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Price discovery and dynamics across housing developers in China

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Abstract

This paper examines the short-term price dynamics in mean and volatility across state, private and overseas housing developers in China. We use a unique transaction dataset of new apartment units over the period 2005-2014. The results do not support the price discovery role of one group of developers neither the presence of domino effects.

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1. Introduction

The housing market plays a major role in the Chinese economy and has been a key engine of its rapid growth. In 2014, real estate investment accounted for 15% of the GDP, compared to 4% in 1997 (Chivakul et al., 2015). According to the National Bureau of Statistics, the housing area increased at an annual rate of 14.1% between 2000-2014, while prices went up at an annual rate of 8.9% (5.7% in real terms), reaching 6,000 RMB (969 US dollars) per square meter in 2014. The participation of private and overseas investment has also been important. The deep reform of the market in 1998 resulted in a gradual increase of private enterprises, which by 2004 represented 60% of all developers (Feng, 2006); in March 2004, the National Development and Reform Commission (NDRC) further issued the Foreign Investment Industrial Guidance Catalogue to spur overseas-funded companies' activities.[1] To date, different developer-ownership types coexist including central and local state-owned, private and overseas enterprises.

This paper evaluates the short-term dynamic price relationship between state, private and overseas developers. We exploit a unique dataset of new apartment units purchased between 2005-2014 in Chengdu, the largest sub-provincial city in Western China.[2] We assess the extent to which prices and volatility are transmitted across developers and the direction of this transmission. In particular, how a shock in one developer segment transmits to the other segments and whether there is a dominant role of one specific group of developers. The study contributes to our understanding of the complex housing price dynamics in China. Similarly, the paper contributes to the general literature on housing domino (ripple) effects, which mainly evaluates price transmission at the mean level, while we extend the analysis to volatility interactions (see, e.g., Chen et al., 2011; Ho et al., 2008; Oikarinen, 2004). In the case of China, previous studies have mostly focused on cross-effects between cities but not between different types of buildings within a city (e.g., Zhang and Mei, 2015; Huang et al., 2010; Zhang and Liu, 2009).

2. Methodology

We follow a multivariate GARCH (MGARCH) approach. As the price series in levels are non-stationary, we work with price returns defined as $r_{it} = \ln(p_{it} / p_{it-1})$, where p_{it} is the price of apartment unit built by developer-type *i* at month *t*. This standard logarithmic transformation approximates monthly percentage variations in prices.

The conditional mean equation is modeled as a vector-error correction (VEC) model to account for cointegration of the price series. In particular,

$$r_t = \theta_0 + \sum_{j=1}^{k} \theta_j r_{t-j} + \prod p_{t-1} + \varepsilon_t \quad , \quad \varepsilon_t \mid I_{t-1} \sim (0, H_t) \qquad (1)$$

where r_t is a 3x1 vector of state, private and overseas developers' price returns; θ_0 is a 3x1 vector of long-term drifts; $\theta_j, j = 1,...,k,$ are 3x3 matrices of parameters capturing own and cross lead-lag

[1] The rapid growth of foreign investment, however, led the government to impose additional regulations between 2006 and 2011, which were recently removed in 2015.

[2] Chengdu is considered a Tier II city and has been the most dynamic housing market in recent years.

relationships between price returns;[3] $\prod$ is a 3x3 matrix of parameters that describe the long-term price relationship and error correction adjustment; and ε_t is a 3x1 vector of innovations with zero mean and variance-covariance matrix H_t, conditional on past information I_{t-1}.

The variance-covariance matrix H_t is specified as a BEKK model, proposed by Engle and Kroner (1995), which is defined as

$$H_t = C'C + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + G'H_{t-1}G \qquad (2)$$

where C is a 3x3 upper triangular matrix of constants $c_{ij}, i.j = 1,...,3$; A is a 3x3 matrix whose elements a_{ij} capture the direct effect of a past innovation in segment i on the current volatility of segment j; and G is a 3x3 matrix whose elements g_{ij} measure the direct influence of past volatility in segment i on the current volatility in segment j. This specification accounts for both own- and cross-volatility spillovers and persistence.

