A Tale of Two Chinese Cities: The Dynamics of Beijing and Shanghai Office Markets

Executive Summary. *We analyze office rental pricing and adjustment processes in two Chinese cities: Beijing and Shanghai. The study period covers 17 years from 1993 to 2009. We find that rents in the two cities responds to demand and supply variables in the long-run model. In the short-run model, the error correction term is correctly signed and statistically significant in all model scenarios; however, adjustment is slower than other major office centers. In the short-run models, the rental adjustment process in Shanghai is affected by both supply and demand; in Beijing, only the vacancy rate has significant impact on rental adjustment. We further test the differences in vacancy rates in the two cities and find that individual city components are statistically significant and different from each other. Shanghai has a lower price elasticity and higher income elasticity than Beijing.*

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Prior to the 1980s, there was no commercial property market in China. Economic reform has led to the creation of a tradable commercial real estate market. With increased openness and economic reform, the commercial property market initially emerged mainly in the cities such as Beijing, Shanghai, and Guangzhou. Office buildings were constructed in these cities to accommodate multinational companies entering China for the first time or firms relocating to Shanghai and Beijing. Now domestic companies have become an important source of office market occupation. Over the past three decades, the Chinese commercial property market has gone through tentative beginnings in the 1980s to rapid development in the late 1990s and into the 2000s. Market transparency has also improved (JLL, 2008).

In terms of sector, the most transparent are office and residential markets due to the increased availability of data on market fundamentals. The most important office markets in China are in Shanghai and Beijing. They are the two largest office markets in terms of office investment and floorspace stock of investible grade buildings. These two real estate markets that are currently favored by established players and new market entrants have attracted the attention of institutional investors. Yield compression in the western developed markets has caused investors to look further abroad for opportunities. The growth of the Chinese economy and the importance of Beijing and Shanghai in particular have established these cities as investment destinations.

Understanding the rent dynamics across real estate cycles of these two largest office markets in China are essential to investors, occupiers, and local government. The two cities that have experienced strong economic growth, increasing volumes of good quality stock, and strong demand from domestic and international companies have been attracting the most attention from investors, especially overseas investors since they are perceived to be more mature, and more transparent markets offering better opportunities with lower risk than other Chinese cities.

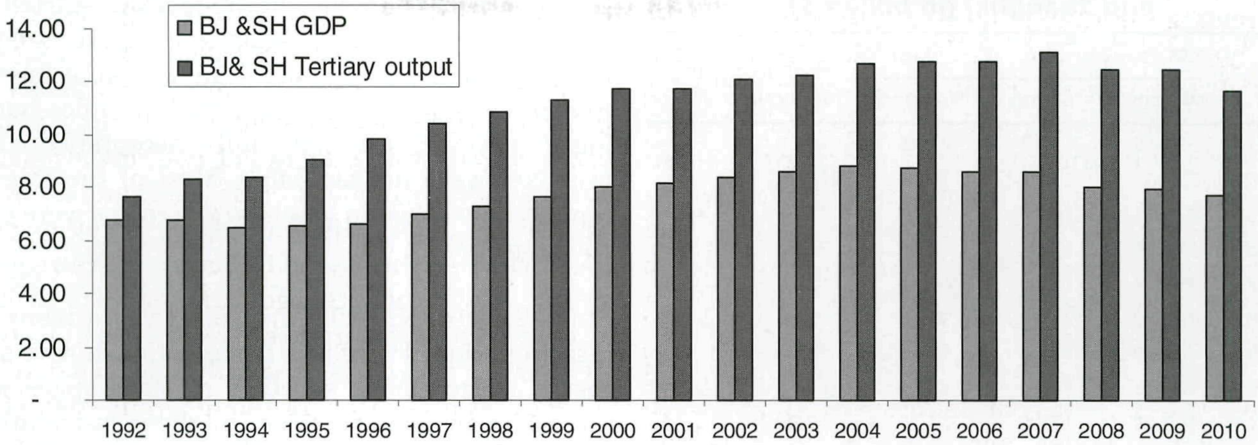
There is a large body of literature on office rent in the United States and the United Kingdom, mainly due to the availability of long time series data, which has made it possible to test demand and supply of office space and analyze rental variation across buildings and leases, rental adjustment for the nation or for a single metropolitan area, or identify long-run relationships (e.g., Wheaton and Torto, 1988; Wheaton, Torto, and Evans, 1997; Hendershott, Lizieri, and Matysiak, 1999; Hendershott, Lizieri, and MacGregor, 2010). Most of these office market studies focus on vacancy rates and model office rents as a function of deviations from the natural vacancy rate that is required to clear the market of rents that are related to changes in employment, office supply, and vacancy levels (e.g., Hekman, 1985; Wheaton and Torto, 1988; Glascock, Kim, and Sirmans, 1993; D'Arcy, McGough, and Tsolacos, 1997; Hendershott, 1996; Hendershott, MacGregor, and Tse, 2002). In the U.S. and U.K., annual data go back beyond 1970, thus it has been possible to identify long-run relationships.

It is an open question as to whether or not structural relationships across metropolitan areas differ. Economic theory suggests that market size and the number of market participants may affect the speed and size of responses of office market conditions to underlying economic factors. The structure difference is defined here to be market size, type of major market players, and growth rate of office employment. In fact, published modeling results for a variety of metropolitan areas do show that structural difference across metropolitan areas exists (e.g., Hekman, 1985; Pollakowski, Wachter, and Lynford, 1992; Hendershott, MacGregor, and White, 2002). For instance, Pollakowski, Wachter, and Lynford (1992) use rental data for 21 metropolitan areas of the U.S. for the time period of 1981 to 1990 to model office market behavior. Their results suggest that market outcomes vary by city size; larger markets are better modeled using standard procedures, and Manhattan behaves quite differently from the other markets. Orr and Jones (2003) analyze office rents of two Scottish cities, Glasgow and Edinburgh, and suggest that Edinburgh responds more quickly to fundamental changes in supply and demand imbalance than Glasgow in the determination of office rents.

The lack of quality data and relatively short history of the Chinese office market has inhibited empirical studies of Chinese office rental dynamics. So far, the empirical studies of China's office market include Webb and Tse (2000), who compare office prices and rents in Shanghai, Guangzhou, and Shenzhen. They find that office prices in Guangzhou and Shenzhen contain highly significant information about the future movements of office property prices, but there is no lead-lag link between the two adjacent cities. Ke and White (2009) examine empirically the rent adjustment process of the Shanghai Puxi office market and find both demand (as represented by GDP) and supply (as represented by office space stock) are significant determinants of rents. Space demand is both price and income elastic. To the best of our knowledge, there is no empirical research on the Beijing office market.

The aims of the paper are to examine the rental adjustment process in Beijing and Shanghai, following the literature in estimating demand, supply, and rental price adjustments equations. We and critically assess the cities in light of the differences between them. The methodology is based upon cointegration techniques from Johansen (1991). We construct reduced form models for rent in each city. Rent is written as a function of economic activity, foreign direct investment, and floor space supply. We use the local economic data series for the two cities. The study period covers 17 years from 1993 to 2009. This period covers the Asian

Exhibit 1
Comparison of Beijing and Shanghai to National Economic Output



Source: China Statistical Year Books.

