# TIPTOE PAST THE DRAGON: REPLICATING AND HEDGING CHINESE DIRECT REAL ESTATE

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## Abstract

Over the last 30 years, Chinese commercial real estate markets have joined the global universe of investable assets, as exemplified by vibrant skylines and the construction of startling new buildings in megacities. Despite the large volume of foreign direct investments in Chinese commercial real estate markets, there has been little academic research done to analyse and characterize the risk structure of Chinese commercial properties. Using a database never applied before in academic literature, this paper fills in the gap by studying the risk characteristics of direct property investments in Chinese first-tier cities. It applies macrovariable models to analyse the risk structure of office properties in Beijing, Shanghai, and Guangzhou. It then tests a selection of instruments that could be used by international investors to hedge the risk of investing in these three sub-markets. It concludes by making a series of recommendations that could help international investors deal with the risk of direct investments in China's property markets.


*"Discard ingenuity, exterminate profit,*

*And there will be no more thieves and bandits."*

Lao-tzu in *Tao Te Ching* (chapter 19)

## 1. INTRODUCTION

Few sights are as striking as first-tier Chinese cities when it comes to witnessing the actual effects of economic growth and urbanization on China. Megacities mirror the drastic changes undergone by the Chinese economy since 1979 when Deng Xiaoping decided to put an end to the Maoist era and initiated a new 'Open Door Policy'. Following the entry of China in the World Trade Organization in December 2001, the pace of economic growth has continued unabated, resulting in more intense urbanization and construction projects on a scale unknown before. The tenets of China's miracle growth are well known (Brandt and Rawski, 2008) whereas their repercussions on commercial real estate are still somewhat of an urban myth. Over the past 10 years, Chinese real estate markets have joined the global universe of investable assets as exemplified by vibrant skylines and the construction of startling commercial properties in Chinese megacities. It is now difficult to ignore a market ranked as the third largest globally by invested stock (DTZ, 2012). In recent months, several international financial powerhouses reputed for their business acumen and a track record of savvy investments (e.g. Soros, KKR) have decided to enter the Chinese direct commercial real estate markets, hoping for many happy, albeit possibly somewhat late, returns[1]. International investors who are often

[1] In September 2011, KKR China Growth Fund L.P. formed a joint venture with Sino-Ocean to invest $140 million in Chinese real estate. A few months later, Soros announced it was creating a property fund targeting Hong Kong and mainland China, triggering speculation his short investment style might be a signal China's property markets are heading south. In addition to financial investors, China's real estate markets attract a range

mesmerized by the historical growth and potential size of the Chinese economy, as well as the reassurance by Chinese authorities that their commercial property markets are sound, might not have a clear understanding of the nature of the risk they face in China. Notwithstanding the focus on operational and legal risks whose need was emphasized by some highly publicised cases of international investors being caught in the complex system of Chinese *guanxi*, international investors venturing into the Chinese direct property markets are faced with many macro risks that have to be addressed[2]. Surprisingly, despite the large volume of foreign investments in the Chinese commercial real estate markets, there has been little academic research done to analyse and characterise the risk structure of Chinese direct commercial properties. As a matter of fact, whilst research on securitized real estate markets in Greater China is quite frequent (e.g. Liow and Newell, 2010), studies pertaining to the Chinese direct real estate markets are scarce, due in large part to the difficulty to access relevant data. For instance, Tse, Chiang, and Raftery analyse the risk of office properties in Shanghai, Guangzhou, and Shenzen based on the Security Market Line but their paper dates back to 1999. Academics have considered the issue of inflation hedging and direct real estate in the Chinese context (Chu and Sing, 2004; Lecomte, 2012) but have not applied to China the type of analysis that has been used to scrutinize commercial properties in Western markets (e.g. Kling and McCue, 1987; Geltner, 1989; Ling and Naranjo, 1997; Liang and McIntosh, 1998).