From the estimated mean and variance equations, we can derive impulse-response functions to evaluate how a shock in one market segment is fully transmitted to other segments. The derivation of impulse responses at the mean level is relatively straightforward after the corresponding orthogonalizations; in the case of volatility responses, we follow Gardebroek and Hernandez (2013), which account for both direct effects (through the variance) and indirect effects (through the covariance). We focus on the one-period responses.

We also estimate a dynamic conditional correlation (DCC) model. This alternative MGARCH model, proposed by Engel (2002), specifies the variance-covariance matrix as a mean-reverting, autoregressive moving-average process.[4] Compared to the BEKK model, the DCC model is more suitable to examine market interdependence (correlations) over time as it approximates a dynamic conditional correlation matrix.[5]

2.1 Data

The data used for the analysis are based on all transactions for new residential apartments purchased in the downtown area of Chengdu between January 2005-December 2014.[6] The data is obtained from Chengdu's Housing Authority transaction system. The dataset contains information on purchase date, transaction price, location, name of building developer, and some building and unit characteristics. The name of the developer is matched with information from the National Enterprise Credit Information Public System and open-source information of companies listed in the stock market to determine the type of developer ownership.[7] The total sample includes 937,134 observations.

As shown at the bottom of Table 1, almost two thirds (63%) of the total housing transactions

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[3] The number of lags is determined by the Schwarz Bayesian information criterion.
[4] See the Appendix (Table A.4) for additional details about the DCC model.
[5] The pattern of correlations obtained with the BEKK model is in fact similar, although much more volatile, than the correlations resulting from the DCC model, which also difficult uncovering any trend patterns.
[6] Residential apartments constitute the vast majority of the housing supply in urban China (97% of transactions in our full sample). Focusing on these units permits to base the analysis on comparable housing units.
[7] We consider the ownership type of the major shareholder in case of multiple ownership types.

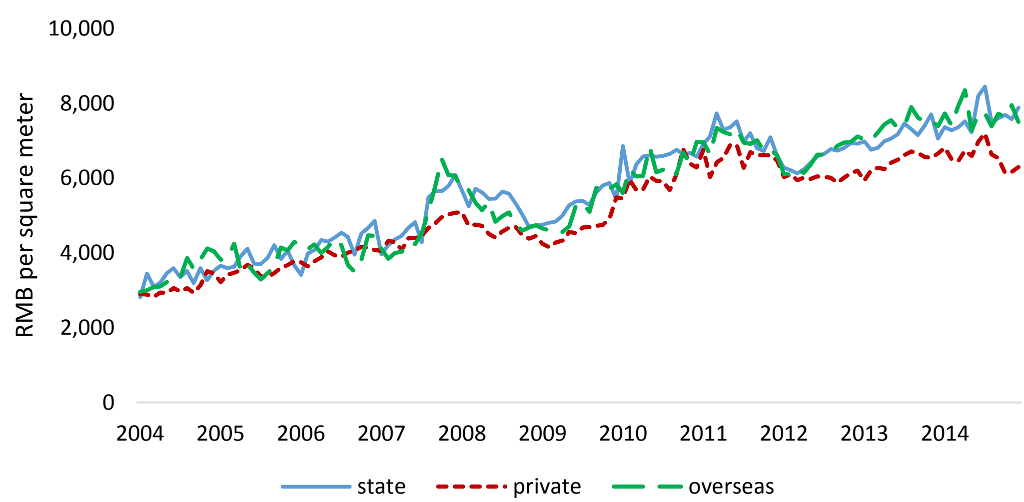
in the sample correspond to units built by private companies. Yet, only a few of these companies are listed, as opposed to state and overseas companies, and their apartment complexes (and units) are typically smaller and with lower management fees, which is indicative of fewer amenities in the building. The average price per square meter of private units is 6,133 RMB versus 7,349 RMB and 6,738 RMB of state and overseas units. In terms of the evolution of prices, Figure 1 shows that prices seem to follow a similar pattern of ups and downs across developers.