Financial Crisis and the more recent global liquidity shortage ('credit crunch'). The Asian Financial Crisis (1997–1998) saw foreign direct investment in China slow down and a large amount of new supply coming onto the markets, leading to the vacancy rate increasing in these two cities to 33% in Beijing and 48% in Shanghai by the end of 1998. The global financial crisis starting towards the end of 2007 delayed the expansion of multi-national companies and pushed the vacancy rate up to 20% in these cities by the end of 2009.

The remainder of the paper is arranged as follows. Section two outlines the evolution of the office markets in Beijing and Shanghai and reviews the history of office markets in the two cities and their role in the Chinese real estate market. Section three describes the data and models employed in the study. Section four discusses the estimation results and section five concludes the paper.

Evolution of Office Markets in Beijing and Shanghai

Beijing, the capital of China and its main political, cultural, and economic center has the country's largest number of high education institutions and scientific research centers. Many of China's large state owned enterprises (SOEs) are headquartered in Beijing. They are important occupiers of office buildings. Beijing is also home to the headquarters of the Bank of China and to Chinese and international financial institutions and insurance companies. Massive infrastructure development was associated with the 2008 Summer Olympic Games. Shanghai, lying at the mouth of the Yangtze River, is China's most important commercial hub, financial center, and its largest container port. Shanghai is the location of choice for multi-national companies. The two cities play an important role in China's economic activities (Exhibit 1). The GDP of Beijing and Shanghai account for 7.7% of the whole country's GDP and their tertiary industry output represents 11.7% of the whole country's tertiary output.

Initially office buildings were constructed to accommodate foreign companies that came to the cities. However, at the early stage of economic openness, foreign direct investment (FDI) was on a small scale. For instance, from 1979 to 1991, the total FDI in China was only $23.35 billion, less than one year's FDI in 1993. Economic reform was further strengthened from 1993. From 1993 to 2009, FDI increased rapidly. Shanghai and Beijing are the two largest recipients of FDI, accounting for 18.26% of the whole country's FDI by the end of 2009 (Exhibit 2). But Shanghai has been attracting more FDI than Beijing. From 1993 to 2009, the aggregate FDI in Shanghai is more than two times that in Beijing. The multi-national corporations

Exhibit 2

Foreign Direct Investment in China, Beijing and Shanghai (in billion $)

	FDI			
Year	National	Beijing	Shanghai	% of Beijing and Shanghai to Nation
1993	275.15	11.17	31.75	15.60
1994	337.67	13.72	39.89	15.88
1995	375.21	10.80	52.98	17.00
1996	417.26	15.53	75.10	21.72
1997	452.57	15.93	63.45	17.54
1998	454.63	21.68	48.16	15.36
1999	403.19	19.75	59.99	19.78
2000	407.15	16.84	53.91	17.38
2001	468.78	17.68	74.10	19.58
2002	527.43	17.25	50.30	12.81
2003	535.05	21.91	58.50	15.03
2004	606.30	30.84	65.41	15.87
2005	603.25	45.52	68.50	18.90
2006	630.21	35.26	71.07	16.87
2007	747.68	50.66	79.20	17.37
2008	924.00	60.82	100.66	17.48
2009	900.30	61.20	103.18	18.26

Note: The source is China Statistical Year Books.

and foreign financial institutions set up their regional headquarters in Shanghai; they are the major office occupiers.

The arrival of foreign companies in these cities stimulated demand for commercial office space and the growth of office markets. Prior to 1980, the development of socialist cities was entirely a matter for the state, as the state owned all the means of production. Land was allocated administratively according to the application procedure of each state enterprise (Walker and Li, 1994). Marketization and rapid economic growth in the 1980s at first created a market for land and buildings from overseas investors and local businesses, which, in turn, led to the establishment of an active real estate market. A corollary of this is that a property development industry was needed to supply the new premises.

Over the past three decades, the Beijing and Shanghai office markets have evolved through these distinct periods (Exhibit 3). The first period, from 1980 to 1992, was the experimental period of land reform. The real estate market started to emerge, with laws and regulations regarding land transfer coming into effect. The arrival of foreign companies created strong demand for office buildings. However, internationally acceptable office premises were not available. Most of the foreign companies worked in hotels where rooms were converted to offices.

Stage 2, between 1993 and 1996, was a transformation period. There was a sharp rise in rent as a result of the severe shortage of office space and increasing demand for space by the massive influx of foreign companies establishing offices. According to DTZ, by the end of 1993, the total prime office stock was 0.15 million square meters in Beijing and 0.12 million square meters in Shanghai, with low vacancy rates. There were few property transactions during this period. Office property was owned by state-owned enterprises. To meet

Exhibit 3

Stages of Commercial Property Market Development

Stage	Period	Factors
Stage 1	Experimental Period (1980 to 1992)	Laws and regulations regarding land transfer came into effect. Unavailability of internationally acceptable office property.
Stage 2	Transformation Period (1993–1996)	Entry of domestic investment and development companies. Entry of foreign companies through joint venture. Commencement of commercial real estate development in large scale. Substantial increase in supply. High demand. High rental growth. High capital growth.
Stage 3	Oversupply Period (1997–2000)	Low take-up rate. High vacancy rate. Falling rental values.
Stage 4	Maturing Period (2001–onward)	Substantially increasing demand for office property. Moderate increase in supply. Rising rent. Entry of foreign investment and development companies.

Exhibit 4
Office Property Investment in Beijing and Shanghai (in billion $)

Year	Office Investment (National)	Growth Rate (National) (%)	Office Investment (Beijing)	Growth Rate (Beijing) (%)	Office Investment (Shanghai)	Growth Rate (Shanghai) (%)	Beijing and Shanghai to National (%)
1999	40.94		6.35		9.83		40%
2000	36.02	−12%	5.47	−14%	6.95	−29%	34%
2001	37.24	3%	8.71	59%	3.17	−54%	32%
2002	46.07	24%	11.77	35%	4.05	28%	34%
2003	61.47	33%	17.26	47%	8.06	99%	41%
2004	78.86	28%	22.72	32%	10.07	25%	42%
2005	92.27	17%	23.72	4%	12.36	23%	39%
2006	118.83	29%	27.75	17%	15.91	29%	37%
2007	140.63	18%	32.91	19%	21.40	34%	39%
2008	162.57	16%	24.93	−24%	27.23	27%	32%
2009	201.46	24%	24.37	−2%	27.65	2%	26%
Aver.		19%		21%		18%	35%

Note: The source is China Statistical Year Books.

the rising demand of multi-national companies, large scale office construction commenced since 1993.

