Jinhai Yan, Lei Feng, Helen X. H. Bao

House Price Dynamics: Evidence from Beijing

Abstract To study the house price dynamics in China, this paper extends the traditional life-cycle model by incorporating land supply, regime shifts and government regulation factors. The models are estimated with an error correction framework using quarterly data from 2000 to 2007 in Beijing. The conclusions are as follows. (1) There exits a stable co-integration relationship between house price and fundamentals; land supply and financial regimes are also important determinants of long-run equilibrium house prices. (2) Short-run dynamics depend on changes of fundamentals and the adjustment process of housing market. Land supply has a significant impact on house price fluctuations while demand factors such as user costs, income and residential mortgage loan have greater influences. The adjustment speed of real house prices to the long-run equilibrium has been reduced significantly since 2005 which means exogenous shocks can cause prolonged deviation of real house prices from the equilibrium level.

Keywords house prices, house price dynamics, regime shifts, macro-regulation,
House Price Dynamics: Evidence from Beijing  

error correction model

**JEL Classification**  R21, R31, R38

1  Introduction

Since the breakthrough of the market-oriented housing reform in 1998, China’s housing market has been experiencing rapid growth that characterized by significant increases in real estate investment, housing stock completed, and property transaction volume. The house prices, especially in large cities such as Beijing, Shanghai, and Shenzhen, also skyrocket after a relative stable period between 1999 and 2004. In the meanwhile, the credit exposure to the property sector through mortgage loan and property development loan has increased from 3.96% in 1999 to 18.4% in 2007.\(^1\) GDP growth rate, driven by export and real estate industries, remains strong from the first quarter of 2003 and reaches 11.4% in 2007.\(^2\) In the meanwhile, housing affordability, measured by house prices to income ratio, has fell significantly over the same period of time.

To curb house prices and protect the economy from overheating, the central government has implemented a series of regulatory measures since 2005. Correspondingly, house prices in major cities such as Shenzhen and Guangzhou, begin to retract to certain degree from 2008. At the same time, the connection between China’s housing market and global financial market is becoming tighter. The realized foreign direct investment in real estate sector increases by 107.65% in 2007.\(^3\) After a 10-years long real estate boom period, US and most EU countries entered into a “correction” phase in late 2006. Many of these countries are facing the possibility of recession due to the global financial crisis triggered by the subprime mortgage crisis in the U.S.

The development of housing market plays an important role in resident welfare, as well as national economy and financial security. In the backdrop of global economy integration, the following questions gain growing attentions: Will China’s housing market experience similar turbulence as in the U.S. and EU countries? Should the central government intervene in the housing market? To forecast house prices and support regulatory policy making, there is a call for a sound understanding of house prices determinants in China’s real estate market,

\(^1\) Data source: *China Monetary Policy Report Quarter Four 2007.*

\(^2\) Data source: *Statistical Communiqué of China on the 2008 National Economic and Social Development.*

\(^3\) Data source: *China Statistical Yearbook 2008.*
and the impacts on housing market by conventional monetary and credit policies (particularly the unique land use policies in China’s leasehold property right system). China’s economy is in the process of rapid urbanization and industrialization amid significant regime shifts and intensive government regulation. Consequently to study the house price dynamics in modern China factors such as land supply, regime changes, and regulation policies must be taken into account in addition to fundamentals that affect housing demand and supply.

This study extends the traditional life-cycle model of house price determination by incorporating unique characteristics of China’s housing market. The models are estimated by error correction method using quarterly data from Beijing over the period between 2000 and 2007. Our findings reveal the role of fundamental determinants of house price, and the impacts from land use policies and monetary regulations. Some policy implications are derived in the last section.

2 Literature Review

As suggested in Meen (2001) life-cycle model and reduced stock-flow model are the two mainstream frameworks used to study house price determinations. The life-cycle model is derived from an intertemporal consumer utility maximizing model. Under the arbitrage condition, the user cost of housing capital, representing the marginal rate of substitution between housing and consumption, equals to the real rental price of housing service. The reduced stock-flow model consists of separated supply and demand equations. Under the assumption that housing supply is fixed in the short-run and evolves slowly over time, house prices are established by finding the equilibrium between housing supply and demand equations.

