reverting and deviate from the rational bubbles in the market, investors can better predict future house prices from the past price trends. In this scenario the housing market would be inefficient. On the other hand, if the housing prices would exhibit random walk which is related to the permanent shocks in the market, it would suggest that investors can't forecast house prices from the past prices, given the availability of all information in the information set (Canarella et al. 2012). One might claim that the arbitrage strategies would be limited as the investors would not be able to forecast the futures price movements of house prices. If this is the case, then hedging possibility through the use of forward contracts by the investors may be infeasible in the housing market. This indicates that predictability of house prices is crucial for buying and selling of the residential property in the emerging markets and in the meantime also provides the possibility of forward contracts and hedging mechanism for investors if the house prices are properly forecasted. Third, if housing prices follow a random walk, any permanent shocks to house price would affect the wealth and income of the households and that in turn would also affect the potential consumption of house owners. On the other hand, if the housing prices are trend reverting rather following random walk, any unexpected shocks affecting the house prices would be transitory and temporary. And as a consequence, both the permanent income and wealth for households would remain unaffected (Canarella et al. 2012).

The remainder of this study is structured in the following way. Section-3 discusses India's housing markets scenario. Section-4 briefly presents data sources used in the analysis. Section-5 highlights the innovative and advanced unit root testing methodology utilised in the present study. Section-6 summarises the empirical results of the study. Section-7 concludes with findings and policy implications.

3. Housing markets scenario in India

3.1. Socio-economic importance of the real estate and housing sector in India

Before discussing the socio-economic significance of real estate and housing sector in the Indian economy, it is fundamentally worth noting to distinguish essential features of real estate and housing sector. The transacting in the real estate is considered as business sector under the broad category of services activity which includes development of commercial and residential real estate properties. Both commercial and dwellings are subset of real estate sector. Hence commercial sector indicates the development of business services and in contrast the dwellings are housing component for households. It is expected to be believed that both components have larger socio-economic contribution in the economy. Among these financial components, housing plays a pivotal role in the economy as it provides social and economic security to the people. From a social perspective, housing is a basic need which provides shelters to the households, business houses to the corporate sector and administrative offices for local, state and central governments when they consume houses for their different purposes. From an economic perspective, housing provides income to the households when they prefer for renting a house. In this sense, it is also called as an 'asset or wealth' that can have significant leveraging effect to support and supplement other means of income generation and poverty alleviation. Moreover, housing is a basic necessity for human life and is the second largest generator of employment, next only to agriculture. A host of other vocations and professions like construction workers, builders, developers, engineers, valuers, property consultants, interior decorators, consultants, and plumbers who derive their livelihood from housing either directly or indirectly. Therefore, housing activities have both forward and backward linkages which not only contribute to capital formation, generation of employment, and income opportunities and also add to economic growth and development. Since housing activities have nearly 300 sub-sectors, such as manufacturing (steel, cement, and builders' hardware), transport, electricity, gas, and water supply, trade, financial services, and construction, therefore it is expected to have higher multiplier effects on employment and output growth of the economy. The recent estimates show that housing sector in India ranks fourth in terms of the multiplier effect on the economy and third among fourteen major industries in terms of total linkage effect (Economic Survey, 2012-13, 2013-14, Government of India).

While looking at the larger social and economic contributions of housing sector in the Indian economy, the economy importance of housing sector on the Indian economy needs to be effectively discussed. The recent estimates show that every rupee invested in housing and construction adds 78 paise to the Indian gross domestic product (GDP). This indicates that housing sector plays a significant role in the investment and production of economic activities (Economic Survey, 2013-14, Government of India). In other words, it also generates capital formation and employment opportunities and thereby stimulating economic growth and development in the economy. Therefore, the housing sector contributes more than 9 per cent of national employment and attracts almost 7 per cent of foreign direct investment (FDI), reflecting its sectoral importance in the economy (Economic Survey, Department of Industrial Policy and Promotion, GOI, 2010-2011). In the statistical sense, it is also pertinent to see the quantitative contribution of both real estate and ownerships of dwellings in the India economy. As per recent Economic Survey (2013-14, GoI), real estate and housing with a share of 5.9 per cent in India's GDP, has grown by 5.6 per cent in 2012-13 compared to its previous growth rate of 7.2 per cent in 2011-12. In general, the growth of the real estate sector services has been impressive consistently at over 26.1 per cent since 2005-06 with 26.3 per cent growth in 2011-12. This also shows the real estate sector boom in India which is linked to the country's economic stability and growth of urbanization, commercialization and liberalisation. In this perspective, it can be said that housing and real sector are regarded as significant engine for growth and development of the economy.

3.2. Housing situation and policy developments in India

Over the years, the nature of Indian housing market has been changing in the context of growing urbanization, rising income growth, and industrialization coupled with social, political and economic upheavals in the global economy. On account of liberalization, privatization and globalization, Indian housing market has become vibrant to carry forward lucrative entrepreneurial activities in the economy and it has been witnessing growing competition with regard to pricing and marketing of new innovative products. The profile of Indian housing market has changed from rigid sellers' market to a competition and choice-oriented buyers' market. Such dynamics in the Indian dwelling markets has led to efficient demand driven market. However, the demand driven housing market has produced adverse effect on the welfare of the people in the society. In this perspective, it is important to point out that India's housing and real estate sector faces many challenges. These challenges have policy concerns. The major policy concern for India is the rising urbanization in India and increasing urbanization in metropolitan cities. According to the recent Census of India (2011), the percentage share of urban population in India's total population is 31.16 % in 2011 compared to 10.8% in 1901. In addition, the estimates show that the share of urban population in total population contributed by 53 metropolitan cities stands at 42.6 per cent in 2011 compared to 5.84 per cent in 1901 contributed by single metropolitan city in India. This also indicates that nearly 32 per cent of the country's population lives in cities and nearly 43 per cent of the country's population lives in 53 urban cities in India. In such situation, it is expected to believe that growing nature of urbanization in country's total population will lead to rising demand for housing given the low level of housing supply. The Eleventh Five Year Plan (2007-12) has also estimated the housing requirement of 24.7 million units in urban areas of which 99 per cent was in the EWS/LIG segment. Moreover, the present urban housing shortage is 18.78 million units of which 95.6 per cent is in economically weaker sections (EWS)/ low income groups (LIG). Given this fact, one can conclude that housing requirements in urban areas in India have been growing over the years. Therefore, the major policy concern is how to mitigate such widening gap between demand for housing and supply of housing units.