The third period (1997–2000) was marked by substantial increases in supply of office property. During the Asian Financial Crisis, China's economic growth slowed down and the office take-up rate was low. The overinvestment in real estate in the previous time period resulted in an oversupply of office space. Consequently, office rents fell. The fourth period that started in 2001 has been characterized by some improvement in market transparency. Sustained economic growth and increases in FDI have stimulated office space demand. Rents had risen and the investment in office buildings was increasing before the global financial crisis began in 2007. In this period, there has been a massive inflow of global funds into the Chinese real estate market.

One of the distinct features of the Chinese office markets is that the investment in office property is concentrated in first tier cities such as Shanghai, Beijing, and Guangzhou. For instance, over the period of 1991–2009, office investment in Beijing and Shanghai accounted for 35% of the whole country's office investment (Exhibit 4). Over the past decade, office property investment has increased 18% per year at both the national and local levels. But compared with many other established markets outside Mainland China, the size of individual markets within the country remains small. According to a report by Jones Lang LaSalle, Beijing and Shanghai's Grade A office markets are by far the largest in Mainland China, but have a combined size that is less than half of Hong Kong's (Jones Lang LaSalle, 2010).

Unlike the other emerging markets in central European cities that are mostly driven by external actors, including property developers, investors, agents, and the users of property (Adair et al., 1999), foreign capital has been restrained in China's property market unless it is for self-occupation. The first generation of local developers grew up by participating in joint ventures between foreign development capital and local land plots in the late 1980s (Zhu, 2005). The initial developers of investment-grade property in Beijing and Shanghai were from Hong Kong. They brought advanced techniques and experience to project construction, which greatly increased the benchmark for quality in these markets. Many of these projects still stand as landmarks in the two cities. As domestic developers gained experience, and began responding to escalating demand from office occupiers, they have upgraded the quality of their developments. The resulting pace of change has been breathtaking, with the completion of all commercial space in Beijing and Shanghai in 2009 being 4.04 and 2.59 times, respectively, that of ten years earlier according to a DTZ report (DTZ, 2010).

Within China, there is an apparent relationship between the openness of the real estate markets and transaction volumes. Shanghai and Beijing are the most transparent markets in China with the highest real estate transaction volumes; 80%–90% of investment transactions in these two cities have involved foreign investors, who have forced the pace of change and encouraged greater transparency (Jones Lang LaSalle, 2008). One of the important driving forces of transparency improvement in these cities is the globalization of real estate investments. Exponential growth in the number of active real estate developers, occupiers, investors, and real estate funds are demanding much greater transparency. The presence of international real estate consultants and advisors has contributed to the market transparency and globalization (D'Archy and Keogh, 1998). The major international real estate players are all present in Beijing and Shanghai. They collect local market data and information, undertake market research, and provide professional services of property management, acquisition, disposal, and investment. In the years immediately prior to the onset of the global financial crisis, international real estate investment around the world was growing rapidly. Much of this was highly leveraged from mature economies, and investors searching for higher returns beyond their local markets. Mainland China is one of the emerging markets around the world that has been increasingly targeted for investment opportunities. Beijing and Shanghai have the largest investable real estate assets in the mainland of China. Therefore, understanding the rent adjustment process in these cities and maintaining investment value appears important.

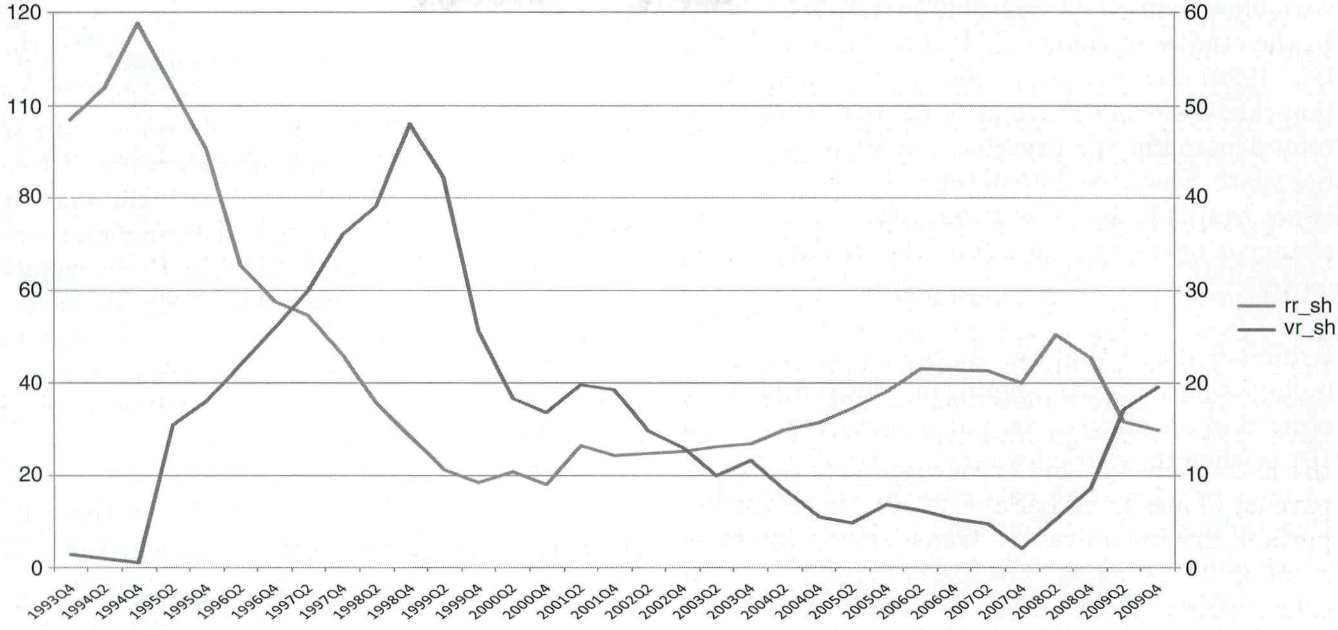
Though these two cities are the most important real estate markets in China, there are some differences between them in light of market size, the level of attractiveness to foreign direct investment, growth rate of office employment, and type of office users. In terms of office market size, Beijing is larger than Shanghai, with more investment in office buildings and larger prime office stock. By the end of 2009, Beijing had prime office space of 6.2 million of square meters, while Shanghai had 5.7 million square meters, according to DTZ reports. As China's political, cultural, and economic center, domestic occupiers and state-owned enterprises in Beijing play a more significant role than they do in Shanghai, where major office occupiers are multi-national companies, banks, and financial institutions. Therefore, local office rents may respond differently to supply and demand due to these differences.

Data and Methodology

The data were collected from the reports published by DTZ, a multi-national real estate service provider that started to collect property market data in mainland China from the beginning of the 1990s. The office rents, which are inflation adjusted, are the semi-annual average asking rent of Grade A office buildings for central business districts in Beijing and Shanghai excluding other outgoings such as management fees, maintenance costs, taxes, and rent-free periods. The study period is from the second half of 1993 to the second half of 2009. Office stock is the total amount of Grade A office space available within the given areas. Buildings being renovated or buildings under construction and not available to the market are excluded. The dataset includes buildings for owner occupation in addition to those for leasing. The vacancy rate is the ratio of vacant Grade A office space to total Grade A office stock in the market. Demand variables include real GDP, total employment, and foreign direct investment value in each of the two cities. Exhibits 5 and 6 present real rents and vacancy rates of the two cities from 1994:Q4 to 2009:Q4.