Early studies mainly focus on the interrelationship between economic fundamentals and house prices. In some recent endeavors emphasis is placed on the disequilibrium characteristic of house prices and the impacts of housing supply and planning regulation on house price dynamics. Abraham and Hendershoot (1996) classify the determinants of real house price appreciation into changes in the equilibrium price and the adjustment dynamics to the equilibrium. Their findings indicate that each factor can explain about two-fifth of real house prices appreciation in the U.S. Malpezzi (1999) estimates an error correction model of house prices to income ratio with panel data from the U.S. and identifies house price determinants such as income, population, interest rate, and regulatory environment. He also finds that the speed of adjustment is slower
in more regulated conditions. Following the framework in Abraham and Hendershoot (1996), Capozza et al. (2004) study real house price dynamics by estimating serial correlation and mean reversion coefficients with panel data between 1979 and 1995 from 62 metropolitan areas in the U.S. They find that variations in the cyclical behaviors of real house prices across these metropolitan areas are determined by changes of local economies and land supply. House prices’ reaction to economic shocks varies among cities that differ in size, income growth rate, population growth rate, and construction costs. Some researches focus on the impact of government policies and regime shifts on house price dynamics. Lum (2002) finds that short-run dynamics of house price in Singapore are significantly affected by policy changes in the public housing sector and the release of state land; Egerd and Mihaljek (2007) argue that institutional developments of housing market and housing finance are important determinants of long-run equilibrium level of house prices in Central and Eastern Europe. Despite of the differences in data and methodology, previous studies in housing prices dynamics reach the following consensus. (1) house price movements can be explained by economic fundamentals in the long-run, but not adequately in the short-term; (2) The primary determinants and their marginal effects, and the adjustment speed of house prices to the equilibrium level are not uniform across countries and estimation periods; and (3) institutional developments are playing more important roles in house price dynamics in countries with transitional economy and intensive government intervention in their housing markets.

Theoretical and empirical research into the house price dynamics in China is scarce. Shen and Liu (2004) make the first attempt to quantify the roles of economic fundamentals in explaining house price appreciation in China. They find that fundamentals can explain house price appreciation in 14 cities, and house prices rise too fast in some cities in recent years. Zhou (2005) identifies a close relationship between house prices appreciation and monetary policy in four municipalities in China. Hui and Shen (2006) verify the existence of house price bubbles in Beijing and Shanghai in 2003. They conclude that there appears to be a bubble in Shanghai in 2003 but not in Beijing. Liang and Gao (2007) find that credit policy has great impacts on house price movements in the eastern and western regions while the role of economic conditions is more prominent in the central region of China. The aforementioned studies form the groundwork for further analysis of the house price dynamics in China. One natural approach to extend previous researches is to incorporate land supply, regime shifts and policy factors into the basic frameworks, and to refine the quantification of existing factors.
3 Theoretical Model

Our theoretical model stems from the traditional life-cycle model, by which the dual role of housing as both consumption goods and investment vehicle are reflected (Meen, 2001). The standard life-cycle model is extended by incorporating regime shifts, land supply, and government regulation factors. An error correction framework is adopted to provide consistent and robust estimation of the revised model, as suggested in Stevenson (2008).

3.1 The Standard Life-cycle Model

3.1.1 Long-run House Price Determination

In a standard life-cycle model a consumer makes consumption decision about housing service and other goods by maximizing total life utility under his income budget constraint. Under the first-order condition, the marginal rate of substitution between housing and the composite consumption goods equals real user cost of housing capital, which is defined as follows.

\[
\frac{u_h}{u_c} = (i_t - \pi_t + \delta_t - \Delta \pi^e_t)P_t
\]

(1)

where \( u_h/u_c \) is the marginal rate of substitution between housing service \( h \) and a composite consumption \( c \), \( P_t \) is real house price, \( i_t \) is nominal mortgage interest rate, \( \pi_t \) is inflation rate, \( \delta_t \) is depreciation rate of housing, and \( \Delta \pi^e_t \) is expected long-run house price growth rate. Under the arbitrary condition, user cost of housing capital equals to imputed rental value of housing services, \( R_t \), which is defined in Eq. (2).

\[
R_t = (i_t - \pi_t + \delta_t - \Delta \pi^e_t)P_t
\]

(2)

In the market of housing services, the rental value of housing services is determined by Eq. (3).

\[
R_t = g(INC_t, POP_t, H_t)
\]

(3)

where \( INC_t \) is income, \( POP_t \) denotes population, \( H_t \) is housing stock.