Table 1. Unit characteristics by developer type

Variable	State	Private	Overseas
Price per square meter	7,349	6,133	6,738
	(2,760)	(2,536)	(2,755)
Total building area (square meters)	410,884	255,869	484,734
	(366,018)	(233,368)	(486,221)
Total floors in building	24.9	23.8	25.1
	(9.4)	(9.2)	(9.3)
If listed company	0.66	0.07	0.37
	(0.47)	(0.26)	(0.48)
If property Class A	0.31	0.18	0.31
	(0.46)	(0.38)	(0.46)
Unit area (square meters)	101.6	94.5	101.2
	(36.5)	(34.4)	(38.6)
Observations	233,362	590,875	112,897
Share of total transactions	25%	63%	12%

Note: Building area is total area of buildings in the complex; Listed companies are developers listed in the stock market; Property class is based on the building management fees divided by quartiles (class A is the highest quartile). Standard deviations reported in parentheses.

Figure 1. Evolution of monthly average housing prices by type of developer, 2004-2014

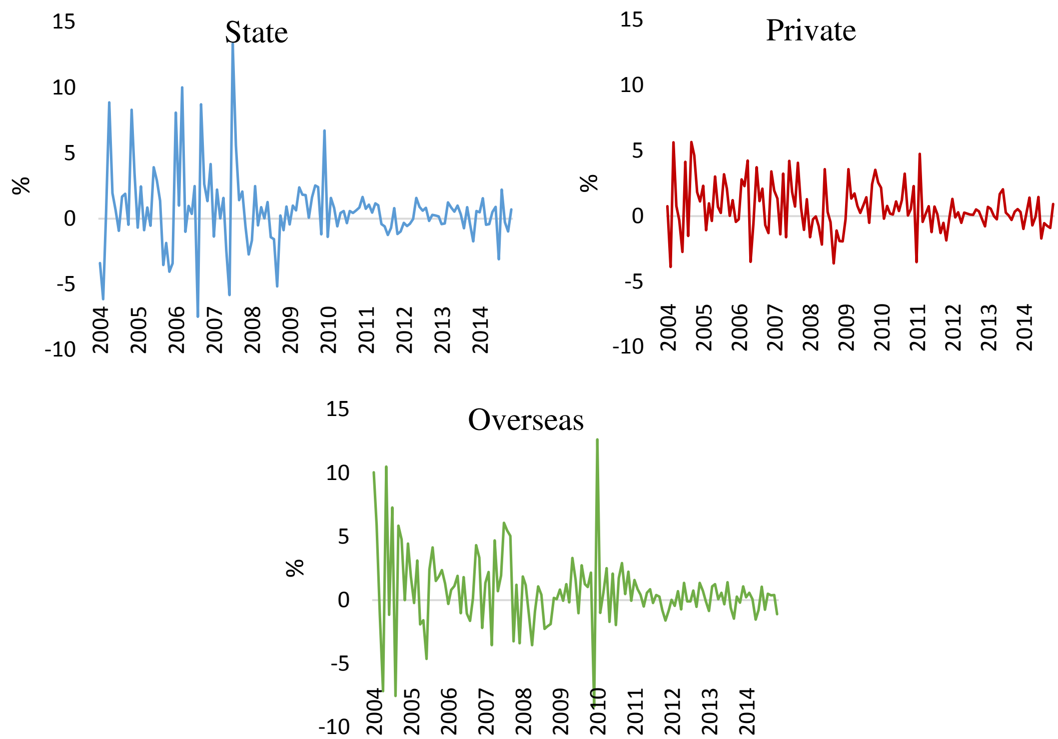


Note: The reported monthly prices are average weighted prices per square meter (using unit size as weights), deflated by the consumer price index (base period = January 2004).