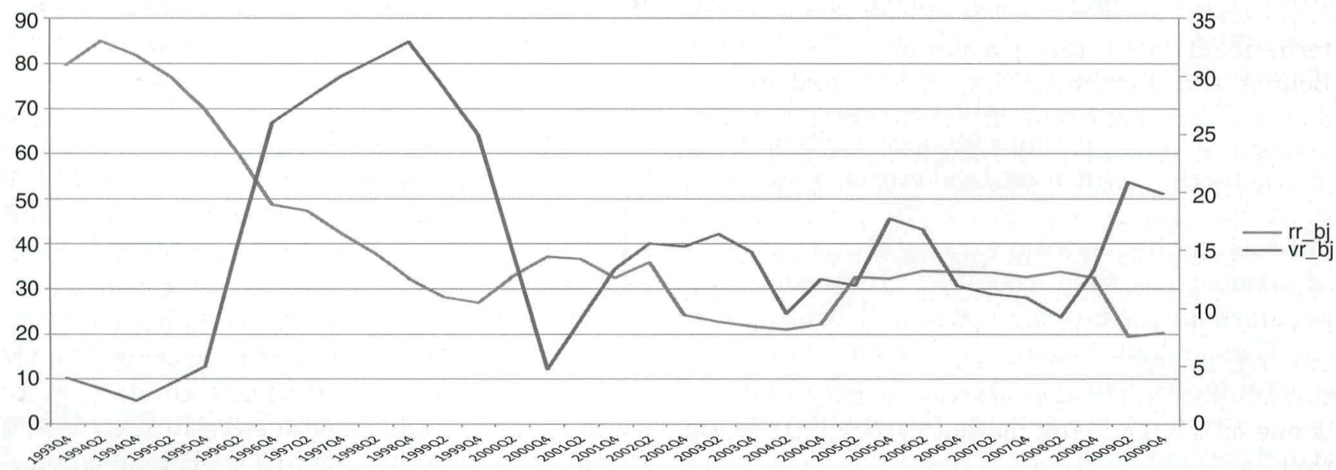
A review of national and regional office models by Chaplin (1999) reveals that lagged rental value, output of financial and business service sectors, GDP, and new orders for office space are the most significant variables in explaining changes in office

Exhibit 5
Real Rent and Vacancy Rates: Shanghai



Source: DTZ, Shanghai, China.

Exhibit 6
Real Rent and Vacancy Rate: Beijing



Source: DTZ, Beijing, China.

rent. Other variables such as absorption rate as a proxy for demand and the space under construction as a proxy for supply are also included occasionally in models. The government statistics on the space under construction and newly completed space in these two cities does not relate specifically to institutional investment quality office space, which is the basis for the rent measures. So we believe that it is inappropriate to use these data in the models. Net absorption or the percentage increase in space demanded is used as a demand variable in some of the studies of office rents (e.g., Hendershott, Lizieri and Matysiak, 1999; Orr and Jones, 2003; Tse and Webb, 2003). For example, Orr and Jones (2003) use the absorption rate as a proxy for demand and find it to be a significant variable in explaining rental growth rate changes. In the studies of Hendershott, Lizieri, and Matysiak (1999) and Tse and Webb (2003), the absorption rate is one of the components used to form the total demand or the expected rate of growth of office space. Since the data of the net absorption rate is not available for these two markets, we use the change of office space as a proxy for demand in the models.[1]

Exhibit 5 shows that the market in Shanghai is highly volatile with significant fluctuations in rents and vacancy rates, particularly during the 1990s when the market was being established. The vacancy rate peaks at just below 50% at the end of 1998 (after the Asian Financial Crisis). It then declines almost continuously to reach a low level of approximately 2% at the end of 2007 (the beginning of the 'credit crunch') before increasing to almost 20% by the end of 2009.

Exhibit 6 shows that the 1990s are again characterized by significant rental and vacancy rate volatility in the Beijing market. Smaller cycles in vacancy rates (and to a lesser extent in rents) can be observed throughout the 2000s. The potential impact of the Asian Financial Crisis and the global financial crisis are perhaps less easy to disentangle in this market from other local economy factors.

The relationship between vacancy rates and rental adjustment has been examined in numerous papers including Wheaton, Torto, and Evans (1997) and Hendershott, Lizieri, and Matysiak (1999). In general terms, rental change is written as a function of the difference between the equilibrium and actual vacancy rate:

$$(R_t - R_{t-1})/R_{t-1} = \lambda(v^* - v_{t-1}), \tag{1}$$

where R is real rent, v^* is the long-run 'equilibrium' vacancy rate, the subscripts refer to the time period, and λ is the adjustment parameter. This model was further developed by Hendershott (1995, 1996) to take equilibrium rent into consideration. This leads to the following model in which equilibrium rent is considered:

$$(R_t - R_{t-1})/R_{t-1} = \lambda(v^* - v_{t-1}) + \beta(R_t^* - R_{t-1}), \tag{2}$$

where R^* is the long-run equilibrium rent.

In equations 1 and 2, neither equilibrium rent nor the equilibrium vacancy rate are observable. These may be the long-run values to which the market adjusts. In the case of Beijing and Shanghai, there may not be a long enough time series to accurately identify the long-run values of these variables. However it is reasonable to expect the market to adjust towards its long-run equilibrium values if exogenous changes have caused it to move away from this position in the short run.

Adjustment in office markets can be captured by using an error correction mechanism (ECM). In this model, a long-run relationship is identified using cointegration methodology and then a short-run adjustment equation is estimated using the lagged error from the long-run model to capture adjustment to equilibrium.

Demand for space can be written as a function of user demand (E) and rent (R). Thus:

$$D = \lambda_0 R^{\lambda_1} E^{\lambda_2}, \tag{3}$$

where λ_1 and λ_2 are price and income elasticities, respectively. In equilibrium, demand for space will be equal to the total supply of space that is occupied. Hence:

$$D = (1 - v)SU, \tag{4}$$

where SU is supply of space. Substituting (4) into (3) and taking logs we have:

$$\ln R = \gamma_0 \ln \lambda_0 + \gamma_1 \ln E + \gamma_2 \ln SU + \gamma_2 \ln(1 - v) + u_t. \tag{5}$$