Using a database never applied before in the academic literature, this paper fills in the gap by studying the risk characteristics of direct office property investments in three first-tier Chinese cities (Beijing, Shanghai, Guangzhou). The paper addresses two research questions: First, what is the nature of real estate risk in Chinese office markets? Secondly, how can Chinese real estate risk be hedged by international investors going directly into these sub-markets, especially in case of a hard landing of the Chinese economy? To answer these questions, the paper is organized according to three sections. In section I, the paper introduces the context surrounding office properties in the three cities under investigation and the role of foreign investors in these markets created ex nihilo over the last 30 years. In section II, the paper implements two classic financial frameworks, i.e. CAPM after Tse, Chiang and Raftery (1999), and macroeconomic variable models (aka MVM) after Chen, Hsieh and Jordan (1997), in order to analyse the risk structure of Chinese direct office properties in the three cities under study. In section III, the analysis replicates Chinese direct office returns and tests a selection of possible hedges (cross-hedges and index-based hedges) that could be used by international investors to manage the risk of investing in these sub-markets. The last section draws on Riddiough (1995) who studies the use of multi-factor cross-hedging instruments in US direct commercial property markets.

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of actors in the global real estate industry. For instance, in May 2012, Tishman-Speyer announced the launch of a RMB 1.2 bln real estate fund aimed at direct investments in China, the first fund raised by a foreign developer.

[2] Guanxi is a Chinese word that refers to the intricate network of connections necessary to do business in China.

## 2. BACKGROUND : THE CREATION OF OFFICE MARKETS IN CHINESE MEGACITIES

The emergence of Central Business Districts (CBD) made up of office buildings of international standard in Chinese megacities is a drastic rupture with the Chinese tradition embodied by the feudal era and more recently the Maoist period. Gaubatz (2005) explains that the increased participation of China to the global economy in the 1980s led to the redefinition of Chinese cities. While the central government granted municipalities the right to prepare their own urban plan, the overall objective was to create 'Great International Cities' modelled after the world's financial capitals. In Beijing, Shanghai and Guangzhou, the designation of Central Business Districts became essential in transforming locally oriented cities into internationally oriented cities, and in creating globally recognizable symbols for these cities.

### Central Business Districts: a recent concept benefiting from stringent locational policies

CBD and grade A office buildings are recent additions to Chinese urban landscapes. Until the end of World War II and the arrival of Mao's communist party in power in 1949, Chinese cities followed an ancestral model that had hardly evolved over three millennia (Gaubatz, 1999). The concept of office building was foreign to this archetypal city, notwithstanding the notable exception of Shanghai whose famous Bund and central district welcomed the headquarters of an array of foreign companies. The socialist city as envisioned by the Maoist ideology aimed to turn cities into production centres at a time when the Chinese economy was entirely geared towards manufacturing activities. These producer cities, as opposed to the consumer cities of capitalism, had no space and no need for office buildings. With the opening of the Chinese economy to the world, everything changed. The establishment of Development Zone Planning helped reorganizing cities around massive planned areas designed to attract outside capital investments (Gaubatz, 1999). For instance, the creation of a financial district in Shanghai benefited greatly from a systematic policy that welcomed foreign investments provided very constraining locational requirements. In 1997-1998, licenses were granted to eight foreign banks to operate in renminbi, with the geographical restriction that they had to be located in Shanghai Pudong new area or in Shenzhen Special Economic Zone (Lardy, 2002). These restrictions on foreign banks were in place until 2005. Likewise, foreign insurance companies and other professional services, such as accounting, law, architecture and engineering were submitted to strict locational restrictions until 2010 when they were eventually lifted[3].

[3] Geographical and project restrictions on foreign investments in real estate were lifted as part of the WTO agreement whereby China committed to progressively liberalize its real estate markets (He et al., 2011).

**Office Markets in Beijing, Shanghai, and Guangzhou**

Chinese planning policies have thus fostered the development of CBD concentrating all grade A quality supply around a few economic clusters.