By substituting Eq. (3) into Eq. (2), the long-run equilibrium house prices, \( P_t^* \), can be derived as follows.

\[
P_t^* = f(INC_t, POP_t, UC_t, H_t)
\]

(4)

where \( UC_t = i_t - \pi_t + \delta_t - \Delta \pi^e_t \).
3.1.2 Short-run House Price Dynamics

House prices may temporarily deviate from the long-run equilibrium level. These divergences can be explained by either the shocks to underlying fundamental factors (denoted $W$) or the deviation of the short-run price from the long-run equilibrium level in previous period. Shocks to underlying fundamentals alter the equilibrium level, and consequently cause house prices to fluctuate. Under the assumption that house prices will gradually revert to the equilibrium level through market self-adjustment mechanism, the deviation of the short-run price from the long-run equilibrium level has a negative impact on the following period’s price changes. Hence the short-run house price changes can be written as in Eq. (5).

$$\Delta P_t = f(\Delta W_t, \text{ecm}_{t-1})$$ (5)

where $\Delta$ denotes the first order difference, $\text{ecm}_{t-1} = P_{t-1} - P^e_{t-1}$ is the error correction term representing the deviation of actual house price from the equilibrium level in the previous period.

3.2 Extensions and Adaptations

3.2.1 Long-run House Price Determination

The standard long-run house price determination model is extended in the following five aspects.

(1) The first factor to be considered is the reform of financing system for housing. The optimal decision of housing consumption is influenced by both income and credit constraints when home buyers use mortgage loans to finance their purchases. Relaxations of credit constraints will lead to a reduction in housing user cost, and consequently an increase of housing demand and property prices in the long run. The establishment of the housing mortgage loan system in late 1990s, coupled with the advance of financial market, unleashed the long-suppressed housing demand in China. While boosting the development of housing market, the housing mortgage loan system also serves as a convenient tool for the government to exercise its control over the market. For example, the government strengthened the requirements for down-payment in 2006 and loan-to-value ratio in 2007 in order to cool down the property market. The effects of credit constraints are captured by including the shadow price of credit constraints, $\lambda_t$, in Eq. (1).

$$u_h/u_c = (i_t - \pi_t + \delta_t - \Delta P^e_t + \lambda_t/u_c)P_t$$ (6)

To quantify shadow price $\lambda_t$, a variety of indicators are adopted in previous
studies. Examples include loan balance, loan to value ratio, incremental loan, among others. In this research new residential mortgage loan $M_t$ is used to measure the degree of credit rationing.

(2) The impact of urban housing reform on housing demand is taken into account in Eq. (3). Starting from the second half of 1998 the urban housing reform in China entered into a new era. The housing allocation system was abolished, replaced by a market-oriented system. Most of the public housing units (owned by the state or state-owned companies) were sold to their sitting tenants at prices below construction costs. The central government announced a series of favorable policies regulating property tax, land lease premium, property transaction procedures to encourage the re-sale of these public housing units. Some families realized considerable capital gains subsequently, and climbed further up the property ladder. The urban housing reform also involves large scale urban re-generation schemes in old cities. Re-located families can enter housing market after receiving resettlement compensations from the government. Most notably, Beijing implemented a five-year re-generation plan in the second half of 2000. A total of 1.14 million square meters of area were planned to be re-developed in the eight inner city districts in 2001 alone, with more than 59 000 households being affected.\(^4\) The scale and pace of re-generation escalated after the successful bid of the Olympic Games in 2001, due to the construction of sport facilities and supporting infrastructures in preparation for the event. Hence, a dummy variable $Dum1$ is introduced to Eq. (3) to reflect the impact of urban housing system reform on imputed rental values.

\[
R_t = g(INC_t, POP_t, Dum1, H_t) \quad (7)
\]

(3) We define the expectation of house price trend is adaptive. $\Delta P_t^e$ in (4) is the average of house price appreciation rate in the last six quarters. There is no lack of evidences that future course of house prices asserts an influence on user cost, and consequently how much one is willing to pay for housing. Because housing market is characterized with low liquidity, information asymmetry, low transaction frequency, high transaction cost, and hedges against inflation, there have been strong evidences that participants in housing market typically behave in the form of adaptive expectation (Capozza et al., 2004; Malpezzi and Wachter, 2005).