This long-run model without the final term containing the vacancy rate has been used by Hendershott, MacGregor, and White (2002). Coefficients γ_1 and γ_2 are expected to be positive and negative, respectively. Price and income elasticities can be retrieved from (5) since $\lambda_1 = 1/\gamma_2$ and $\lambda_2 = -\gamma_1/\gamma_2$. The residual from this relationship is the difference between actual rent and those values estimated by the model. Hence:

$$u_t = \ln R_t - \hat{\gamma}_0 - \hat{\gamma}_1 \ln E_t - \hat{\gamma}_2 \ln[(1 - v_t)SU_t], \quad (6)$$

where u_t is the residual from the long-run model. If (5) is a cointegrating relationship comprising individual variables that are integrated of order one, I(1), then the error term will be integrated of order zero, i.e., is stationary, I(0), and an error correction mechanism can be constructed using the lagged value of the residual from (5) in a short-run dynamic model:

$$\Delta \ln R_t = \phi_0 + \phi_1 \Delta \ln E_t + \phi_2 \Delta \ln SU_t + \phi_3 \Delta \ln(1 - v_t) + \phi_4 u_{t-1}. \quad (7)$$

In this model, the change in rents is a function of the change in demand and supply and is also related to the lagged difference between actual and long-run rent reflecting market disequilibrium. The coefficient ϕ_1 is expected to be positive while ϕ_2 and ϕ_3 are expected to be negative. The coefficient ϕ_4 is expected to range between 0 and -1, where a 0 value implies no adjustment, -1 implies full adjustment, and values within this range of 0 to -1 imply partial adjustment. A value smaller than -1 implies over-adjustment.

In considering the variables for estimation of (5) and (7), the available data obviously play a deciding factor. Demand is captured by local real GDP. Other alternative demand measures are total employment and foreign direct investment (FDI). The test results are presented separately for both. Earlier studies have also employed these variables to capture demand side influences (e.g., Guissani, Hsia, and Tsolacos, 1993; D'Arcy, McGough, and Tsolacos, 1997, 1999; De Wit and Van Dijk, 2003; Mouzakis and Richards, 2007). We include FDI as proxy of the demand variable, since at the early stage of the Beijing and Shanghai office markets, the demand was driven by foreign companies that came into these cities to set up business.

Exhibit 7 shows that Shanghai consistently receives significantly more FDI than Beijing. However, total FDI in China as measured on the right-hand scale is substantially higher than either city and although both are important investment destinations, they are not overwhelming. This matters because unlike European research that suggested national level statistics were relevant for local rent determination (e.g., Brounen and Jennen, 2009), neither Beijing nor Shanghai are large enough in the Chinese economy for such relationships to be significant.

For supply, office floorspace stock has been used previously. Vacancy rates and new construction have also been employed as supply-side variables.[2] The stock variable is used here. Hence, we can rewrite (5) and (7) substituting these variables as:

$$\ln R = \gamma_0 \ln \lambda_0 + \gamma_1 \ln D + \gamma_2 \ln Stock + \gamma_2 \ln(1 - v) + u_t. \quad (8)$$

$$\Delta \ln R_t = \phi_0 + \phi_1 \Delta \ln D_t + \phi_2 \Delta \ln Stock_t + \phi_3 \Delta \ln(1 - v_t) + \phi_4 u_{t-1} + \varepsilon_t. \quad (9)$$

The demand variable D represents either employment or GDP, and the stock measure is floorspace. *FDI* is also added as an extra explanatory variable.

Results

Prior to estimation of the models above, Augmented Dickey-Fuller unit root tests were undertaken to discover the order of integration of each time series variable used (Exhibit 8). The standard regression for this approach is:

$$\Delta x_t = \alpha + \beta_1 x_{t-1} + \sum_{i=1}^{\rho-1} \delta_i \Delta x_{t-i} + \mu_t, \quad (10)$$

where the chosen value for ρ is such that μ_t will be a white noise error term. The t-statistic on β_1 is compared with the critical values found in Fuller (1976). When only the lagged value of x is present, the test is referred to as a Dickey-Fuller (DF) test. When lagged difference terms are added, the resulting test is an Augmented Dickey-Fuller (ADF)

Exhibit 7
Real FDI: China, Beijing, and Shanghai

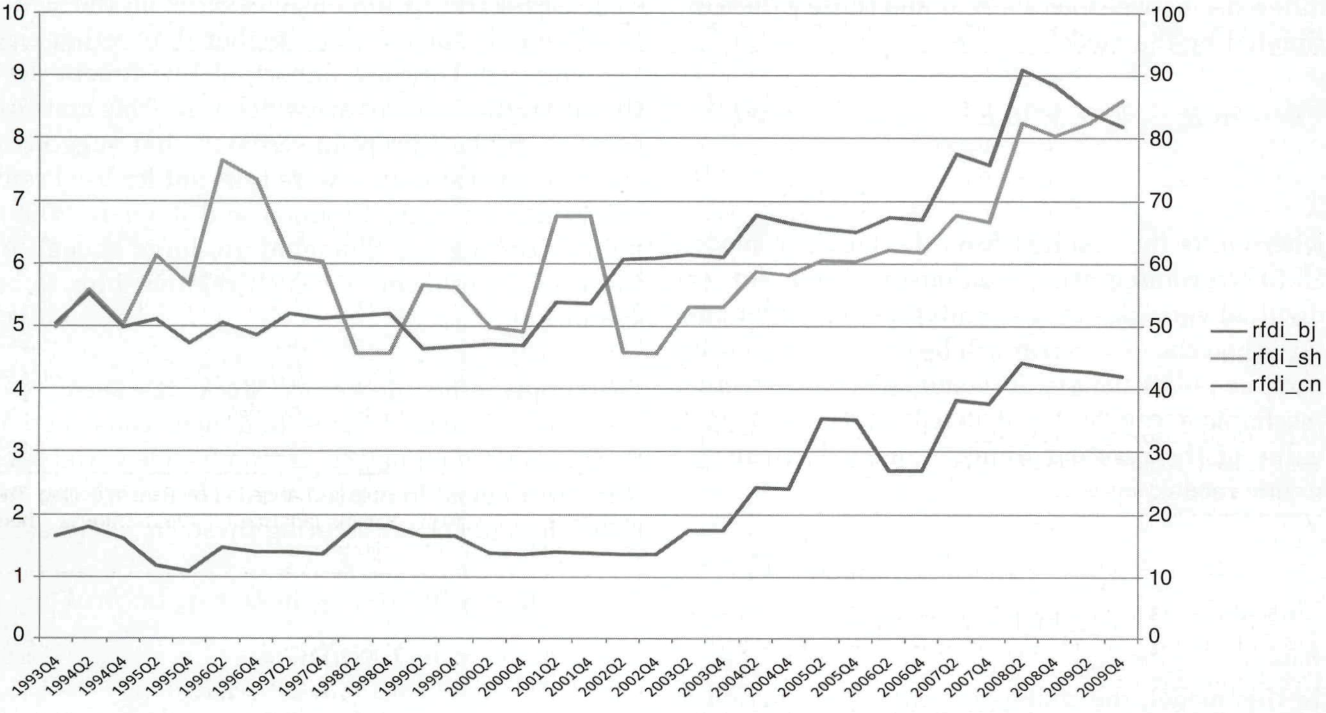


Exhibit 8
Unit Root Tests: Beijing and Shanghai

	Beijing		Shanghai	
	ADF	PP	ADF	PP
Rent	−3.034**	−5.027***	−5.541*** I(2)	−4.244***
GDP	−3.501**	−8.644***	−5.438***	−24.179***
Stock	−3.813***	−5.854***	−6.153*** I(2)	−3.222**
Vacancy Rate	−3.057** I(0)	−4.228***	−2.748* I(0)	−5.868***
FDI	−4.195***	−5.643***	−5.285***	−6.647***

Notes: The variables are I(1) unless stated otherwise.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

test. An alternative approach to adding lagged values of the dependent variable has been suggested by Phillips (1987) and extended by Perron (1988) and Phillips and Perron (1988). They suggest adding a non-parametric correction to the *t*-test statistic. This accounts for autocorrelation that may be present.