Another key challenge for the Indian housing markets is the provision of institutional credit. To support the growth of the housing and real estate sector, many institutions have been set up especially for financing housing. But the housing market in India is still untapped and it has been growing in a significant way. Due to this, the sector is not benefited from the formal housing finance. This limited housing finance from institutional sources, the gap between housing demand and supply is also widening. Besides, the mortgage market in India is also unstructured and underdeveloped. Though mortgages as a percentage of GDP has been rising from 3.4 per cent in 2001 to 9 per cent in 2012-13, the share is relatively lower than in many other countries, such as China (12 per cent), Thailand (17 per cent), Malaysia (29 per cent), Hong Kong (40 per cent) and the USA (65 per cent). The subsequent difficulty related to the Indian housing market is about procedures involved while taking up housing and other construction projects. According to the World Bank's Doing Business (2014), India ranks 182nd position in terms of construction permits, requiring a total of 35 procedures to get permit as compared to an average of 16 in South Asia and 13 in OECD countries (Economic Survey, 2013-14, GOI). Another added advantage for the Indian housing market is that 100 per cent inflows of FDI is allowed to the housing sector, creation of town-ships and enhancing other physical infrastructure in India under automatic root of the Reserve Bank of India (RBI). It could be much better for the Indian housing markets if FDI is allowed in real estate business segment. Taken together housing conditions and housing policy scenario in the Indian dwelling markets, we suggest that these highlighted issues need to be addressed effectively before the policymakers and various governments to make housing not only more affordable but also easy to own. From the policy perspective, we further suggest that housing sector needs special attention as housing is a major contributor to the country's economic and social development. Housing is the largest component of service sector and is central to economic growth as it is capable of creating multiplier effects on various other sectors and thereby adding to employment generation and poverty reduction.

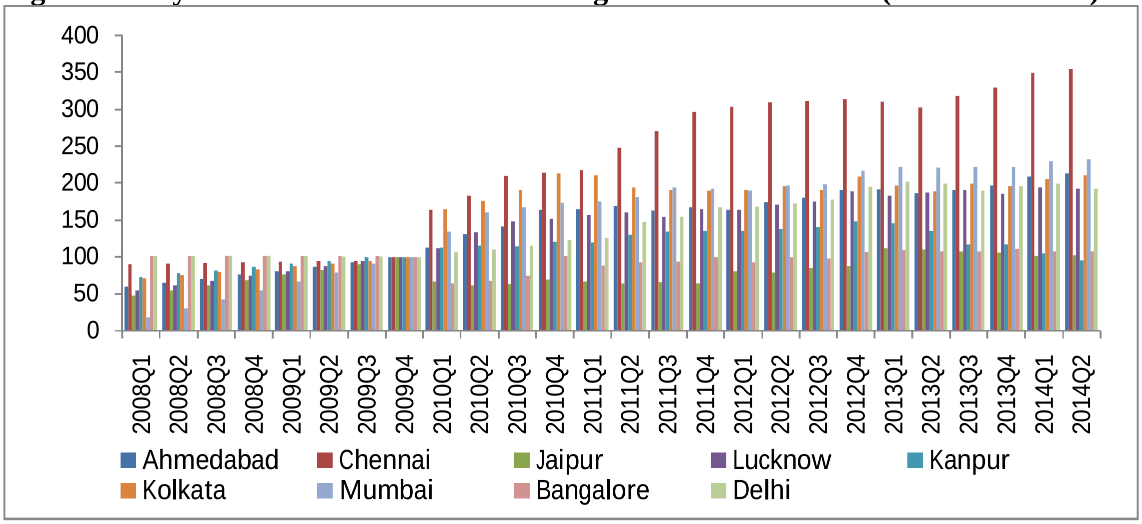
3.3. An overview of the urban housing markets in India

Before embarking on to analyse the trend of residential housing price behaviour across nine major cities in India, it is important to discuss more on the historical stylized facts of Indian urban property price and its significance on various agents and economic activities. Since the recent study by Mallick and Mahalik (2014) used the NHB's RESIDEX data in their recent empirical analysis of regional housing price behaviour in India, it seems that NHB is the primary source of providing the real picture of residential housing price index data for urban cities in India. Given that perhaps it is more necessary to analyse the some background about tracking prices of residential properties in Indian dwelling markets. As already discussed the significance of real estate sector in general and housing markets in particular on the social and economic activities, Government of India has made a maiden effort to develop a residential housing price index for metro cities in India with objective of monitoring the Indian economy on a regular basis. There are various stakeholders such as NHB, RBI and other housing finance companies who have competently developed this index not only to judge the performance of national and regional housing markets but also to provide with maximum information for policymakers as well as to other potential agents operating in the housing markets are finance companies, property investors, developers, sellers, and consumers of the markets. With looking at the trend of residential housing markets at the regional and disaggregated levels in developing country like India, so-called potential agents available in the dwelling markets will be able to forecast their decisions of investment and intervention in the regional housing markets. Based on the accurate performance and forecasting of regional housing markets, it would be much easier for these housing markets in gauging the true picture of national or aggregate housing markets in India. Given this perspective, it is important to highlight additional significance of housing price index developed at the regional levels in India. Regional residential housing price index will provide insights into consumer activity and will track construction of new houses and the demand for housing. It is also considered by policymakers in developing country like India as one of the leading indicators of larger consumption and investments activities as well as growing nature of the economy as a whole. This is also barometer of housing demand and demand for input materials like cement, steel, furniture, labour requirements, credit demand and demand for rented houses.