(4) The effect of the land supply system is also addressed. Housing supply is influenced by both house prices and building costs, of which land cost is the

\(^4\) Data source: Beijing Statistical Yearbook 2002.
largest component (Lum, 2002). In most cities where land is an increasingly scarce commodity, land prices are significantly affected by land use regulations governing both the quantity and the quality of land supply. Tighter land use regulations usually lead to inelastic land and housing supplies, and eventually long term appreciation of land and property prices (Ihlanfeldt, 2007). In China the government has a complete monopoly over urban land distribution, and consequently decisive impact on housing supply through land supply. In the second half of 2004 the method to distribute commercial use land parcels was changed fundamentally by switching from private negotiations of raw land to public transactions of developed land. This change facilitates the commercialization of China’s land market, escalates land prices, and accelerates the consolidation of real estate development industry. The combined effect on housing supply, property prices, and market structure is profound and long-lasting. In sum, housing supply is defined as follows.

\[ H_t = q(P_t, CC_t, LSC_t, Dum2) \]  

(8)

where \( LSC_t \) is cumulative land supply, \( CC_t \) is construction cost, and \( Dum2 \) is a dummy variable representing land supply regime shift.

(5) We also consider the effects of monetary policies and liquidity surplus. A floating exchange rate system was adopted on 21 July 2005 in China. After the exchange rate between USD and RMB dropped below eight, an expectation of long term appreciation of RMB was formed. This derived capitals to flow into China’s property market from both overseas and domestic sources. A serious liquidity surplus has emerged in the monetary market since 2006. Excess capital flooded the assets market as a combined result of low interest rates, disappointing investment return in other sectors, and expectation toward real estate appreciation. We introduce a dummy variable \( Dum3 \) to reflect the effect of foreign exchange rate regime shifts. \( Dum3 \) equals to one from the third quarter of 2006 and zero otherwise.

After taking into account the five aforementioned factors, the long term equilibrium house prices are defined as follows.

\[ P_t^* = f(INC_t, POP_t, Dum1, UC_t, LSC_t, CC_t, Dum2, Dum3, M_t) \]  

(9)

Rewriting equation (9) in a log linear reduced form, the econometric model of long-run house prices is given as Eq. (10).

\[ \ln P_t = \alpha_0 + \alpha_1 \ln INC_t + \alpha_2 \ln POP_t + \alpha_3 UC_t + \alpha_4 \ln LSC_t + \alpha_5 \ln CC_t \\
+ \alpha_6 Dum1 + \alpha_7 Dum2 + \alpha_8 Dum3 + \alpha_9 LN M_t + \eta_t \]  

(10)

where LN is the natural log transformation notation, and \( \eta_t \) is a white noise
process.

3.2.2 Short-run House Price Dynamics Model

Similar to the long-run model, credit availability and land supply are also introduced to Eq. (5) besides fundamentals such as income, population and construction cost. In the short-run, a reduction of down-payment ratio will give more households the access to mortgage loans so that they can participate in the housing market. This generally will cause house prices to increase. Before 2004, land supply expands quickly as a result of growing housing demand and local governments’ pursue for GDP growth and fiscal revenue. Whilst from 2005 onwards residential land supply is reduced greatly as a result of the tight land policy by the central government. Hence it is important to study the impact of land supply policy changes on house price dynamics. Specifically, the reduced log linear form equation of house price dynamics in short-run is given by,

$$
\Delta \ln P_t = \beta_0 + \beta_1 \Delta \ln P_{t-1} + \beta_2 \Delta \ln INC_t + \beta_3 \Delta \ln POP_t + \beta_4 \Delta UC_t + \\
\beta_5 \Delta \ln LSC_t + \beta_6 \Delta \ln CC_t + \beta_7 \Delta \ln NM_t + \gamma_0 \text{ecm}_{t-1} + \varepsilon_t
$$

where $\gamma_0$ is the error correction coefficient representing the speed of adjustment of house prices to the long-run equilibrium level, and $\varepsilon$ is a white noise process.