From the transaction data, we construct a monthly price index for state, private and overseas units. Following Wu et al. (2014), we implement a hedonic modeling approach, which provides a more accurate quality-adjusted price index for newly-built houses than a simple average method and the matching method proposed by Deng et al. (2012). We regress (log) prices per square meter on a set of building controls (area, number of floors and property class), developer characteristics (if listed company), unit controls (area, ratio unit floor to total building floors, if duplex, sale duration), and location and time fixed effects.[8] The year-month dummies serve to derive the price indexes and returns.

Figure 2 plots the corresponding monthly price returns. Two patterns emerge from the figure. First, the returns exhibit important fluctuations over time, with periods of high variation combined with periods of relative calm. Second, price changes in all market segments, particularly in the state segment, have become less volatile after 2008-2009; this could be connected to the additional regulations passed by the Chengdu government that forbade developers to keep land vacant, which was a common practice among state developers, likely reducing potential speculative behavior.[9] Table 2 reports, in turn, the summary statistics of the returns series. We observe that overseas returns are, on average, higher than state and private returns (0.68% versus 0.63% and 0.61%), but they also show a higher dispersion. The Ljung-Box (LB) test rejects the null hypothesis of no autocorrelation for the squared price returns, which supports the use of MGARCH modeling.

Figure 2. Monthly price returns by developer type



[8] The estimation results are reported in Appendix Table A.1.

[9] In 2010, state-owned enterprises across China whose main business was not real estate development were also required to exit the market.

Table 2. Summary statistics for monthly price returns

Statistic	State	Private	Overseas
Mean	0.629	0.605	0.684
Median	0.523	0.298	0.462
Minimum	-7.480	-3.898	-8.392
Maximum	13.340	5.652	12.635
Std. Dev.	2.808	1.835	2.874
Skewness	1.212	0.374	0.737
Kurtosis	7.850	3.420	6.988
Jarque-Bera	160.500	4.021	98.670
p-value	0.000	0.134	0.000
# obs.	131	131	131
	Returns autocorrelations		
LB (6)	4.5559	5.6439	13.377**
LB (12)	16.746	13.528	20.013
	Squared returns autocorrelations		
LB (6)	7.399	13.963**	37.975**
LB (12)	21.247**	20.551**	40.838**
	Tests for stationarity		
ADF (lag=6)	-4.044**	-3.520**	-4.515**
KPSS (lag=6)	0.037	0.042	0.061
	Tests for stationarity (log prices)		
ADF (lag=6)	-1.457	-2.547	-2.038
KPSS (lag=6)	0.416**	0.375**	0.360**

Note: ** denotes rejection of the null hypothesis at the 5 percent significance level. The price returns are multiplied by 100. LB is the Ljung-Box autocorrelation test; ADF is the Augmented Dickey-Fuller test; and KPSS is the Kwiatkowski-Phillips-Schmidt-Shin test for stationarity.