PP tests suggest that the variables are uniformly I(1). However, this is not always the case with the ADF tests. The vacancy rate is I(0) for both cities using the ADF test but I(1) on the PP test. The extreme volatility in the vacancy rate may partly explain why the results are inconclusive. It may be more appropriate to consider testing in the presence of a structural break in the series, especially in markets that are relatively underdeveloped at the beginning of the period.

Next, we estimate the long-run model for Beijing using GDP as the demand variable (Exhibit 9). The vacancy rate is also included. However, endogeneity of vacancy rates means that we replace the actual vacancy rate with a predicted vacancy rate. For Beijing, the best fit prediction comes from an autoregressive moving average (ARMA) (2, 1) model.[3]

The demand and supply variables are statistically significant and have the correct signs, a priori. The results also imply that the higher the vacancy, the lower will be the rental value.

Exhibit 9
Long-Run Model for Beijing

Variable	Coeff.	Std. Error	t-Stat.	Prob.
C	7.688	0.404	19.027	0.000
Real GDP	0.357	0.110	3.240	0.003
Stock	−0.389	0.056	−6.892	0.000
1 − vacancy rate	0.167	0.056	3.000	0.006
R^2	0.801	Mean dependent var.		3.536
Adj. R^2	0.779	S.D. dependent var.		0.373
S.E. of regression	0.175	AIC		−0.524
Sum squared resid.	0.831	Schwarz criterion		−0.339
Log-likelihood	12.117	F-statistic		36.272
Durbin-Watson stat.	0.970	Prob(F-statistic)		0.000

Notes: The dependent variable is Real Rent in Beijing. The method is Least Squares. Sample (adjusted): 1994S2–2009S2. There are 31 observations after adjustments.

Exhibit 10
Short-Run Adjustment Model: Beijing

Variable	Coeff.	Std. Error	t-Stat.	Prob.
C	−0.029	0.038	−0.779	0.443
Change in Real GDP	0.184	0.241	0.764	0.452
Change in Stock	−0.116	0.134	−0.862	0.340
Change in 1 − vacancy rate	0.155	0.080	1.942	0.064
Error Correction	−0.456	0.173	−2.642	0.014
R^2	0.310	Mean dependent var.		−0.047
Adj. R^2	0.199	S.D. dependent var.		0.161
S.E. of regression	0.144	AIC		−0.891
Sum squared resid.	0.517	Schwarz criterion		−0.657
Log-likelihood	18.359	F-statistic		2.805
Durbin-Watson stat.	1.759	Prob(F-statistic)		0.047

Notes: The dependent variable is Change in Real Rent in Beijing. The method is Least Squares. Sample (adjusted): 1995S1–2009S2. There are 30 observations after adjustments.

This model is then tested for cointegration following Johansen (1991). The results are presented in the Appendix in Exhibit A1. The test indicates the presence of one cointegrating equation. Thus we can set up the error correction and estimate the short-run model. This is presented in Exhibit 10.

In the short-run model, only the error correction term is significant at the 5% level, all other variables are insignificant, the vacancy rate term marginally so. Exhibits 11 and 12 present results for long- and short-run models, respectively, in Shanghai. The predicted vacancy rate is calculated from an AR(1) model in Shanghai, similar to Ke and White (2009), who also find this to be the best fit for the vacancy rate. The results show both demand and supply variables to be correctly signed and significant.

Exhibit 11
Long-Run Model: Shanghai

Variable	Coeff.	Std. Error	t-Stat.	Prob.
C	9.897	0.629	15.723	0.000
Real GDP	0.838	0.216	3.883	0.001
Stock	−0.661	0.1041	−6.330	0.000
1 − vacancy rate	0.142	0.068	2.091	0.046
R^2	0.849	Mean dependent var.		3.638
Adj. R^2	0.833	S.D. dependent var.		0.505
S.E. of regression	0.206	AIC		−0.201
Sum squared resid.	1.193	Schwarz criterion		−0.018
Log-likelihood	7.222	F-statistic		52.412
Durbin-Watson stat.	1.069	Prob(F-statistic)		0.000

Notes: The dependent variable is Real Rent in Shanghai. The method is Least Squares. Sample (adjusted): 1994S1–2009S2. There are 30 observations after adjustments.

Johansen cointegration tests suggest that there are up to two cointegrating equations (Exhibit A2 in the Appendix).

The short-run model for Shanghai as reported in Exhibit 12 shows the error correction term to be significant and correctly signed. The change in vacancy rate term and stock variables are also significant and correctly signed. Compared with the findings for Beijing market as presented in Exhibit 10, the short-run rental adjustment process for Shanghai offices is affected by both supply and demand, while it is not for the Beijing market, where only the supply side, represented by vacancy rate, has significant influence on rental adjustment process.

From the long-run models in Exhibit 13, we can calculate the associated price and income elasticities. Demand for space is more price elastic in Beijing than in Shanghai. In contrast, demand for

Exhibit 12

Short-Run Adjustment Model: Shanghai

Variable	Coeff.	Std. Error	t-Stat.	Prob.
C	0.008	0.033	0.244	0.809
Change in Real GDP	0.037	0.179	0.207	0.838
Change in Stock	−0.378	0.180	−2.097	0.046
Change in 1 − vacancy rate	0.101	0.046	2.184	0.038
Error Correction	−0.362	0.140	−2.59	0.016
R^2	0.428	Mean dependent var.		−0.040
Adj. R^2	0.340	S.D. dependent var.		0.165
S.E. of regression	0.134	AIC		−1.035
Sum squared resid.	0.467	Schwarz criterion		−0.803
Log-likelihood	21.039	F-statistic		4.868
Durbin-Watson stat.	1.808	Prob(F-statistic)		0.005

Notes: The dependent variable is Change in Real Rent in Shanghai. The method is Least Squares. Sample (adjusted): 1994S2–2009S2. There are 31 observations after adjustments.

Exhibit 13

Price and Income Elasticities of Demand for Space

	Beijing	Shanghai
Price Elasticity	−2.577	−1.513
Income Elasticity	0.920	1.268

space is income inelastic in Beijing but income elastic in Shanghai. This in turn may reflect the different characteristics of office demand in these two cities.

Next we estimate the models above using employment as the demand variable. Results are reported in Exhibit 14. The results using employment as the demand variable are broadly similar to those using GDP. Explanatory power is slightly greater for the long-run Shanghai model and the short-run Beijing model. Error correction terms are similar to the previous results.