In addition, the impacts of government regulations over the period between 2005 and 2007 on housing market self-adjustment mechanism are investigated. A series of regulation policies may change housing market’s ability to respond to shocks. Hence a dummy variable, $\text{Dum4}$, is created to form an interaction term with the error correction term. The final short-run house price dynamics model is

$$
\Delta \ln P_t = \beta_0 + \beta_1 \Delta \ln P_{t-1} + \beta_2 \Delta \ln INC_t + \beta_3 \Delta \ln POP_t + \beta_4 \Delta UC_t + \\
\beta_5 \Delta \ln LSC_t + \beta_6 \Delta \ln CC_t + \beta_7 \Delta \ln NM_t + \gamma_0 \text{ecm}_{t-1} + \gamma_1 \text{Dum4} \times \text{ecm}_{t-1} + \varepsilon_t
$$

4 Empirical Findings

4.1 Estimation Method

The Engle and Granger two-step procedure is adopted to estimate the reduced form error correction model. In the first step, the equilibrium level of house price in the long-run is estimated with the OLS method. Augmented Dickey-Fuller unit root test method is used to check each variable for stationarity. If all variables are of the same order of integration, the linear regression Eq. (10) can be estimated with the OLS method. On the condition that the residual derived from this
regression is stationary in the level, the estimation results are valid and there exist a long-run equilibrium relationship between house price and other explanatory factors. With the estimated model the equilibrium level of long-run house prices can be derived. In the second step, the one period lagged residuals in Eq. (10) are taken as the error correction terms in the short-run dynamics model. Equations (11) and (12) are estimated with the OLS method. Diagnostics tests are also carried out on residual terms of the resultant estimations.

4.2 Data and Variables

The data used in this study are from Beijing over the period between 2000 and 2007. All nominal variables are converted into real values by using the consumer price index (1999=100). Table 1 gives definitions of continuous variables and data sources. \( Dum1 \) equals to 0 before 2001 and 1 otherwise; \( Dum2 \) equals to 1 from the 4\(^{th} \) quarter of 2004 and 0 otherwise; \( Dum3 \) equals to 0 before the 3\(^{rd} \) quarter of 2006 and 1 otherwise; \( Dum4 \) equals to 1 from 2005 and 0 otherwise. House prices are measured by the average selling prices of all first-hand sales.

Table 1  Variable Definitions and Data Sources

<table>
<thead>
<tr>
<th>Notation</th>
<th>Variable name</th>
<th>Definition</th>
<th>Measuring unit</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P )</td>
<td>House price</td>
<td>Real average selling price</td>
<td>RMB/sq. m</td>
<td>Beijing Municipal Bureau of Statistics</td>
</tr>
<tr>
<td>( i )</td>
<td>Interest rate</td>
<td>Nominal mortgage interest rate with above 5 year maturity</td>
<td>%</td>
<td>The People’s Bank of China</td>
</tr>
<tr>
<td>( \pi )</td>
<td>Inflation rate</td>
<td>Consumer Price Index (1999=100)</td>
<td>–</td>
<td>Beijing Municipal Bureau of Statistics</td>
</tr>
<tr>
<td>( INC )</td>
<td>Income</td>
<td>Real per capita disposable income</td>
<td>RMB</td>
<td>Beijing Municipal Bureau of Statistics</td>
</tr>
<tr>
<td>( POP )</td>
<td>Population</td>
<td>Permanent urban population</td>
<td>Person</td>
<td>Beijing Municipal Bureau of Statistics</td>
</tr>
<tr>
<td>( CC )</td>
<td>Building cost</td>
<td>Real average construction cost of completed residential units</td>
<td>RMB/sq. m</td>
<td>Beijing Municipal Bureau of Statistics</td>
</tr>
<tr>
<td>( LSC )</td>
<td>Land supply</td>
<td>Cumulative area of leased residential land</td>
<td>Hectare</td>
<td>Beijing Municipal Bureau of Land and Resources</td>
</tr>
<tr>
<td>( M )</td>
<td>Loan</td>
<td>Real residential mortgage loan</td>
<td>RMB</td>
<td>The People’s Bank of China</td>
</tr>
<tr>
<td>( UC )</td>
<td>User cost of housing capital</td>
<td>( = ) Real mortgage rate–expected long-run house price appreciation rate</td>
<td>%</td>
<td>Authors’ calculation</td>
</tr>
</tbody>
</table>
residential properties sold in each quarter. Population statistics cover the total number of permanent residents in Beijing (including non-registered residents). Due to the high correlation between income and population (0.97), we use total income $INCP$ (per capita disposable income multiplied by population) in the empirical analysis. Real user cost of housing capital is calculated as the difference between real interest rate and the expectation of house price growth (measured by the average of real house price appreciation over the last six quarters).

