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Supplementary Appendix to be made available online for readers

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Appendix. Supplementary Results

Table A.1. Hedonic price regressions

Coefficient	(1) State	(2) Private	(3) Overseas
	Dependent variable: Ln price per square meter		
Ln total building area (square meters)	0.014**	0.013**	-0.002*
	(0.001)	(0.000)	(0.001)
Total floors in building	-0.003**	0.003**	-0.001**
	(0.000)	(0.000)	(0.000)
If property Class C	0.066**	0.042**	0.008**
	(0.001)	(0.001)	(0.002)
If property Class B	0.125**	0.113**	0.099**
	(0.001)	(0.001)	(0.002)
If property Class A	0.286**	0.234**	0.167**
	(0.002)	(0.001)	(0.002)
If listed company	0.061**	0.091**	0.006**
	(0.001)	(0.001)	(0.002)
Ln unit area (square meters)	0.092**	0.004**	0.030**
	(0.001)	(0.001)	(0.002)
Ratio unit floor to total floors in building	0.011**	0.016**	0.027**
	(0.001)	(0.001)	(0.002)
If duplex apartment	0.004	0.038**	-0.019
	(0.038)	(0.012)	(0.014)
Ln sale duration (months)	-0.011**	-0.014**	-0.026**
	(0.001)	(0.000)	(0.001)
Constant	7.677**	7.823**	7.858**
	(0.013)	(0.006)	(0.013)
Observations	233,362	590,875	112,897
R-squared	0.828	0.821	0.860

Note: **, * denote significance at 5 and 10 percent level. Robust standard errors in parentheses. All regressions include location (blocks) fixed effects and the year-month dummies used to derive the price indexes. The six districts in Chengdu's city center can be divided into 28 blocks. 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 paid divided by quartiles (class D is the lowest quartile and base category); Sale duration is the number of months the unit was on sale until it was purchased.

Table A.2. Estimation results of the conditional mean equation (VEC model)

Coefficient	State (i=1)	Private (i=2)	Overseas (i=3)
	Conditional mean equation		
θ_0	0.002	0.008**	0.002
	(0.003)	(0.002)	(0.002)
θ_{1i}	0.127	0.079	0.312**
	(0.092)	(0.065)	(0.080)
θ_{2i}	0.221	-0.001	-0.344**
	(0.142)	(0.100)	(0.124)
θ_{3i}	-0.070	-0.059	0.014
	(0.088)	(0.063)	(0.077)
adjustment_{ce1i}	-0.367**	0.061	0.058
	(0.080)	(0.056)	(0.069)
adjustment_{ce2i}	0.231**	-0.163**	0.405**
	(0.107)	(0.076)	(0.094)
Normalized cointegrating equation 1 (ce1)			
ln state	ln private	ln overseas	constant
1	0	-1.133	0.803
		(0.027)	
Normalized cointegrating equation 2 (ce2)			
ln state	ln private	ln overseas	constant
0	1	-1.040	0.333
		(0.016)	
Lagrange multiplier (LM) test for serial correlation (H_0: no serial correlation)			
LM(6)			5.535
p-value			0.785
LM(12)			9.583
p-value			0.385
Log likelihood			957.9
SBIC			-13.988
# observations			130

Note: **, * denote significance at 5 and 10 percent level. Standard errors reported in parentheses.

VEC model estimation

The two cointegrating relationships between the (log) price series were determined using the Johansen trace and eigenvalue test. The selected number of lags (one lag) is based on the Schwarz Bayesian information criterion. The Lagrange Multiplier (LM) test on the residuals and the eigenvalue stability condition (not reported) support the adequacy of the model specification.

Table A.3. Estimation results of the conditional variance equation (BEKK model)

Coefficient	State (i=1)	Private (i=2)	Overseas (i=3)
	Conditional variance-covariance equation		
c_{i1}	-0.0002	-0.0013	-0.0019
	(0.0026)	(0.0083)	(0.0116)
c_{i2}		-0.0011	-0.0013
		(0.0103)	(0.0151)
c_{i3}			0.0000
			(0.0001)
a_{i1}	0.388**	0.050	-0.005
	(0.125)	(0.058)	(0.089)
a_{i2}	-0.248*	-0.137*	-0.186*
	(0.149)	(0.078)	(0.100)
a_{i3}	0.137	0.103	0.373**
	(0.153)	(0.138)	(0.100)
g_{i1}	0.898**	-0.066**	0.074
	(0.038)	(0.012)	(0.062)
g_{i2}	0.142**	0.974**	-0.119**
	(0.030)	(0.023)	(0.030)
g_{i3}	-0.104**	0.055	0.931**
	(0.053)	(0.064)	(0.031)
v			10.348**
			(4.031)
Wald joint test for cross-volatility coefficients (H_0: a_{ij}=g_{ij}=0,$\forall i \neq j$)			
Chi-sq			417.115
p-value			0.000
Wald test for block-exogeneity in variance of state enterprises (H_0: a_{1j}=g_{1j}=0, j=2,3)			
Chi-sq		28.535	3.953
p-value		0.000	0.139
Wald test for block-exogeneity in variance of private enterprises (H_0: a_{2j}=g_{2j}=0, j=1,3)			
Chi-sq	14.744		0.732
p-value	0.001		0.392
Wald test for block-exogeneity in variance of overseas enterprises (H_0: a_{3j}=g_{3j}=0, j=1,2)			
Chi-sq	3.350	20.919	
p-value	0.187	0.000	