Given the expanding nature of urbanization, growing economic activities and competitive markets driven reforms coupled with welfare strategy of providing ‘‘Affordable Housing’’ for socially and economically weaker sections in the rural and urban societies, this concern was gaining exponential importance before the Government of India. Motivated by the approach of ‘‘Affordable Housing’’, the National Housing Bank (NHB) in India took an initiative of providing residential housing prices in India across cities and over time. Therefore NHB launched RESIDEX for tracking prices of residential properties in India on a comprehensive scale, in July 2007, covering data up to 2005 with 2001 as the base year. Initially the pilot study was covered for 5 urban cities including Bangalore, Bhopal, Delhi, Kolkata and Mumbai. These data are compiled in India following 2001 as old base year. Subsequently with the help of housing finance companies (HFCs) and National Council of Applied Economic Research (NCAER), the NHB has extended RESIDEX data to ten more cities, such as Ahmedabad, Faridabad, Chennai, Kochi, Hyderabad, Jaipur, Patna, Lucknow, Pune, and Surat. This implies that the NHB RESIDEX has been expanded to 15 cities altogether with 2007 as the new base year. From 2008 to 2009, the RESIDEX is being updated on half-yearly basis. In a similar manner, NHB has recently expanded the collection of RESIDEX data to 11 other urban cities including Bhubaneswar, Guwahati, Ludhiana, Vijayawada, Indore, Chandigarh, Coimbatore, Dehradun, Meerut, Nagpur, and Raipur. The NHB RESIDEX is now being updated on a quarterly basis with 2007 as the base year from January 2010. The present collected regional residential housing price index data for 26 urban cities does not reflect the behaviour of national housing price index in India. In order to make it a truly national index in nature, the government of India intended to extend the NHB RESIDEX to 63 cities which are covered under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). We believe that NHB will extend such data collection process to 37 urban cities over the years (Report on Trend and Progress of Housing in India, 2010, NHB and Economic Survey, 2013-14, GoI). Looking at the residential housing price movements across major cities in different regions of India, Figure-1 indicates all the cities are witnessing more or less soaring house prices.

Chennai is located in the southern part of India: not only has it been experiencing the greatest rise in house prices among the southern states, but also among all the states in all four broad regions of India. Ahmedabad, Kanpur, Jaipur and Mumbai are the major cities in the south-west parts of India experiencing similar and relatively faster rise in house prices. Lucknow, Delhi and Kolkata are also experiencing similar but relatively low rises in house prices compared to the cities in the south-western states including Chennai. Moreover, Bangalore being the city of southern India is also witnessing higher house price rise. Above all, we conclude that rising residential house price is quite significant and phenomenal across all cities in the urban housing markets in India.

Figure-1: City Wise NHB's RESIDEX Housing Price Index in India (2007 Base Year)



Source: National Housing Bank (NHB, 2014).

4. Data source and its discussion

This study concentrates quarterly residential housing price index (RESIDEX) data for the recent period from 2008Q1-2014Q2. The RESIDEX data for nine urban cities of various regions in India are collected from National Housing Bank (NHB). Our study simply relies on house price index created only for the residential houses. Presently, the NHB's RESIDEX is constructed for twenty six urban cities located in various regions of India with 2007 as the new base year. For the sake of consistency and comparability, the NHB's RESIDEX data for nine urban cities have been selected for our analysis. In the NHB, the RESIDEX had earlier been calculated biannually, i.e. from January to June, 2008 and July to December till 2009. From 2010 onwards, the RESIDEXhas been calculated by NHB on quarterly basis. In this study, the data from January to June, 2008 and July to December till 2009 has been interpolated by us to make available of quarterly data for all nine urban cities in various regions of India.[6] Hence, our study employs quarterly data from 2008Q1-2014Q2 giving a sum of 26 quarters.

5. Econometric Methodology

5.1. Univariate unit root tests

The starting point for this analysis is to examine the stationary proprieties of house prices across a number of major cities in India by applying the univariate tests without breaks points. Therefore, we employ the LM unit root test proposed by Schmidt and Phillips (1992) which has better size and power properties than standards tests (ADF, PP and KPSS). This

[6]The formula for RESIDEX data interpolation can be available from authors upon request.

preliminary analysis serves as a benchmark that we can use to compare with results of unit root tests allowing for the structural breaks in the series. The two statistic tests ($Z(\rho)$ and $Z(\tau)$) suggested by Schmidt-Phillips (1992) define the same set of nuisance parameters under both the null and the alternative hypotheses, after correction for serial correlation.

However, the Schmidt-Phillips unit root test does not allow for the structural breaks. For this reason we apply the LM unit root tests with one and two structural breaks developed by Lee and Strazicich (2003, 2013). The authors suggested four models as follows: The "Crash Model A" which allows for one structural break in level under the alternative hypothesis, the "Model C" that allows for one structural break in both level and trend, the "Crash Model AA" which allows for two endogenous shifts in the intercept and "Model CC" that includes two changes in the intercept and slope. The LM unit root tests can be explained by using the following Data Generating Process (DGP):

$$y_t = \delta' Z_t + e_t \, , \; e_t = \beta e_{t-1} + \varepsilon_t \tag{1}$$

Where Z_t is a vector of exogenous variables and $\varepsilon_t \sim N(0, \sigma^2)$. The DGP contains break under the null and alternative hypothesis in a consistent process. The one structural break models can be considered as follows. The Model A is described by $Z_t = [1, t, D_t]'$ where $D_t = 1$ for $t \succ T_B + 1$, and zero otherwise. T_B denotes the time period of the structural break. The Model C can be described by $Z_t = [1, t, D_t, DT_t]'$ where $DT_t = t - TB_t$ for $t \succ T_B + 1$, zero otherwise. The two structural breaks can be considered as follows. The Model AA that allows for two shifts in level is described by $Z_t = [1, t, D_{1t}, D_{2t}]'$ where $D_{jt} = 1$ for $t \succ T_{Bj} + 1$, *j=1,2*, and zero otherwise. Finally, the Model CC that contains two changes in level and trend is described by $Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]'$ where $DT_{jt} = t - TB_{jt}$ for $t \succ T_B + 1$, *j=1,2*, zero otherwise. Depending on value of β, in model AA we have:

Null hypothesis $$y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + y_{t-1} + v_{1t}$$

Alternative hypothesis $$y_t = \mu_1 + \gamma . t + d_1 D_{1t} + d_2 D_{2t} + v_{2t}$$

Where v_{1t} and v_{2t} are stationary error terms; $B_{jt} = 1$ for $t = T_{Bj} + 1$, *j=1,2*, zero otherwise. For the model CC we have the following null and alternative hypotheses:

Null hypothesis $$y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + d_3 D_{1t} + d_4 D_{2t} + y_{t-1} + v_{1t}$$

Alternative hypothesis $$y_t = \mu_1 + \gamma . t + d_1 D_{1t} + d_2 D_{2t} + d_3 DT_{1t} + d_4 DT_{2t} + v_{2t}$$

The LM unit root test statistic can be estimated by regression according to the LM (score) principle as follows:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t \tag{2}$$