Contrary to results found by Ke and White (2009) in Shanghai, foreign direct investment is not found to be statistically significant for either Beijing or Shanghai in either long- or short-run models.[4] Exhibit 15 reports results where the model includes FDI and GDP as the demand variable. However,

Exhibit 14

Long- and Short-Run Models for Beijing and Shanghai using Employment

	Beijing		Shanghai	
	Coeff.	t-Stat.	Coeff.	t-Stat.
Panel A: Long-run model				
Constant	−0.147	−0.050	−3.020	−1.383
Employment	1.237	2.519	2.089	5.312
Stock	−0.239	−8.318	−0.383	−10.428
1 − vac rate	0.188	3.173	0.256	5.898
Adj. R^2	0.752		0.872	
DW	0.649		0.981	
Prob F-stat.	0.000		0.000	
Panel B: Short-run adjustment model				
Δ Constant	−0.019	−0.622	−0.006	−0.181
Δ Employment	2.101	3.082	1.483	1.951
Δ Stock	−0.075	−0.616	−0.308	−1.374
Δ (1 − vac rate)	0.127	1.616	0.107	2.171
Error Correction	−0.435	−2.660	−0.393	−2.141
Lagged Real Rent	0.250	1.350	0.166	0.875
Adj. R^2	0.298		0.295	
DW	2.034		2.079	
Prob F-stat.	0.017		0.015	

Exhibit 15

Long- and Short-Run Models for Beijing and Shanghai with FDI

	Beijing		Shanghai	
	Coeff.	t-Stat.	Coeff.	t-Stat.
Panel A: Long-run model				
Constant	7.772	12.199	8.962	14.552
GDP	0.327	1.580	0.609	2.561
Stock	−0.386	−6.382	−0.577	−5.850
1 − vac rate	0.168	2.946	0.169	2.440
FDI	0.036	0.174	0.409	1.876
Adj. R^2	0.771		0.842	
DW	0.951		1.023	
Prob F-stat.	0.000		0.000	
Panel B: Short-run adjustment model				
Δ Constant	−0.030	−0.771	0.013	0.389
Δ GDP	0.168	0.683	−0.005	−0.033
Δ Stock	−0.125	−0.890	−0.401	−2.745
Δ (1 − vac rate)	0.152	1.860	0.112	3.707
Error Correction	−0.445	−2.512	−0.380	−2.362
Δ FDI	0.062	0.376	0.076	0.439
Adj. R^2	0.168		0.333	
DW	1.739		1.790	
Prob F-stat.	0.092		0.008	

there are some differences between this study and the earlier paper. This study has a longer data set and may therefore be more statistically robust. Also, there is evidence from the data that FDI, while more important in Shanghai, has become a smaller proportion of GDP and hence its impact may be lessened. However, given the absolute level of inward investment, this counterintuitive result would need further investigation. We do find that FDI has a statistically significant impact on GDP in each city. However, even when allowing for the possibility of multicolinearity and instrumenting GDP, FDI still has no significant impact on office rents in either city.

From Exhibit 13, we can calculate elasticities. These are presented in Exhibit 16. Both cities now show that demand for space is both price and income elastic. In comparison to Exhibit 12, all elasticities have increased (i.e., demand has become more sensitive to price and income changes). However, Shanghai still has lower price elasticity (in absolute terms) and higher income elasticity than Beijing.

Differences in Beijing and Shanghai may also impact upon the vacancy rates in their office markets. The economic structure of the two cities differs, implying a difference in the occupier mix. Voith and Crone (1988) examine vacancy rates in office markets across U.S. cities. They separate the components of the vacancy rate into market, time, and random elements. Grenadier (1995) examines national and local vacancy rate determinants. Both papers build upon the concept of a natural (or equilibrium or long-run) vacancy rate toward which the market adjusts. The natural vacancy rate can be different in different markets. Grenadier (1995, p. 58) suggests that "the natural vacancy rate is an equilibrium level of inventory of space, in the sense that both the matching process between landlord and tenant is facilitated, and that building owners hold an optimal buffer stock of inventory to meet future leasing contingencies."

Exhibit 16

Price and Income Elasticities of Demand for Space

	Beijing	Shanghai
Price Elasticity	−4.177	−2.610
Income Elasticity	5.166	5.453

The actual vacancy rate observed in a given city i is the sum of the natural vacancy rate v^* and a random deviation from this natural rate, ε, such that:

$$v_{it} = v^*_{it} + \varepsilon_{it}. \qquad (11)$$

The natural vacancy rate comprises a city-specific element, α, and a time-varying component that would impact office markets in different cities:

$$v^*_{it} = \alpha_i + f(t). \qquad (12)$$

The specific form of $f(t)$ can vary but could, for example, be approximated by a polynomial of order n (in general terms) such that:

$$v^*_{it} = \alpha_i + \sum_{i=1}^{n} \beta_i t^i + \varepsilon_{it}. \qquad (13)$$

Allowing for non-instantaneous adjustment to long-run equilibrium, the stochastic disturbance term can be permitted to follow an AR(1) process such that:

$$\varepsilon_{it} = \rho_i \varepsilon_{it-1} + u_{it}, \qquad (14)$$

where ρ is a city-specific persistence term. The closer it is to 1 (0), the slower (faster) the adjustment and the longer (shorter) the impact that a shock has on the vacancy rate.

Combining equations gives:

$$v_{it} = \alpha_i(1 - \rho) + \beta_{it} t + \rho_i v_{it-1} + u_{it}, \qquad (15)$$

where α is the city-specific element of the natural vacancy rate, β is the time-specific element, and ρ is a measure of the persistence of shocks. Applying this model to Beijing and Shanghai vacancy rates, Exhibit 17 indicates the values for the city, time, and persistence components. Individual city components are statistically significant in both cities and are statistically different from each other, with

Exhibit 17
Vacancy Rate Components

	City Component	Time Component	Market Component
Beijing	10.745**	0.001	0.799***
Shanghai	7.321**	0.011	0.731***

Notes:
** Significant at the 5% level.
*** Significant at the 1% level.

the vacancy rate being higher in Beijing than Shanghai.

There is no evidence of a time component causing the natural vacancy rate to drift up or downwards over time, although care should be taken with this result as these are still relatively young markets that have experienced significant cyclicality in vacancy rates (and rent), particularly in the 1990s.

The market component suggests a high persistence of shocks, implying that it is taking time for market imbalances to be adjusted toward long-run equilibrium.

Conclusion

This paper has examined the office markets in Beijing and Shanghai, which are the most important markets in China. In both markets, long-run relationships are identified and short-run error correction models constructed. Cointegration tests suggest the presence of at least one cointegrating relationship and hence supported the validity of the long-run relationships identified.

Results showed clear consistency when using alternative demand variables. Error correction is significant for both cities. However, foreign direct investment does not have explanatory power (although just marginally insignificant in Shanghai), which is perhaps unexpected given earlier research. Further research will be required to shed additional light on this result. We also find that the short-run rental adjustment for the Shanghai market is more responsive to the changes in supply and demand than the Beijing market.