- *Beijing and Shanghai:* Customarily called the two dragons, Beijing and Shanghai are at the forefront of China's new economic geography. While traditionally a political and cultural center, Beijing was redefined as a center for politics, culture, international affairs and finance (Gaubatz, 2005). Shanghai has a century old history of welcoming foreign companies and investors combined with a strong manufacturing base. Yusuf and Nabeshima (2010) explain that as a necessary step toward becoming truly global cities, both Beijing and Shanghai are now aiming to increase the share of the finance sector and its affiliated activities in their GDP[4]. Concomitantly, the sustained economic growth over the last 10 years has enlarged the traditional range of activities for these two megacities, with Beijing becoming a magnet for high-tech and high-value industries including the creative industry, and Shanghai expanding beyond its traditional manufacturing and commercial activities to tap into tertiary education and research. In 2008, Beijing and Shanghai accounted for a similar and relatively small share of China's population (16 million for Beijing or 1.2%, and 19 million for Shanghai or 1.4%). However, their economic footprint is much larger, with Beijing and Shanghai accounting for respectively 4% and 5% of the national economy. At the end of 2011, Beijing is China's most expensive city in terms of office rentals, and the third most expensive office market in Asia, behind Hong Kong and Tokyo (Cushman and Wakefield, 2012). Demand in Beijing is driven from the high-tech/telecom and finance sectors, mostly domestic. The city boasts 3 business districts, including the new Finance Street (Jinrong Jie) whose goal is to become the Middle Kingdom's version of Wall Street. In contrast, Shanghai is still dominated by MNCs, especially those from the financial, pharmaceutical and hi-tech sectors. The city is viewed as one of the most favourable cities for foreign companies with possibly the most open and competitive real estate market in China (Chen and Hao, 2008). Shanghai has two business districts: Puxi which is the city's historical center and Pudong to the East.
- *Guangzhou:* Guangzhou is the capital city of the South China's Guangdong Province. Although a first-tier city like Beijing and Shanghai, it cannot claim the same clout. Guangzhou has traditionally enjoyed a positive economic outlook due to its location in the Pearl River Delta, one of China's main manufacturing and commercial regions. Various schemes were implemented in the 1990s to help foster the city's trade and manufacturing base

[4] Both cities play specific roles in China's financial centre network. As Lai (2012) explains, "Beijing is responsible for policy making and macro planning while Shanghai is tasked with testing new products, developing new markets and financial innovation". The People's Bank of China has recently adopted a dual headquarter strategy in Beijing and Shanghai, which reflects these two very distinctive roles.

(Free Trade Zone, Nansha Export Processing Zone). Guangzhou's airport is the country's second busiest airport in terms of freight movements. In the early 2000, China's transition away from the export-driven development economic paradigm has meant that costal hubs such as Guangzhou have entered a more mature, less exciting, growth pattern (Ness and Kramer, 2012).

**Real estate investments and international investors in Chinese megacities**

The development of Chinese property markets has been highly successful so far. In 2011, as investments amounted to 50% of GDP, real estate accounted for 23% of all fixed asset investments in China. Geng and N'Diaye (2012) estimate that the real estate sector represents over 10% of the Chinese economy, with the bulk of the activity stemming from the eastern provinces. In 2011, the volume of transactions for all property types in the three cities under study was $57bln (Real Capital Analytics, 2012). Land acquisition accounted for the largest share ($45bln) followed by office properties ($5bln in Shanghai, $2bln in Beijing)[5]. Office property is the single largest property type in the three cities, Beijing and Shanghai being the biggest office markets in China. Linked with Deng's Open Door Policy was the arrival of foreign real estate investors in Chinese metropolises. Tse et al. reports that Guangzhou started to sell its land use rights as early as 1979 in cooperation with a Hong Kong developer. Foreign direct investments in real estate have been instrumental in turning real estate which was once a public good into a commercial product (Fung et al., 2006). Since the mid-1990s, FDI inflows into real estate have consistently amounted to 10-15% of total FDI (He, Wang, Cheng, 2011). After the initial emerging phase of the 1990s and liberalization following the WTO, foreign investors such as private equity funds have shown an accrued interest for China's real estate markets, using the joint venture structure to access the direct market. Noticeably, although domestic investors still dominate real estate markets in Asia, China is the Asian country where foreign investors represent the largest proportion of acquisitions. Over the 2009-2011 period, total acquisitions of commercial properties (office, retail, industrial, mixed use) in China amounted to $22bln, of which $6.5bln were completed by foreign investors (CBRE, 2011). In spite of their attractiveness, Chinese real estate markets remain very opaque. The Jones Lang Lasalle Transparency Index ranks first-tier Chinese cities 45 out of 81 globally in 2010 with an overall score of 3.14, a notable improvement since when they were first ranked in 2001, but still lacking behind other Asian cities such as Singapore and Hong Kong (ranked 16th and 18th in 2010 respectively)[6]. In this respect alone, it is quite obvious that investing in China's direct property markets is not devoid of risks[7].