Where $\widetilde{S}_{t-1} = y_t - \widetilde{\psi}_x - Z_t\widetilde{\delta}, t = 2,...,T, \widetilde{\delta}$ are coefficients in the regression of Δy_t on ΔZ_t, $\widetilde{\psi}_x$ is given by $y_1 - Z_1\widetilde{\delta}$. The unit root null hypothesis is described by $\phi = 0$ and the LM test statistics are given by:

$$\widetilde{\rho} = T.\widetilde{\phi}$$

$$\widetilde{\tau} = \text{t-statistic testing null hypothesis } \phi = 0$$

The minimum LM unit root test determines the break points TB_{jt} endogenously by using a grid search as follows:

$$LM_{\rho} = \underset{\lambda}{Inf}\ \widetilde{\rho}(\lambda)$$

$$LM_{\tau} = \underset{\lambda}{Inf}\ \widetilde{\tau}(\lambda)$$

Where $\lambda = T_B/T$. The break points are determined to be where the test statistic is minimized. In order to eliminate the end points, we use the trimming region $(0.15T, 0.85T)$, where T is a sample size. The critical values for one break and two breaks are given by Lee and Strazicich (2003, 2013).

5.2. Panel unit root tests

As suggested by Maddala (1999), the use of panel data unit root tests is one way of increasing the power of the unit root tests. These tests can be divided into two groups: the "first generation panel unit root tests" which contain LLC test (Levin et al. (2002)), IPS test (Im et al. 2003), MW test (Maddala and Wu, 1999) and Choi test (Choi, 2001)) and the "second generation panel unit root tests" that include MP test (Moon and Perron, (2004), Pesaran test (Pesaran, 2007) and Choi test (Choi, 2006)). The first class panel unit root tests are based on the assumption of independent cross section units; however, the second class of tests relaxes the independence hypothesis. The LLC test employs the following adjusted t-statistic:

$$t_{\rho}^{*} = \frac{t_{\rho}}{\sigma_T^{*}} - NT\hat{S}_N\left(\frac{\hat{\sigma}_{\hat{\rho}}}{\hat{\sigma}_{\tilde{\varepsilon}}^{2}}\right)\left(\frac{\mu_T^{*}}{\sigma_T^{*}}\right) \quad (3)$$

Where $\hat{S}_N$ denotes the average of individual ratios of long-run to short-run variances for the individual *i*. $\hat{\sigma}_{\hat{\rho}}$ and $\hat{\sigma}_{\tilde{\varepsilon}}^{2}$ are respectively the standards deviations of slope coefficients and error term. The mean adjustment μ_T^{*} and standard deviation adjustment σ_T^{*} are tabulated by Levin, Lin, and Chu (2002, p. 14) for various periods T.

The IPS (Im, Pesaran and Shin, 2003) test which assumes the *heterogeneity* of the first order autoregressive parameters, employs a standardized t_bar statistic that is based on the limiting distribution of the individual Augmented Dickey-Fuller statistics:

$$Z_{tbar}(p;\beta) = \frac{\sqrt{N}[t\ bar_{NT} - E(t_{iT})]}{\sqrt{V(t_{iT})}} \quad (4)$$

Where $E(t_{iT})$ and $Var(t_{iT_i})$ are respectively the expected mean and variance of t_{iT} (the t-statistic).

The MW test (Maddala and Wu, 1999) which uses Fisher type test (1932) is based on the combined p-values p_i or P_{MW}, from unit root test-statistics for each cross-sectional unit *i*. The

MW test (Maddala and Wu, 1999) proposed the following statistics: $P_{MW} = -2\sum_{i=1}^{N} \ln(p_i)$ which has a χ^2 distribution with $2N$ degrees of freedom as $T \to \infty$ and N fixed. This is the test suggested by Fisher (1932). In addition, Choi (2006) suggested the following standardized statistic:

$$Z_{MW} = \frac{\sqrt{N}\{N^{-1}P_{MW} - E[-2\ln(p_i)]\}}{\sqrt{V[-2\ln(p_i)]}} \quad (5)$$

Under the null hypothesis as $T_i \to \infty$ and $N \to \infty$, $Z_{MW} \to N(0,1)$ (Hurlin, 2004). Concerning the second-generation unit root tests, which assume the cross sectional dependence between units, this paper used the MP test (Moon and Perron, 2004); Pesaran test (Pesaran, 2007) and Choi test, (Choi, 2006). In order to take into account the cross-sectional dependence assumption, Moon and Perron (2004) use an AR(1) Model with common factors in the error terms:

$$\begin{aligned} y_{i,t} &= (1-\lambda_i)\mu_i + \lambda_i y_{i,t} + u_{i,t} \\ u_{i,t} &= \delta_i' F_t + e_{i,t} \end{aligned} \quad (6)$$

For $i = 1,\ldots,N$ and $t = 1,\ldots,T$. F_t is a $(k \times 1)$ vector of commons factors, δ_i is the coefficients vector corresponding to the common factors and $e_{i,t}$ is an idiosyncratic error term which is cross-sectionally uncorrelated and follows an infinite Moving Average (MA) process. The null hypothesis corresponds to the unit root hypothesis H_0: λ_i =1 for $i = 1,\ldots,N$ against the heterogeneous alternative hypothesis H_1: $\lambda_i < 1$ for some *i*. For testing, under the data are de-factored and then the panel unit root test statistics based on the de-factored data are proposed.

To construct a unit root test, Moon and Perron (2004) consider the factors as nuisance parameters and develop two t-statistics, which are based on a pooled de-factored series. Specifically, if we let $\hat{\lambda}^*$ denote the pooled least squares estimate of λ using the de-factored data, Moon and Perron (2004) suggestthat the following two statistics can be used:

$$t_a^* = \frac{\sqrt{N}T(\hat{\lambda}^* - 1)}{\sqrt{\frac{2\hat{\varphi}_\varepsilon^4}{\hat{\omega}_\varepsilon^4}}} \xrightarrow[T,N\to\infty]{} N(0,1) \quad (7)$$

$$t_b^* = \sqrt{N}T(\hat{\lambda}^* - 1)\sqrt{\frac{1}{NT^2} tr(Y_{t-1} Q_{\hat{\Delta}} Y_{t-1}')}\left(\frac{\hat{\omega}_\varepsilon}{\hat{\varphi}_\varepsilon^2}\right) \xrightarrow[T,N\to\infty]{} N(0,1) \quad (8)$$

where φ_e^2 denotes the cross-sectional average of the long-run variances $\omega_{\varepsilon_i}^2$ of residuals ε_{it} and $\hat{\varphi}_\varepsilon^4$ denotes the cross-sectional average of $\omega_{e_i}^4$. The statistics t_α^* and t_b^* are based on an estimator of the projection matrix and estimators of long-run variances $\omega_{\varepsilon_i}^2$. In Pesaran's test (2007), the author suggests to augment the cross-sectional unit $ADF(p_i)$ regressions by the cross-sectional means of lagged levels and first-differences of the individual time series. The cross-sectionally augmented ADF regressions are given by:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + c_i \left[(1/N) \sum_{i=1}^{N} y_{i,t-1} \right] + d_i \left[(1/N) \sum_{i=1}^{N} \Delta y_{i,t} \right] + \varepsilon_{i,t} \quad (9)$$