4.3 Empirical Findings

4.3.1 Results of Unit Root Tests

In Table 2, the results of Augmented Dickey-Fuller (ADF) tests are reported for the level and first differences of all the economic time series included in the cointegrating regression (dummy variables are excluded from the test). MacKinnon (1996)’s one-side $p$-values are reported in addition to the ADF $t$-statistics. We conclude that each of the series is integrated of order 1.

<table>
<thead>
<tr>
<th></th>
<th>Levels</th>
<th>First differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$t$-statistic</td>
<td>Prob.</td>
</tr>
<tr>
<td>Real house price</td>
<td>$(c, t, 3) = 0.41$</td>
<td>0.99</td>
</tr>
<tr>
<td>Real total income</td>
<td>$(c, t, 4) = -1.43$</td>
<td>0.84</td>
</tr>
<tr>
<td>Real mortgage loan</td>
<td>$(c, t, 0) = -2.34$</td>
<td>0.40</td>
</tr>
<tr>
<td>Cumulative land supply</td>
<td>$(c, t, 0) = -1.56$</td>
<td>0.79</td>
</tr>
<tr>
<td>Real construction cost</td>
<td>$(c, t, 1) = -1.23$</td>
<td>0.89</td>
</tr>
<tr>
<td>Real user cost</td>
<td>$(n, n, 3) = -0.69$</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Note: $c$ represents the constant in test equation, $t$ denotes the trend in test equation, the number 0 to 4 represents the lag length based on SIC, $n$ denotes no constant or trend in test equation, Prob. is MacKinnon(1996) one-side $p$-values, all variables are in the logarithm form except user cost variable.

4.3.2 Estimates of the Long-term Relationship

Table 3 reports the results of linear regression of long-run determinants of house prices. All variables are included in Model 1, but the coefficient of construction cost (LNCC) is not statistically significant. After excluding this variable in Model 2 all remaining variables have significant coefficients at the 5% level. The ADF test results reported in Table 4 indicate that the residual series of Model 2 is
stationary in the level. Hence, the long-run equilibrium level of house prices can be explained by land supply, demand-side variables and policy factors.

Table 3  OLS Estimates of Long-term Determinants of House Prices

<table>
<thead>
<tr>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.97(0.64)</td>
</tr>
<tr>
<td>LNINCP</td>
<td>0.65*** (2.67)</td>
</tr>
<tr>
<td>LN M</td>
<td>0.14*** (4.63)</td>
</tr>
<tr>
<td>UC</td>
<td>–1.91*** (–2.91)</td>
</tr>
<tr>
<td>LNLSC</td>
<td>–0.20*** (–2.23)</td>
</tr>
<tr>
<td>LNCC</td>
<td>0.23(1.19)</td>
</tr>
<tr>
<td>Dum1</td>
<td>0.11‘(1.90)</td>
</tr>
<tr>
<td>Dum2</td>
<td>0.11’(1.68)</td>
</tr>
<tr>
<td>Dum3</td>
<td>0.23*** (4.49)</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.94</td>
</tr>
<tr>
<td>F-statistic</td>
<td>60.41</td>
</tr>
<tr>
<td>Durbin-Watson statistic</td>
<td>1.96</td>
</tr>
</tbody>
</table>

Note: $t$ values of the estimated coefficients are given in the parentheses, *, ** and *** denotes 10%, 5% and 1% significant level respectively.

Based on the point estimates of the long-run house prices model, we reach the following conclusions. (1) On the demand-side, an increase in total income by 1% causes house prices to rise by 0.84%; a decrease in real user costs by one percentage point increases real house price by 1.8%. The results indicate that income growth and population expansion are important driving forces for house prices appreciation in Beijing. In the meanwhile interest rate and expectation of long-run house price appreciation also play important roles in determining house price equilibrium level. (2) The elasticity of house price to mortgage loan is 0.15, which highlights the impacts of financing market development and mortgage loan policies on house prices. Similar results can be found in Egerd and Mihaljek (2007). (3) On the supply-side, house prices are predicted to fall by 0.27% in response to a 1% increase in cumulative land supply. This coefficient estimate is smaller than 1%, most likely due to the following two reasons. Firstly, the increases of marginal cost of land places a cap on housing supply. Secondly, some land parcels are not developed immediately after being leased from the local government but reserved in developers’ ‘land banks’. This is motivated by the expectation that postponing the development will warrant higher profit margins assuming the shortage of land supply will further push up house prices.
in the future. (4) Besides the fundamentals, the coefficients of the three dummy variables show that regime shifts play important roles in determining long-run house price equilibrium levels in transition economy. Reform of urban housing system, change of land supply policies and exchange rate regime shift all have significant positive impacts on house prices.