[5] As matter of comparison, with $13bln of transactions in 2011, Tokyo dwarfed the two Chinese megacities.
[6] As a matter of comparison with another BRICS country, Russia's third-tier cities are ranked in 42nd position by the JLL Transparency index.
[7] Although they find no evidence that a weak rule of law is detrimental to FDI in China, Wang, Xu and Zhu (2011) note in their report for the World Bank that Chinese idiosyncratic ways of doing business can negatively

## 3. MODELING CHINESE DIRECT REAL ESTATE RISK

In this section, we introduce the data and theoretical frameworks used to model Chinese direct real estate returns. We first analyse Chinese property returns using the CAPM (after Tse et al., 1999). Once we have characterized the risk structure in terms of systematic and idiosyncratic risks, we apply a MVM framework (after Chen, Hsieh, and Jordan, 1997). This enables us to model Chinese direct real estate returns based on a selection of macroeconomic variables.

### Data and methodology

- *Property returns at the city level*

CBRE Capital Return indices for the Beijing, Shanghai and Guangzhou's office markets are used as proxies for the direct office market in the three cities. All data are year on year quarterly returns in local currency from Q12002 to Q42010 (i.e. 9 years or 36 observations). This choice which is consistent with the importance of capital returns in investors' decisions to invest in Chinese direct real estate markets is imposed by the availability of the indices[8]. Given China's grade A commercial real estate assets are still recent, CBRE coverage only started in 2001 and long term time series are not available. This is a major limitation to any in-depth statistical analysis. As a result, regression outputs have to be interpreted with care, especially for the shorter periods. As stated by Boaz (2005), one is almost always condemned to 'second best' as far as Chinese real estate indices. Ideally, the locations of the properties in the basket reflecting the market segment should be disclosed along with other qualitative information about the buildings[9]. Unfortunately, CBRE's baskets and methodology are not public information. We can only report that CBRE's indices focus on prime office buildings in the core CBD of each city (e.g. Puxi in Shanghai), their coverage being in that sense extremely focused. Table 1 summarizes the main statistics for the three returns (Panel A).

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affect the level of FDI. For instance, their model shows that the cost of maintaining *guanxi* has a negative impact on the ability of local governments to attract foreign investors. Notwithstanding this finding, Wang et al. note that strong economic fundamentals and potential for high returns dominate investors' decision with respect to foreign direct investment in China. He et al. (2011) confirm the fact that foreign investors in Chinese real estate markets are primarily return-driven and make rational locational decisions by investing in regions with the largest expected returns.

[8] In his analysis of US commercial property markets' optimal cross-hedges, Riddiough (1995) also focuses on the property appreciation component of the Russell/NCREIF index (RNI). He explains this component of the return is by far the most volatile, and therefore its variation explains much of the variation in total returns. By the same token, Lecomte and McIntosh (2006) who analyse the feasibility of NPI-based property futures contracts assess that hedging instruments would be most useful for NCREIF indices' capital appreciation components.

[9] In the case of Shanghai, Boaz (2005) mentions the difficulty of selecting grade A buildings of international standard and not of local Chinese standard. These two standards should not be mixed, lest the mixture dilutes the index's performance of buildings defined as international grade A. Some observers argue that this is partly what is happening in the current Chinese real estate's success story, namely that the impressive increase shown by the indices might merely stem from an upgrade in stock from local Chinese grade A to international grade A.