Pesaran, (2007) suggested the following truncated test statistics which is denoted as a cross-sectional augmented IPS (CIPS):

$$CIPS(N,T) = \frac{1}{N} \sum_{i=1}^{N} t_i(N,T) \quad (10)$$

Where $t_i(N,T)$ is the t-statistic of the OLS estimate of ρ_i (denoted as CADF). The Peseran statistic test is the modified IPS statistics based on the average of individual CADF. The next panel unit root test is the Choi (2006) test which combines p-values of the Augmented Dickey-Fuller univariate unit root tests. In the first step, the panel unit root tests of Choi (2006) use Elliott et al. [1996] GLS de-trending to the panel to eliminate the cross-sectional correlations and controlling for the deterministic trends. In the second step, meta-analytic panel tests can then be used. Choi [2006] assumes the following two-way error-component model:

$$y_{it} = \alpha_i + \theta_t + \upsilon_{i,t} \quad (12)$$

$$\upsilon_{i,t} = \sum_{j=1}^{p_i} d_{i,j} \upsilon_{i,t-1} + \varepsilon_{i,t}$$

Where $\varepsilon_{i,t}$ is $i.i.d\left(0, \sigma_{\varepsilon_i}^2\right)$.

Then, after having obtained the p-values of the t-statistics, Choi (2006) combined these into panel test (Fisher's type) statistics as follows:

$$P_m = -\frac{1}{\sqrt{N}} \sum_{i=1}^{N} [\ln(p_i) + 1] \xrightarrow[T,N\to\infty]{} N(0,1) \quad (13)$$

$$Z = -\frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i) \xrightarrow[T,N\to\infty]{} N(0,1) \quad (14)$$

$$L^* = -\frac{1}{\sqrt{\pi^2 N/3}} \sum_{i=1}^{N} N \ln\left(\frac{p_i}{1-p_i}\right) \xrightarrow[T,N\to\infty]{} N(0,1) \quad (15)$$

Where Φ is the standard cumulative normal distribution function and p_i is the asymptotic p-values of the Dickey-Fuller-GLS statistic for country *i*.

The first and second generation panel unit root tests which do not allow for the structural breaks may suffer from significant loss of power if the data exhibit real breaks. This is why; we suggest using the Lagrange Multiplier (LM) panel unit root test developed by Im, Lee and Tieslau (2005). Based on the univariate LM unit root statistic (Lee and Strazicich, 2003), Im, Lee and Tieslau (2005) suggested a panel LM unit root t-statistic. We recall that the Lee and Strazicich's model can be considered as follows:

$$\Delta Y_{i,t} - \gamma_i' \Delta Z_{i,t} + \delta_i \tilde{S}_{i,t-1} + \varepsilon_{i,t} \quad (16)$$

where Δ is the first difference operator, $\tilde{S}_{i,t-1}$ is the detrended variable of $Y_{i,t-1}$ and $\varepsilon_{i,t}$ is the error term. The t-statistic (denoted t_i^*) for the null hypothesis H_0: $\delta_i = 0$ can be calculated for each unit in order to conclude the panel LM test statistic:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i^* \quad (17)$$

This in turn can be used to determine the following standardized panel LM test statistic:

$$LM(\bar{t}) = \frac{\sqrt{N}(\bar{t} - E(\bar{t}))}{\sqrt{V(\bar{t})}} \quad (18)$$

$E(\bar{t})$ and $V(\bar{t})$ are tabulated by Im, Lee and Tieslau (2005).

6. Empirical Results and Discussion

Table-1: Descriptive statistics

	Ahmedabad	Bangalore	Chennai	Delhi	Jaipur	Kanpur	Kolkata	Lucknow	Mumbai
Mean	135.8824	117.4909	116.2097	149.8439	139.7636	119.6533	151.4067	141.5742	162.4858
Median	128.6000	104.3500	115.4500	119.2000	152.5000	118.0000	155.6000	132.7000	158.2500
Maximum	198.3333	151.7000	160.733	278.0667	200.0000	148.7000	275.9667	226.3333	259.3667
Minimum	75.6400	98.5000	83.9000	99.70000	68.6500	86.2200	83.1400	74.0000	54.3600
Std. Dev.	39.8045	20.2394	21.3061	59.8726	39.5448	18.2636	58.9389	47.3914	63.0757
Skewness	0.1303	0.6625	0.4331	0.9198	-0.3912	-0.2036	0.7388	0.4546	-0.0597
Kurtosis	1.6422	1.6539	2.1981	2.3935	1.9153	1.9514	2.4199	2.0590	1.8460
Jarqu-Bera	1.7521	3.2703	1.2772	3.4397	1.6398	1.1598	2.3099	1.5694	1.2336
Probability	0.4164	0.1949	0.5280	0.1790	0.4404	0.5599	0.3150	0.4562	0.5396
Sum	2989.413	2584.800	2556.613	3296.567	3074.800	2632.373	3330.947	3114.633	3574.687
Sum Sq. Dev.	33272.51	8602.343	9533.011	75279.50	32839.70	7004.780	72949.69	47164.85	83549.49

Table-2: Results of LM unit root test with no break (Schmidt and Phillips, 1992)