3. Results

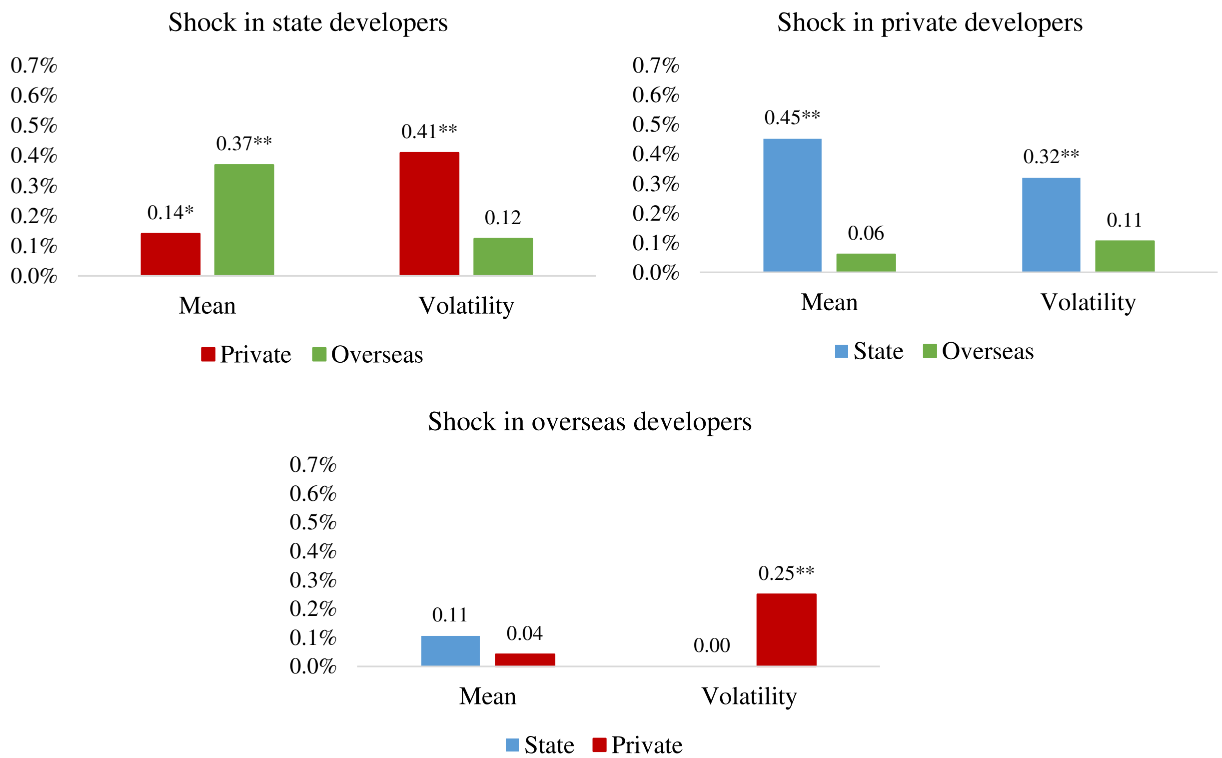
Figure 3 presents the one-period responses in mean and volatility (measured in % change) after a shock in each developer group. The responses are based on the estimation results of the VEC and BEKK models.[10] In the case of interactions at the mean level, price changes in the state group lead to price changes in the other two groups. A shock among state developers that increases their prices in 1% leads to a 0.14% and 0.37% increase in the private and overseas segment. Price changes in the state group, however, are similarly influenced by price variations in the private group. A 1% price increase in the private segment leads to a 0.45% increase in the state segment. Price variations in the overseas segment does not seem to transmit to the other segments.

In terms of volatility transmission, we also observe significant interactions between the state and private group. A shock that increases price volatility in the state segment by 1% leads to a 0.41% volatility increase in the private segment; likewise, a 1% volatility increase in the private segment results in a 0.32% increase in the state segment. Interestingly, there is some volatility transmission from the overseas to the private group (0.25% volatility increase following a 1% increase in the overseas segment). Overall, there is a close price interrelationship between properties built by state and private developers, both in terms of levels and volatility, and the

[10] See Appendix Tables A.2 and A.3 for the full estimation results.

interactions are bidirectional. The prices of units built by overseas developers are, in contrast, less connected with the other groups.