**[INSERT TABLE 1]**

- *Property returns at the national level*

There are no proxies for Chinese commercial property market at the national level. The IPD annual China index which started in 2007 is too recent to be used in this study. However, in order to conduct the first stage of the analysis based on the CAPM, a proxy of the Chinese office property market is needed. Faced with no satisfactory alternatives, we follow the same methodology as the one applied by Tse et al. (1999), by building a market index from city level data. Tse. et al's analysis is focused on four southern cities (Shanghai, Guangzhou, Shenzen, and Hong Kong). They design two market indices for office properties in these cities by applying different weights to the city level individual indices. They then test their findings to make sure they are consistent irrespective of the weights in the market index. This paper adopts a similar approach. Two market indices for the Chinese office market are constructed by combining Beijing, Shanghai and Guangzhou data with two sets of weights:

- National office market index 1: Beijing: 4, Shanghai:5, Guangzhou: 1 (relative GDP weights)[10],
- National office market index 2: equal weightage for the three cities (neutral weights).

Descriptive statistics for the two national indices are reported in Table 1 above (Panel B).

- *Macroeconomic variables*

Macroeconomic variables are selected to explain office property capital returns. Due the possible lack of convergence of economic data in a transitional economy like China, we decide to collect macroeconomic variables at the city level, rather than the country level, whenever available[11]. Hence, city level data are collected from China's National Bureau of Statistics in order to explain city level office property capital returns. The process is relatively easy for Beijing and Shanghai but more difficult for Guangzhou where detailed time series at the city level are not available for all variables included in the analysis. Table 2 below summarizes the data for the three cities as well as the 6 macrovariables collected at the country level. Reported figures are based on year on year % changes in the macro-variables. At the local level, 10 variables cover a wide spectrum of phenomena: demographics (employment, population), real estate markets (projects under

[10] Weights used in national office market index #1 are based on each city's average GDP as a percentage of total China's GDP over the period Q12002-Q42010.

[11] Whether the law of one price does apply to China is an open debate. Zax and He (2011) show that the law of one price does not hold in China despite efforts by the authorities to reduce factor price dispersions before the country's accession to the World Trade Agreement.

construction, fixed asset investments, foreign investments in real estate), business environment (business climate index, entrepreneur index), specific indicators linked to the city's economic base (exports, imports, seaport cargo in the case of Guangzhou), and macro-variables such as per capita disposable income (as a proxy for local private consumption), GDP, gross output of industry, inflation. For the latter variable, we apply an ARIMA (1,0,3) model to decompose actual inflation rate into expected inflation rate and unexpected inflation rate, in accordance with Chu and Sing (2004). At the national level, variables include short and long term interest rates, monetary supply M2, private consumption, the FTSE Xinhua A50 index representative of the Chinese stock markets, and Chinese first tier cities' Jones Lang Lasalle transparency index. Although the analysis aims for maximum consistency across cities, all three sub-markets are not analysed according to the same factors as some variables are not available for all three cities over the full period under study (Q12002-Q42010). In particular, the business climate index and entrepreneur index are available over the period Q42004-Q42010 in Beijing. Only the business climate index is available in Shanghai (Q12004-Q42010) whereas none of the two indices are available in Guangzhou. Table 2 lists in front of each local variable the city where it is available. Local variables available for a city are included into that city's analysis in addition to national macro-variables. Apart from the two indices mentioned before, all variables in table 2 are available over the full period. A fundamental issue pertaining to the use of macroeconomic variables in China stems from their definition and reliability. In several instances, Chinese statistics have been stigmatized for lacking relevance and transparency. As an illustration, the CPI's exact weights are still not public information. According to Orlik (2012), political interference has become a lesser problem than the ability of the National Bureau of Statistics to keep track of a rapidly changing economy[12]. When interpreting the findings, we need to be mindful of Chinese economic indicators' idiosyncrasies. For example, the definition of GDP by the National Bureau of Statistics follows a 'production approach' inherited from the erstwhile all manufacturing Maoist model. Hence, the quarterly GDP measures the sum of added value across all sectors of the economy (94 sectors starting in 2011, only 16 before then). In contrast, the US GDP follows the 'expenditure approach', by adding up household consumption, investment, government spending, and net exports (Orlik, 2012). The Chinese definition of GDP is not good at capturing value created by intangibles provided by the service sector, which might have a significant impact on office property markets. Once again, the pragmatic 'second best' approach has to be adopted.