### Table 4  ADF Unit Root Tests Results of Residual Series of Model 2

<table>
<thead>
<tr>
<th>Residual series of Model 2</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n, n, 1)</td>
<td>–5.56</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

#### 4.3.3  Estimates of Short-term Relationship

After establishing the long-run relationships between house prices and the determinants, the analysis proceeds to the estimation of the reduced form error correction model based on equations (11) and (12). We firstly estimate the model by including all variables, only find that construction cost and change of one period lagged house prices are statistically insignificant. So these two variables are excluded from the two models reported in Table 5. No serial correlation and heteroskedasticity are detected in the two models. The null hypothesis of normality is not rejected either.

### Table 5  Estimates of the Error Correction Model for Real House Prices

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.26** (3.22)</td>
<td>0.26** (3.39)</td>
</tr>
<tr>
<td>(LN(P_i-\text{LN}(P^*<em>i))</em>{-1}</td>
<td>–0.55** (–2.64)</td>
<td>–0.88** (–3.23)</td>
</tr>
<tr>
<td>(LN(P_i-\text{LN}(P^*<em>i))</em>{-1} Dum4</td>
<td>0.66** (1.77)</td>
<td></td>
</tr>
<tr>
<td>(\Delta \text{LNINCP}_i)</td>
<td>–0.62** (3.43)</td>
<td>0.69** (3.88)</td>
</tr>
<tr>
<td>(\Delta \text{LNIM}_i)</td>
<td>0.10** (3.81)</td>
<td>0.10** (4.13)</td>
</tr>
<tr>
<td>(\Delta UC_t)</td>
<td>–1.26** (–2.75)</td>
<td>–1.28** (–2.90)</td>
</tr>
<tr>
<td>(\Delta \text{LNLS}_{-1})</td>
<td>–0.05** (–3.12)</td>
<td>–0.55** (–3.32)</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>F-statistic</td>
<td>5.64</td>
<td>5.62</td>
</tr>
<tr>
<td>Breusch-Godfrey Serial Correlation LM test</td>
<td>F(6, 19)=0.67(0.67)</td>
<td>F(6, 18)=1.06(0.42)</td>
</tr>
<tr>
<td>Heteroskedasticity ARCH test</td>
<td>F(5, 25)=0.80(0.56)</td>
<td>F(6, 24)=0.61(0.72)</td>
</tr>
<tr>
<td>Normality test</td>
<td>Jarque-Bera=1.44(0.49)</td>
<td>Jarque-Bera=0.71(0.70)</td>
</tr>
</tbody>
</table>

Note: t values of the estimated coefficients and p values of diagnostic tests are given in the parentheses, * and ** denotes 10% and 1% significant level respectively.
The difference between model 1 and model 2 is the presence of an interaction term between Dum4 and the error correction term in model 2. The inclusion of this variable in model 2 is justified by a significant change of the coefficient estimates for the error correction term, a 4% increase in adjusted $R^2$ squares, and most importantly, a coefficient estimate that is statistically significant at the 10% level. The coefficient of the error correction term suggests that 88% of house prices’ deviation from the long-run equilibrium level can be corrected within the next quarter before 2005. The adjustment speed is reduced to 22% from 2005 onward. Some possible explanations of this phenomenon are as follows. (1) On the supply-side, since 2005 housing supply has been reduced by a significant land supply reduction and tighter regulations on planning and development. The supply was further cut short when more land parcels are placed into land banks by developers. Receding profit margins and increasing cost associated with construction, financing, and taxation also reduced the supply elasticity. These factors in combination caused housing supply to be less responsive to price shocks from 2005 onward. (2) From the demand side, although speculation is restrained to some extent by macro-level policies regulating taxation, financing and the resale of pre-sale housing units, both the expectation of RMB appreciation and excessive liquidity supported a strong housing demand. Population growth and income increases also drove the demand of both first-time purchases and housing upgrades. Government’s ineffective measurements to dampen house prices fueled expectations for further house prices appreciation. All these aforementioned factors contributed to an exuberant housing demand since 2005. With the gap between demand and supply widening, the speed of house prices to reverse to the equilibrium level slowed down. Although an expectation of house prices depreciation was gradually established by the end of 2007 as a result of tightened credit policies and strengthened affordable housing provisions, consumers chose to wait and delay their purchases. At the same time, many developers were still fighting to maintain house prices by reducing the number of housing units for sales. The market was characterized by reduced transaction volume and sticky house price. (3) The significant reduction in affordable housing units between 2005 and 2007 also contributed to the mismatch between housing supply and demand in the private housing market, which further reduced the adjustment ability of private market.