Lags	**0**		**1**		**2**		**3**		**4**	
Cities	$Z(\rho)$	$Z(\tau)$	$Z(\rho)$	$Z(\tau)$	$Z(\rho)$	$Z(\tau)$	$Z(\rho)$	$Z(\tau)$	$Z(\rho)$	$Z(\tau)$
Ahmedabad	-10.5610	2.6334	-11.2431	-2.7171	-10.7630	-2.6585	-11.5101	-2.7492	-10.2800	-2.5982
Bangalore	-6.2841	-1.8682	-5.5759	-1.7597	-5.6667	-1.7740	-6.5255	-1.9037	-7.3324	-2.0180
Chennai	-8.7761	-2.3109	-10.0216	-2.4695	-11.1216	-2.6015	-9.8478	-2.4480	-8.2554	-2.2413
Delhi	-1.7474	-0.7850	-2.3830	-0.9167	-2.6561	-0.9678	-3.1234	-1.0495	-3.7824	-1.1549
Jaipur	-4.8086	-1.6302	-4.4910	-1.5755	-5.2926	-1.7103	-5.8411	-1.7968	-6.1400	-1.8422
Kanpur	-2.7987	-1.1104	-3.5065	-1.2429	-4.4096	-1.3938	-4.8655	-1.4641	-5.1140	-1.5010
Kolkata	-5.5327	-1.6998	-7.1155	-1.9277	-8.0127	-2.0456	-7.8944	-2.0304	-7.1872	-1.9374
Lucknow	-6.4888	-1.9363	-7.6525	-2.1028	-6.6229	-1.9562	-6.2857	-1.9058	-6.6971	-1.9671
Mumbai	-21.6688**	-4.5576***	-21.5818**	-4.5485***	-19.6410**	-4.3391***	-20.0633**	-4.3855***	-18.5411***	-4.2159***

Note: *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Table-3: Results of LM test with one break in the intercept (Model A).

Cities	**TB**	**K**	S_{t-1}	B_t
Ahmedabad	2010:04	0	-0.9162* (-3.5404)	12.1360*** (2.7193)
Bangalore	2011:02	0	-0.4246 (-1.8162)	30.9821*** (8.3250)
Chennai	2010:03	3	-1.3134** (-3.5763)	-0.9677 (-0.0774)
Delhi	2010:03	4	-0.3135 (-2.1616)	3.0860 (0.2868)
Jaipur	2009:03	4	-0.5301 (-2.8941)	24.7930*** (4.4859)
Kanpur	2009:02	2	-0.4063 (-2.3896)	-14.6384** (-1.7878)
Kolkata	2011:04	2	-0.8567* (-3.4416)	27.0055*** (2.4541)
Lucknow	2012:02	0	-0.4884 (-2.0848)	14.6736***(1.6299)
Mumbai	2009:03	0	-1.1997*** (-4.4001)	-6.9862 (-0.9597)

Notes: Critical values for the LM test at 10%, 5% and 1% significance levels = -3.211, -3.566 and -4.239 respectively. Critical values for the dummy variable denoting the break date follows the standard asymptotic distribution. TB is the break date; K is the lag length; S_{t-1} is the LM test statistic; B_t is the coefficient on the break in the intercept. *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Table-4: Results of LM test with one break in the intercept and slope (Model C).

Cities	**TB**	**K**	S_{t-1}	B_t	D_t
Ahmedabad	2010:03	3	-1.1948 (-3.7006)	-11.9645** (-1.7064)	11.9522*** (3.5710)
Bangalore	2011:01	4	-1.8426*** (-5.2546)	-25.3323*** (-3.7855)	28.9950*** (5.0221)
Chennai	2011:03	2	-1.0055 (-3.4223)	-17.8626* (-1.6274)	4.4404 (0.8243)
Delhi	2009:04	4	-1.2383** (-4.4966)	19.3674*** (2.3559)	-6.8445* (-1.3155)
Jaipur	2009:03	4	-0.8800 (-2.9796)	26.3737*** (5.1096)	-4.5367** (-1.6566)
Kanpur	2011:02	2	-1.9988*** (-6.9926)	-5.2429* (-1.3119)	-0.3679 (-0.1713)
Kolkata	2010:03	4	-1.9959 (-4.0910)	28.7272** (1.7491)	-16.7840** (-2.1472)
Lucknow	2011:04	1	-1.1576* (-4.3255)	-7.6297 (-1.1304)	18.8483*** (4.2465)
Mumbai	2009:03	0	-1.2180** (-4.5138)	-11.2134* (-1.5313)	-3.6144 (-0.8013)

Note: *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Table-5: Results of LM test with two breaks in the intercept (Model AA).

Cities	TB_1	TB_2	**K**	S_{t-1}	B_{t1}	B_{t2}
Ahmedabad	2010:02	2010:04	1	-1.5736*** (-4.6560)	-8.0682*** (-2.1681)	12.8308*** (3.5586)
Bangalore	2010:03	2011:02	2	-1.0923 (-3.0445)	9.6872*** (3.5697)	30.6340*** (11.0075)
Chennai	2010:01	2011:03	2	-1.1447** (-3.9948)	8.7309 (0.7810)	-22.9829** (-2.2338)
Delhi	2010:0	2011:0	4	-0.3010	-19.8296**	0.9590

	2	1		(-2.4696)	(-2.1146)	(0.0986)
Jaipur	2009:03	2010:02	4	-0.5844* (-3.4375)	25.7028*** (4.7850)	6.6153** (1.6494)
Kanpur	2009:01	2009:02	2	-0.4736 (-2.5909)	-7.6918 (-0.9396)	-15.7529** (-1.8883)
Kolkata	2009:03	2011:04	2	-0.8485** (-4.0674)	-16.9957** (-1.8775)	29.1570*** (3.0193)
Lucknow	2009:01	2012:01	4	-0.7028* (-3.3005)	13.9145*** (3.1556)	27.8663*** (4.8354)
Mumbai	2009:03	2012:04	0	-1.3551*** (-4.9296)	-7.6722 (-1.1135)	-11.2913* (-1.5422)

Notes: Critical values for the LM test at 10%, 5% and 1% significance levels = -3.211, -3.566 and -4.239 respectively. Critical values for the dummy variable denoting the break date follows the standard asymptotic distribution. TB is the break date; K is the lag length; S_{t-1} is the LM test statistic; B_t is the coefficient on the break in the intercept. *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Table-6: Results of LM test with two breaks in the intercept and slope (Model CC).