We further test the differences in vacancy rates in the two cities and find that individual city components are statistically significant and different from each other. The market component suggests high persistence of shocks, implying that it is taking time for market imbalances to be adjusted toward long-run equilibrium.

Care should be taken with the results as the time series of office rent is relatively short compared with other similar studies and these are still relatively young markets that had experienced significant cyclicality in vacancy rates (and rent), particularly in the 1990s.

Appendix

Exhibit A1

Johansen Cointegration Test: Beijing

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.[b]
Panel A: Unrestricted cointegration rank test (trace)				
None [a]	0.635	57.116	47.856	0.005
At most 1	0.471	27.888	29.797	0.082
At most 2	0.272	9.401	15.495	0.330
At most 3	0.007	0.196	3.841	0.658

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.[b]
Panel B: Unrestricted cointegration rank test (maximum eigenvalue)				
None[a]	0.635	29.228	27.584	0.031
At most 1	0.471	18.487	21.132	0.113
At most 2	0.272	9.205	14.265	0.270
At most 3	0.007	0.196	3.841	0.658

RR_BJ	RGDP_BJ	STK_BJ	FVR_BJ	
Panel C: Unrestricted cointegrating coefficients (normalized by b' * S11 * b = I)				
−0.958	−0.886	0.545	1.542	
−3.606	0.808	−0.378	−1.691	
7.508	−4.106	3.908	0.844	
1.201	−4.365	1.948	−0.211	
Panel D: Unrestricted adjustment coefficients (alpha)				
D(RR_BJ)	0.027	0.054	−0.057	0.005
D(RGDP_BJ)	0.020	0.041	−0.021	−0.005
D(STK_BJ)	0.020	−0.112	−0.051	−0.004
D(FVR_BJ)	−0.219	0.042	−0.004	−0.009

RR_BJ	RGDP_BJ	STK_BJ	FVR_BJ
Panel E: Normalized cointegrating coefficients (standard error in parentheses)			
1.000	0.925	−0.569	−1.610
	(0.681)	(0.360)	(0.346)
Panel F: Adjustment coefficients (standard error in parentheses)			
D(RR_BJ)	−0.026		
	(0.030)		
D(RGDP_BJ)	−0.019		
	(0.020)		
D(STK_BJ)	−0.019		
	(0.039)		
D(FVR_BJ)	0.210		
	(0.041)		

Notes: Trace test indicates 1 cointegrating equation(s) at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level. 1 Cointegrating Equation(s): Log-likelihood is 57.829.
[a] Rejection of the hypothesis at the 0.05 level.
[b] MacKinnon-Haug-Michelis (1999) *p*-values.

Exhibit A2

Johansen Cointegration Test: Shanghai

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.[b]
Panel A: Unrestricted cointegration rank test (trace)				
None [a]	0.712	68.050	47.856	0.000
At most 1 [a]	0.500	30.737	29.797	0.039
At most 2	0.280	9.940	15.495	0.285
At most 3	0.003	0.091	3.841	0.763

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.[b]
Panel B: Unrestricted cointegration rank test (maximum eigenvalue)				
None [a]	0.712	37.313	27.584	0.002
At most 1	0.500	20.797	21.132	0.056
At most 2	0.280	9.849	14.265	0.222
At most 3	0.003	0.091	3.841	0.763

RR_SH	RGDP_PX	STK_SH	FVR_SH	
Panel C: Unrestricted cointegrating coefficients (normalized by b' * S11 * b = I)				
1.440	9.152	−4.863	4.446	
−0.289	2.278	−2.073	−0.067	
−7.204	12.074	−7.275	0.444	
0.523	7.288	−2.748	1.419	
Panel D: Unrestricted adjustment coefficients (alpha)				
D(RR_SH)	−0.025	−0.034	0.067	−0.001
D(RGDP_PX)	0.003	−0.019	−0.005	−0.003
D(STK_SH)	0.048	0.037	0.018	−0.001
D(FVR_SH)	−0.301	0.226	−0.097	−0.004

RR_SH	RGDP_PX	STK_SH	FVR_SH
Panel E: Normalized cointegrating coefficients (standard error in parentheses)			
1.000	6.355	−3.377	3.087
	(1.263)	(0.650)	(0.420)
Panel F: Adjustment coefficients (standard error in parentheses)			
D(RR_SH)	−0.036		
	(0.040)		
D(RGDP_PX)	0.004		
	(0.017)		
D(STK_SH)	0.069		
	(0.021)		
D(FVR_SH)	−0.434		
	(0.124)		

RR_SH	RGDP_PX	STK_SH	FVR_SH
Panel G: Normalized cointegrating coefficients (standard error in parentheses)			
1.000	0.000	1.332	1.812
		(0.417)	(0.500)
0.000	1.000	−0.741	0.201
		(0.065)	(0.078)

Exhibit A2 (continued)
Johansen Cointegration Test: Shanghai

Panel H: Adjustment coefficients (standard error in parentheses)		
D(RR_SH)	−0.026	−0.307
	(0.040)	(0.255)
D(RGDP_PX)	0.010	−0.016
	(0.017)	(0.107)
D(STK_SH)	0.059	0.526
	(0.018)	(0.119)
D(FVR_SH)	−0.499	−2.243
	(0.107)	(0.685)

Panel I: Normalized cointegrating coefficients (standard error in parentheses)

RR_SH	RGDP_PX	STK_SH	FVR_SH
1.000	0.000	0.000	0.503
			(0.070)
0.000	1.000	0.000	0.929
			(0.206)
0.000	0.000	1.000	0.983
			(0.371)

Panel J: Adjustment coefficients (standard error in parentheses)			
D(RR_SH)	−0.505	0.496	−0.291
	(0.172)	(0.358)	(0.210)
D(RGDP_PX)	0.045	−0.075	0.060
	(0.083)	(0.173)	(0.101)
D(STK_SH)	−0.069	0.740	−0.441
	(0.089)	(0.185)	(0.108)
D(FVR_SH)	0.198	−3.410	1.701
	(0.514)	(1.071)	(0.629)

Notes: Trace test indicates 2 cointegrating equation(s) at the 0.05 level. Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level. 1 Cointegrating Equation(s): Log-likelihood is 89.201. 2 Cointegrating Equation(s): Log-likelihood is 99.600. 3 Cointegrating Equation(s): Log-likelihood is 104.5249.
[a] Rejection of the hypothesis at the 0.05 level.
[b] MacKinnon-Haug-Michelis (1999) *p*-values.

Endnotes

1. We thank the referee for commenting on this point.
2. The statistical data of new construction is at the regional level and not related specially to prime A offices in the central business districts studied in these two cities, so it is inappropriate to include them in the models here.
3. This approach has some similarity to work by Voith and Crone (1988) and Grenadier (1995). Hendershott, MacGregor, and White (2002) also use an AR(3) process to explain the vacancy rate.
4. FDI is marginally insignificant for Shanghai in the long-run model.

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