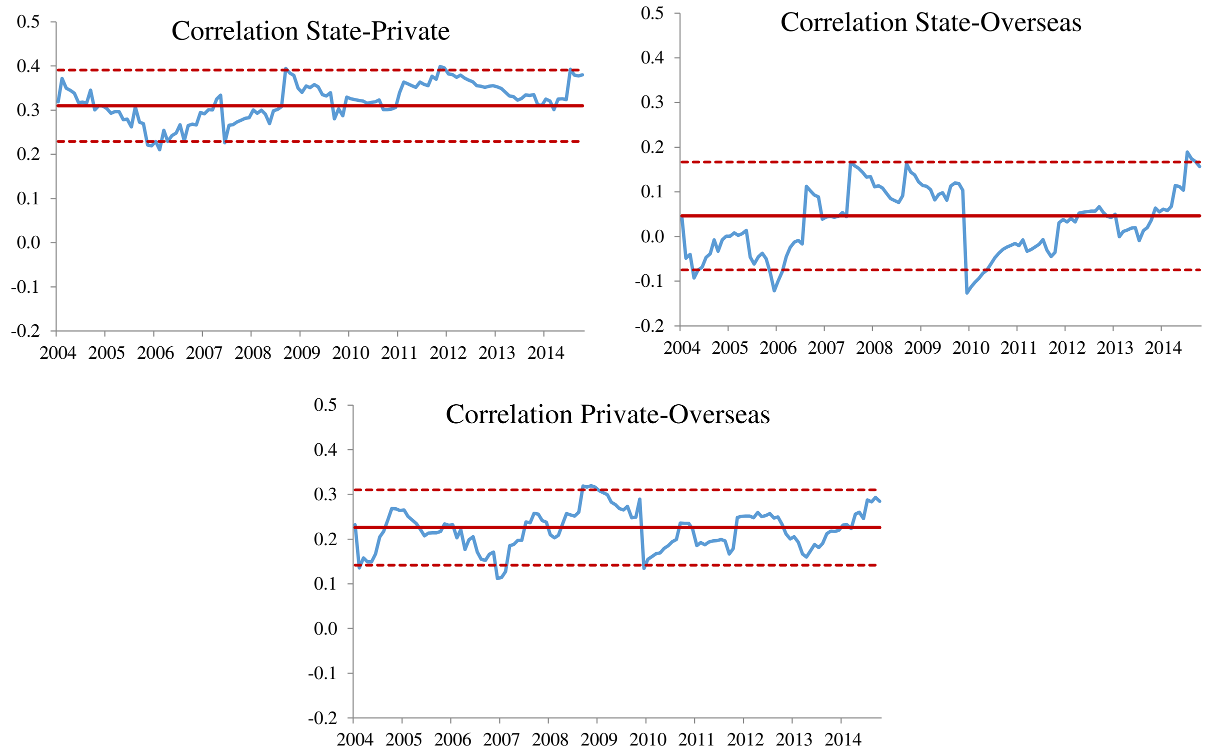
Figure 3. Price transmission in mean and volatility



Note: Calculations based on the derivation of impulse-response functions using the estimation results of the VEC and BEKK models. The responses are the corresponding one-period responses after a shock in the indicated market segment. The shock is equivalent to a shock that results in a 1% increase in price or volatility in the market segment. The responses are normalized for comparison purposes. Significance based on 300 bootstrap replications. **, * denote significance at 5 and 10 percent level.

The higher interrelation between the state and private segment is further reflected in the pairwise conditional correlations resulting from the DCC model, presented in Figure 4. The average correlation between price changes in the state and private group is 0.32 versus 0.22 in the private-overseas pair and 0.03 in the state-overseas pair. The correlations also exhibit important variations over time and there is not a general increasing trend in them. In fact, there was a sharp decline in the price correlation between the overseas and the other two groups in 2010, probably due to the additional regulations on land purchases and cross-border investment and financing activities imposed by the government after the financial crisis of 2008-2009, which most likely affected foreign developers; after the decline, only the correlation between the state and overseas segment have shown some sort of sustained increase. Thus the degree of price comovement across developer groups has not intensified with the expansion of Chengdu’s housing market.

Figure 4. Dynamic conditional correlations based on DCC model



Note: The dynamic conditional correlations are derived from the estimation results of the DCC model. The solid line is the estimated constant conditional correlation with confidence bands of one standard deviation.

4. Conclusion

This paper has examined the short-term price dynamics across developers in a major Chinese housing market. We find significant price and volatility transmission between state and private developers but the interactions are bidirectional, which do not support the leading role of one group. We also do not observe domino effects across the state, private and overseas segments. The lack of dominance of one particular group could be linked to the fact that while state-owned enterprises receive the support of the government and have access to more financing channels, private enterprises are generally more cautious and could be taking advantage of better investment opportunities (Mao et al., 2014; Wang et al., 2007). The lack of domino effects differ, in turn, with the results of Ho et al. (2008) who find price transmission from lower to higher quality tiers in Hong Kong. Future research should continue analyzing the price dynamics in the sector in light of the continued expansion of the housing market.

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