Cities	**TB$_1$**	**TB$_2$**	**K**	**S$_{t-1}$**		**B$_{t1}$**		**B$_{t2}$**		**D$_{t1}$**		**D$_{t2}$**	
Ahmedabad	2009:03	2011:04	3	-2.0748***	(-6.7942)	16.2225***	(3.8381)	-11.0053***	(-2.9169)	-12.5744***	(-4.0802)	17.1263***	(5.0197)
Bangalore	2009:04	2011:01	4	-2.4728***	(-8.7359)	7.5602**	(2.1017)	-27.4212***	(-6.3590)	-3.6192*	(-1.5039)	23.8971***	(7.3205)
Chennai	2009:02	2011:01	2	-1.8725***	(-6.8476)	8.9589*	(1.4243)	17.5896***	(2.7251)	17.3158***	(3.7390)	-25.7255***	(-4.5955)
Delhi	2010:01	2011:04	1	-2.1561**	(-6.1239)	-7.6617*	(-1.3557)	2.5074	(0.4232)	17.1873***	(5.3640)	15.8685***	(4.2269)
Jaipur	2009:02	2011:02	3	-1.8284*	(-5.6288)	-12.6188***	(-2.4370)	4.1161	(0.8627)	16.2400***	(4.0540)	-17.9125***	(-4.6204)
Kanpur	2011:02	2012:03	3	-2.7687***	(-7.6300)	-4.5233*	(-1.6036)	18.6637***	(5.5130)	-0.1570	(-0.0998)	-8.0458**	(-1.8776)
Kolkata	2009:04	2011:02	3	-2.5721***	(-11.5021)	-32.4739***	(-6.0831)	1.9828	(0.3460)	35.9980***	(9.7081)	-19.7224***	(-5.4533)
Lucknow	2009:04	2011:04	1	-1.8578***	(-8.0267)	-0.9397	(-0.2321)	-10.9980***	(-2.5094)	-6.1487***	(-2.3768)	16.3620***	(6.0733)
Mumbai	2010:01	2011:02	3	-1.8959***	(-9.2539)	18.5783***	(4.6264)	-48.0831***	(-11.2349)	-17.9661***	(-4.8864)	18.5809***	(5.3554)

Note: *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Table-7: Comparison between the model C and the LM unit root test with no break

Cities	No-Break Test	Model C	No-break test/Model C
Ahmedabad	NS	NS	NS
Bangalore	NS	S	S
Chennai	NS	NS	NS
Delhi	NS	S	S
Jaipur	NS	NS	NS
Kanpur	NS	S	S
Kolkata	NS	NS	NS
Lucknow	NS	S	S
Mumbai	S	S	S
Decision	**1/9 stationary**	**5/9 stationary**	**5/9 stationary**

Table-8: Comparison between the model C and the LM unit root test with no break

Cities	No-break test/Model C	Model CC	No-break test/Model C/ModelCC
Ahmedabad	NS	S	S
Bangalore	S	S	S
Chennai	NS	S	S
Delhi	S	S	S
Jaipur	NS	S	S
Kanpur	S	S	S
Kolkata	NS	S	S
Lucknow	S	S	S
Mumbai	S	S	S
Decision	**5/9 stationary**	**9/9 stationary**	**9/9 stationary**

Table-9: Cross Sectional Dependence Test Analysis

Cross sectional dependence test	Panel data (9 Indian urban cities of various regions)
Frees' test of cross sectional independence (p-value)	1.805 (0.0000)
Pesaran's test of cross sectional independence (p-value)	-2.265 (1.9765)
Friedman's test of cross sectional independence (p-value)	8.036 (0.4300)

Table-10: Panel Data Unit Root Analysis[7]

First Generation of Panel Unit Root Tests: Full Panel				
Types of test statistic	*Test statistic*	*1 % CV*	*5 % CV*	*10 % CV*
LLC test statistic	10.4318***	-2.3263	-1.6449	-1.2816
IPS test statistic	-1.6107*	-2.3263	-1.6449	-1.2816
MW test statistic	7.4722	34.8053	28.8693	25.9894

[7]Matlab codes (Version 7.00) provided by Christophe Hurlin are used to implement these first and second-generation panel unit root tests (http://www.univ-orleans.fr/deg/masters/ESA/CH/churlinR.htm).

Choi test statistic	-1.8460**	2.3263	1.6449	1.2816
Second-generation panel unit root tests: Full Panel				
Moon Perron1 statistic (ta_bar statistic)	-2.0895**	-2.3263	-1.6449	-1.2816
Moon Perron2 statistic (tb_bar statistic)	-3.0225***	-2.3263	-1.6449	-1.2816
Pesaran test (2007) statistic	-1.5000	-2.5632	-2.3332	-2.2085
Choi test statistic (P_m)	-1.8410**	2.3263	1.6449	1.2816
Choi test statistic (Z)	2.3737***	-2.3263	-1.6449	-1.2816
Choi test statistic (Lstar)	2.4549***	-2.3263	-1.6449	-1.2816

Note: *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

Testing the null hypothesis of stationarity against the alternative of a unit root, Schmidt and Phillips (1992) LM unit root test (Table-2) reject the null hypothesis of unit root at any lag length (from zero to four) except for Mumbai. Therefore, the unit root null hypothesis of housing price cannot be rejected for eight urban cities in India. However, Schmidt-Phillips test does not allow for structural breaks and therefore it becomes biased toward rejecting the alternative hypothesis when the null is not true (Amsler and Lee, 1995). For this reason, we used the LM unit root test for one and two structural breaks (Lee and Strazicich, 2003, 2013). Results of LM unit root test with one break in the intercept (Model A) and one break in the level and trend (Model C) are depicted in Table-3 and 4. The model A provides evidence in favor of non-stationarity. The unit root null cannot be rejected for four Indian cities (Ahmedabad, Chennai, Kolkata and Mumbai). However, when we employ the LM unit root test with break in the level and trend (model C), the unit root null can be rejected for 5 of 9 Indian cities (Bangalore, Delhi, Kanpur, Lucknow and Mumbai) implying improvement of power when we endogenously take into account one structural break in both the level and trend. However, models A and B suggest different results. The unit root null is rejected in model C, but not model A, for Bangalore, Delhi, Kanpur and Lucknow, while the unit root null was rejected in model A, but not model C, for Ahmedabad, Chennai and Kolkata. The break in the intercept and/or slope is statistically significant in model C for eight of nine cities. Many scholars show that the use of model C is superior to model A. Sen (2003a, 2003b) argued through Monte Carlo simulation that model C performs better than model A in the case of unknown breakpoint dates. Then, as shown in Table-4, there is evidence of housing prices stationarity for 5 cities at 10% level or better. Comparing the model C with no-break unit root test, the result of model C should be preferred if the break in the intercept and/or the trend is statistically significant (Lean and Smyth, 2014a, b). Table-7 reports the results of the comparison between the no-break LM unit root test and model C. We find some evidence in favor of the stationarity hypothesis for 5 of 9 cities (more than 50% of the sample).