[12] Whether full transparency can ever reach commercial property in China markets is debatable. In most Asian countries, due to their economic significance, fluctuations in real estate markets can become politically charged. Noticeably, there are no functioning commercial real estate indices akin to the US NCREIF Property Index in Asia, in spite of many agents' endeavors (e.g. private index providers such as IPD or professional organization such as APREA) and even though international investors all agree the lack of long term, robust performance indicators seriously hinders these markets' claim to transparency (e.g. Van Den Berg, 2012).

**[INSERT TABLE 2]**

- *Methodology: single beta model and macrovariable model*

The analysis is conducted in two steps. In the first step, we apply a simple CAPM framework to year on year quarterly office property capital returns at the city level and break down total risk between systematic risk and unsystematic risk over the full 9-year period (Q12002-Q42010) using the two above-mentioned national office market indices as a proxy for China's office market. We compute the beta for each sub-market and infer from this analysis the sub-market with the largest amount of total risk and that with the largest idiosyncratic risk. In the second step, we apply a multivariate regression model to explain office property capital returns with a selection of city level and national macrovariables. A stepwise regression method is used whereby an optimal model is determined for each city level office property capital return index (dependent variable) based on a selection of macro-variables (independent variables). The criteria for determining the optimal model is based on the following rule: for each dependent variable, a model is optimal when the coefficient of determination of the regression (Adjusted $R^2$) is maximized while multicollinearity of the included independent variables is under control (i.e., individual Variance Inflation Factor- VIF- inferior or close to 2.5 for each macro-variable included in the optimal model[13]). This analysis is conducted according to two timeframes[14]:

  - First, for the full period Q12002 to Q42010 (36 observations), with two sub-periods marking the entry of China in the WTO and the sub-prime crisis: Q12002-Q42007 (from WTO to Sub-prime: 28 observations) and Q12008-Q42010 (post Global Financial Crisis: 12 observations).
  - Second, for five 5-year rolling periods (20 observations): Q12002-Q42006, Q12003-Q42007, Q12004-Q42008, Q12005-Q42009, Q12006-Q42010.

**Results**

- *CAPM analysis - Systematic risk vs. idiosyncratic risk*

Sharpe ratios reported in table 1 above indicate that Shanghai is by far the most attractive city among the three cities under study in terms of risk/return trade-off (Sharpe ratio: 0.897). Beijing

[13] The VIF detects the severity of multicollinearity in an OLS analysis by measuring the degree to which the variance of an estimated regression coefficient has been increased because of collinearity. A threshold set at 2.5 as used in this study is quite stringent. For instance, Marquardt (1970) mentions 10 as indicative of harmful multicollinearity.

[14] Due to the constraints surrounding access to reliable historical databases of property returns in China, optimal macrovariable models are based on relatively short time series. The relevance of our findings for the shorter time periods (Q12008-Q42010) has therefore to be scrutinized with care. Interestingly, Riddiough's analysis (1995) is based on similarly short time series for the US market (Q31989-Q31993), i.e. only 14 quarterly returns.

records a slightly negative Sharpe ratio as its average capital return is lower than the average risk free rate over the period. Guangzhou is flatly dominated by Shanghai. Of course, this analysis is only partial as rentals may play a big role in each city's expected return and, consequently, potential attractiveness to investors. Table 3 below summarises the results of the CAPM based analysis.