According to the coefficients of fundamentals’ changes in model 2, we have the following observations. (1) On the demand-side, the short-run elasticity of house prices to total income is 0.7; a decrease in user cost by 1% will increase house prices by 1.3%, which is the largest among all factors. Reductions in user cost and strong total income growth are the two driving forces of housing prices
to deviate from the equilibrium level. (2) The coefficient of changes in new residential mortgage loan is 0.1. New residential mortgage loan increased by 15% in 2004, and retracted by 40% annually in the next two years. According to the relationship identified in our model, this will effectively curb the house prices in Beijing. However, property prices saw a significant increase recently due to the expansion of residential mortgage loan in 2007. (3) On the supply-side, if land supply increases by 1%, house prices will decrease by 0.05% in the next quarter. Although the estimated coefficient has a small absolute value, the overall effect on house price growth is large given the dramatic changes in land supply. For example, land supply in 2005 is reduced by 90% from previous year’s level; land supply in 2007 is less than that in 2001. Therefore the overall impact by land supply is significant.

5 Conclusion and Policy Implication

This paper examines the determinants of house price dynamics in an emerging housing market from a transition economy. Taking into account the uniqueness of China’s housing market, the traditional life-cycle house price model is revised and estimated with an error correction framework. Using quarterly data from Beijing over the period from 2000 to 2007 this paper presents new empirical evidence on the role of economic fundamentals and government intervention on house price dynamics in China. Our findings suggest the followings. (1) In the long-run, there exit a co-integration relationship between house prices and fundamentals. Urban housing system reform, changes of land supply and exchange rate policies have significant impacts on house prices. (2) In the short-run, house price dynamics depend on changes of fundamentals and the inherent adjustment process of housing market. The overall effect of land supply on house price dynamics can be substantial when land supply changes significantly over a short period of time. Demand-side factors such as user cost, income and residential mortgage loan have greater influences than supply-side factors. Reduction in user cost and strong income growth are the driving forces of rising house prices from 2005 to 2007. (3) After 2004 housing demand has been rising rapidly whilst housing supply has been increasingly insensitive to price shocks. Consequently the adjustment speed of house prices to the equilibrium level is reduced by about 75%. From 2005 onward house prices deviations caused by exogenous shocks tend to persist for a longer time.

From the above analysis, we derive the following policy implications. (1) With the establishment of a market economy system, monetary and credit policies can
be effectively transmitted in the Beijing housing market via controls over credit and interest rate. Facing a global financial crisis and the slowdown of economic growth, policymakers in China should monitor the flow of international capital into China’s housing market and, more importantly, stakeholders’ expectation towards future house prices appreciation. Measures should be taken swiftly to restore the confidence of homebuyers and developers, to stabilize transaction volumes, and to reduce the turbulence in the housing market. (2) Our findings suggest that land supply has significant impacts on house prices both in the long-run and the short-term. As the sole supplier of urban land, the Chinese government can and should use land supply to stabilize housing market. A middle-to-long term land supply plan should be established, under which the government can effectively adjust the quantity and the timing of land releases in response to changes in the housing market. By pacing new land supply strategically the government can avoid unnecessary market turbulences that might potentially undermine the market self-adjustment mechanism. (3) There is a close relationship between public housing sector and private housing market. Public housing policies have significant impacts on house prices. In November 2008 the central government moved forward with a three year plan with a 900 billion RMB investment in affordable housing. This scheme will help to meet the housing demand of low-income households, stimulate economic growth, and enhance the adjustment ability of private housing market. But at the same time the government should monitor the volume and speed of affordable house construction closely to avoid the ‘crowding-out’ effects on private housing market.

Acknowledgements We acknowledge the financial support provided by the Ministry of Education’s Humanities and Social Science Research Fund (No. 02JA790055).

References