Failure to reject the non-stationarity for 4 Indian urban cities may be the result of a loss of power to allow for a second possible break in housing price series. Thus, we apply the LM unit root test with two endogenous breaks in the intercept (Model AA) and two breaks in the intercept and trend (Model CC). Table-5 and 6 present the results of LM unit root test with two breaks. In model AA (Table-5), the unit root null is rejected only for 6 cities, however in model CC the unit root null was rejected for the nine Indian cities (100% of the sample). The results from both models show that there is a difference between the two models AA and CC. However, the model CC has the advantage that it contains the model AA (Lean and Smyth, 2014). This is why we choose the model CC over the model AA. Comparing to "no-break test/Model C", the model CC is preferred if the second break in the intercept and/or trend is statistically significant. As reported in Table-6, the second break in the intercept is significant for eight of nine cities, while the second break in the trend is statistically significant for 100% of the sample. Table-8 reports the results comparing model CC with "No-break LM test/Model C". We come to the conclusion that Ahmedabad, Bangalore, Chennai, Delhi, Jaipur, Kanpur, Kolkata, Lucknow and Mumbai have stationary housing price series. Hence, as shown in Table-8, results provide greater support for stationarity (at 10% level or better) for 100% of the sample). These findings overturn the results of early studies tested for a unit root in housing prices by using conventional tests without structural breaks (Im et al. 2005). Generally, by allowing for two breaks, the both models (AA and CC) provide stronger support for housing price stationarity.

For robustness check, the panel unit root tests are performed. However, before investigating the stationarity of our series we have to test the assumption of cross sectional dependence in panels which can arise due to a multiplicity of factors such as unobserved or/ and omitted common factors, spatial correlations, economic distance and common unobserved shocks. Three tests for cross section dependence have been used in our study namely, Pesaran's (2004) cross sectional dependence test, Friedman's (1937) statistic and the test statistic suggested by Frees (1995). Table-9 reports that both Pesaran and Friedman tests can not reject the null hypothesis of no cross-sectional dependence. However, these tests exhibit substantial size distortion if N is fixed and T not sufficiently large (in our model N = 9 and T = 22). On the other hand, the average absolute correlation between the cross-sectional units is 0.493 for the two tests, which is a very high value. Hence, there is evidence suggesting the presence of cross-sectional dependence between Indian cities. Finally, Frees' test supports the evidence of dependence between units. This result underlines therefore the importance of taking into account the cross-sectional dependence when investigating the housing price stationarity. Hence, the second generation panel unit root tests that assume cross sectional dependence between units) are better for our panel data.

In spite of cross-sectional dependence among Indian cities, we will report the results of the first generation panel unit root tests (that assume cross sectional independence between units) as a benchmark exercise. Table-10 shows that null hypothesis of unit root test for housing price series is not rejected by the first generation panel unit root tests except for MW test. However, these tests are criticized for the assumption of cross-sectional dependence between the individual units. For this reason, we apply the second generation panel unit root tests. The results, which are reported in Table-10, indicate that null hypothesis of unit root test in housing price series is rejected by all the tests except for Pesaran test. Finally, the panel unit root test of Im, Lee and Tieslau (2005) is performed (Table-11). Using the ILT (2005) test with structural breaks, we find robust evidence supporting the stationarity of housing prices for Indian cities' panel.

Table-11: Panel unit root test with structural breaks (Im, Lee and Tieslau, 2005)[8]

Panels	No break	One break	Two breaks
Full Panel	-1.211	-3.747***	-6.642***
Model A (Bangalore, Delhi, Jaipur, Kanpur and Lucknow)	-0.810	-0.952	-1.813**
Model C	-0.681	-0.893	-1.563*

[8]Gauss codes provided by Junsoo Lee are used to implement the Im, Lee and Tieslau (2005) test (http://old.cba.ua.edu/~jlee/gauss).

(Ahmedabad, Chennai, Jaipur and Kolkata)`			
Model AA (Bangalore, Delhi and Kanpur)	-1.079	-1.044	-1.909**

Note: 1%, 5% and 10% critical values for the panel LM unit root tests with structural breaks are -2.326, - 1.645 and - 1.282 respectively. Note: *, ** and *** show statistical significance at 1%, 5% and 10% levels respectively.

7. Conclusion and Practical Policy Implications

The study has examined the stationarity of house prices for nine regional cities in India using univariate and panel LM unit root tests with one and two structural breaks. The univariate LM unit root tests provide evidence of stationarity for all the Indian cities of our sample. On the basis of model C which is for the estimation of LM unit root test with break in the level and trend, we find evidence of stationarity for all the Indian cities studied. The panel LM unit root test with one and two structural breaks also support the stationarity of series. Furthermore, the results from the panel LM unit root test with structural breaks find evidence in support of housing price stationarity. From this we conclude that the series are stationary (individually as well as in the panel) after taking into account of the structural breaks.

From the above empirical evidence, we conclusively conclude that any shock to residential housing prices has a transitory impact for all nine urban cities located in various regions of India, suggesting that urban residential housing prices are mean reverting rather following random walk in their behaviour over the time. In other words, this implies that residential housing prices across all nine urban cities in India will turn back to its time long term trend. In reality, although the existence of unexpected shocks whether they be endogenous or exogenous are many but based on our empirical results, we believe that any unexpected shocks affecting the regional residential house prices will be transitory and temporary in the Indian urban dwellings markets. In this respect, one can claim that both the permanent income and wealth for households will be unaffected. This is consistent with Canarella et al. (2012) findings for the USA economy. Moreover, the results of our study are also consistent with Lean and Smyth's (2013) findings in which they have empirically indicated that the Malaysian regional house prices are stationary at their levels. In this regard, the study raises the policy concern for state and central governments of developing countries in general and India in particular that policymakers should not design any adverse housing policy related to the Indian urban residential housing markets which may hamper wealth of households and investors and, in turn, causing adverse effect on the strong multiplier effects of housing sector on capital formation, employment generation, and economic growth of the Indian economy.

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