(*Cont.*)

Coefficient	State (i=1)	Private (i=2)	Overseas (i=3)
Ljung-Box test for autocorrelation (H_0: no autocorrelation in squared residuals)			
LB(6)	2.028	4.073	0.772
p-value	0.917	0.667	0.993
LB(12)	6.815	9.389	1.999
p-value	0.870	0.669	0.999
Lagrange multiplier test for ARCH residuals (H_0: no serial correlation in squared residuals)			
LM(6)	2.388	1.469	1.277
p-value	0.881	0.962	0.973
LM(12)	10.417	9.146	2.595
p-value	0.579	0.690	0.998
Hosking Multivariate Portmanteau test for cross-correlation (H_0: no cross-correlation in squared residuals)			
M(6)			26.141
p-value			1.000
M(12)			61.717
p-value			1.000
Log likelihood			1,037.7
SBIC			-15.028
# observations			130

Note: **, * denote significance at 5 and 10 percent level. Model estimated using a Student's t distribution to account for leptokurtic distribution of the returns series. Standard errors reported in parentheses. ν is the degrees of freedom parameter. LB, LM and M stand for the corresponding Ljung-Box, Lagrange Multiplier and Hosking test statistics.

BEKK model estimation

The residual diagnostic tests — Ljung-Box (LB), Lagrange Multiplier (LM) and Hosking Multivariate Portmanteau (M) tests —show no evidence of autocorrelation, ARCH effects, and cross correlation in the standardized squared residuals, which support the appropriateness of the model specification. The Wald joint test for cross-volatility coefficients ($H_0 : a_{ij} = g_{ij} = 0, \forall i \neq j$) indicate the overall presence of direct volatility spillovers and persistence between the market segments.

Following Gardebroek and Hernandez (2013), the impulse-response functions are derived in two steps. First, we estimate the size of a shock in one of the market segments ($\tilde{\varepsilon}_i$) such that the estimated steady-state conditional variance in that segment ($\bar{h}_{ii}$) increases in 1% after one period. Second, we introduce shock $\tilde{\varepsilon}_i$ in the conditional variance of the other segments h_{jj}, $j \neq i$, and iterate the change in these variances with respect to their steady-state value.

Table A.4. Estimation results of DCC model

Coefficient	State (i=1)	Private (i=2)	Overseas (i=3)
	Conditional variance-covariance equation		
ω_i	0.146	0.383	0.109
	(0.151)	(0.261)	(0.089)
α_i	0.282	0.355*	0.357*
	(0.216)	(0.184)	(0.201)
β_i	0.725**	0.537**	0.686**
	(0.165)	(0.189)	(0.093)
α			0.022
			(0.029)
β			0.886**
			(0.069)
v			7.725**
			(2.061)
Wald joint test for adjustments coefficients (H_0: α=β=0)			
Chi-sq			192.164
p-value			0.000
Ljung-Box test for autocorrelation (H_0: no autocorrelation in squared residuals)			
LB(6)	2.706	2.926	2.035
p-value	0.845	0.818	0.916
LB(12)	9.050	5.534	4.963
p-value	0.699	0.938	0.959
Lagrange multiplier test for ARCH residuals (H_0: no serial correlation in squared residuals)			
LM(6)	3.127	2.375	2.288
p-value	0.793	0.882	0.891
LM(12)	9.795	8.007	5.249
p-value	0.634	0.785	0.949
Hosking Multivariate Portmanteau test for cross-correlation (H_0: no cross-correlation in squared residuals)			
M(6)			30.153
p-value			0.993
M(12)			79.402
p-value			0.975
Log likelihood			1,014.5
SBIC			-15.046
# obs.			130

Note: **, * denote significance at 5 and 10 percent level. Model estimated using a Student's t distribution to account for leptokurtic distribution of the returns series. Standard errors reported in parentheses. ν is the degrees of freedom parameter. LB, LM and M stand for the corresponding Ljung-Box, Lagrange Multiplier and Hosking test statistics.

DCC model estimation

The variance-covariance matrix in the DCC model is specified as

$$H_t = D_t R_t D_t \tag{A.1}$$

where $D_t = diag(h_{11,t}^{1/2} ... h_{33,t}^{1/2})$; $h_{ii,t}$ is a GARCH(1,1) specification, i.e. $h_{ii,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{ii,t-1}, i = 1,...,3$; $R_t = diag(q_{ii,t}^{-1/2}) Q_t diag(q_{ii,t}^{-1/2})$; $Q_t = (q_{ij,t}), i, j = 1,...,3,$ is a 3x3 symmetric positive-definite matrix given by $Q_t = (1-\alpha-\beta)\overline{Q} + \alpha u_{t-1} u_{t-1}^{'} + \beta Q_{t-1}$; and $u_{i,t} = \varepsilon_{i,t} \big/ \sqrt{h_{ii,t}}$. $\overline{Q}$ is the 3x3 unconditional variance matrix of u_t, and α and β are non-negative adjustment parameters satisfying $\alpha + \beta < 1$.

The residual diagnostic tests — Ljung-Box (LB), Lagrange Multiplier (LM) and Hosking Multivariate Portmanteau (M) tests —show no evidence of autocorrelation, ARCH effects, and cross correlation in the standardized squared residuals, which support the appropriateness of the model specification. The Wald joint test for adjustment coefficients ($\mathrm{H}_0 : \alpha = \beta = 0$) is indicative of time-varying conditional correlations in price returns between the market segments.