**[INSERT TABLE 3]**

The analysis consistently indicates that of the three cities, Guangzhou is the riskiest. Its standard deviation is the largest in the group (8.42%), followed by Shanghai (6.77%) and Beijing (5.02%). By the same token, irrespective of the office market index used as a proxy for the national office market, risk in the three cities is overwhelmingly idiosyncratic. In relative terms, Beijing's total risk appears to be the most systematic whereas Shanghai's total risk and, to an even greater extent, Guangzhou's total risk are dominated by idiosyncratic risk, illustrating the fact these two cities' office markets are influenced by unique factors. Idiosyncratic risk is on average twice as large in Guangzhou than in Beijing. These findings are consistent with Tse et al. (1999) who also identify Shanghai's office market as the most attractive in terms of risk/return and Guangzhou's as the most volatile and idiosyncratic office market over the period 1991-1997. Their analysis is based on total returns whereas this paper only covers capital returns. Although it is difficult to compare the findings given the use of different property market proxies, it is striking to note the contrast in overall volatility between the two studies[15]. Returns over the period 2002-2010 are much less volatile than those used in Tse et al. (1999) over the previous decade (e.g. in the case of Shanghai: 6.77% vs. 13.09% over 1991-1997), which could hint at a certain form of maturing process for Chinese megacities' commercial property markets since the WTO accession.

- *Macrovariable Models (MVM)*

Results describing the optimal macrovariable models for the three sub-markets are presented as follows:

- In appendix 1 for the full period Q12002-Q42010 and the two sub-periods (from WTO to Sub-prime: Q12002-Q42007, and post Global Financial Crisis: Q12008-Q42010);
- In appendix 2 for the five 5-year rolling periods.

[15] Tse et al.'s market indices are somewhat biased insofar as they only include four Southern cities (Shanghai, Guangzhou, Shenzhen and Hong Kong). In that respect, no matter how imperfect, our national office market indices which encompass the three largest megacities in the eastern provinces from North to South are more representative of the Chinese national market.

Table 4 below summarises the first factor (panel A) and second factor (panel B), along with associated Adjusted $R^2$ (1st factor) and variation in Adjusted $R^2$ (2nd factor), for the optimal models reported in appendices 1 and 2.

**[INSERT TABLE 4]**

Over the full period 2002-2010 (Appendix 1), MVM is good at replicating real estate returns in Beijing and Guangzhou, where the models' coefficients of determination reach 0.893 and 0.948 respectively. Conversely, Shanghai's office market capital returns are poorly explained by macrovariables (Adj. $R^2$=0.193). Whilst Shanghai is dominated by local variables (GDP, expected inflation, employment), both Beijing and Guangzhou display strong links with national variables. Long term rates and private consumption top in Beijing's optimal models whereas Guangzhou sub-market is affected by shorter term, more volatile variables (3-month T Bill and FTSE Xinhua A50) coupled with population. In that sense, Beijing appears like the ultimate macro city in the group. In contrast, Shanghai is the quirkiest. The comparison between the two sub-periods reveal that the sub-prime crisis had an impact on the three sub-markets' risk structures. In the early part of the decade, the WTO accession and the resulting breakneck economic growth translate into the optimal models. Shanghai office returns are driven by GDP[16]. Likewise, Guangzhou market is driven by population and private consumption. Interestingly, post Global Financial Crisis, optimal models tend to differ: expected inflation becomes a significant factor in Beijing while Shanghai's business climate starts to matter.

The 5-year rolling period analysis (Appendix 2) confirms the previous findings. Whilst Beijing office market is dominated by national variables (i.e. long term rate and private consumption), Shanghai office market is overwhelmingly driven by local variables, which epitomizes its idiosyncratic dimension. Macrovariable models are overall less efficient at capturing Shanghai's risk than in the two other cities. With respect to Guangzhou, demographics play an important role in the city's property market, whereas it has a more limited impact in the two other markets. Interestingly, in the last 5-year period (Q12006-Q42010), the strong presence of expected inflation (Beijing) and unexpected inflation

[16] Interestingly, β(Local GDP) in Shanghai's optimal models (reported in appendices 1 & 2) are consistently negative (significant at 1% level). A possible explanation for this counterintuitive finding lies in the nature of the proxy used for the city's direct office market. The CBRE index is focused on Grade A properties in the historic core CBD area (within Puxi) while in recent years, Shanghai has witnessed the emergence of a decentralized Grade A office market in Puxi and Pudong (between Inner Ring Road and Middle Ring Road), in part owing to improved public transportation (Jones Lang LaSalle, 2009). On average, decentralized space has been 30% cheaper than CBD space, attracting tenants from manufacturing, technology and other industries. As over half of decentralized tenants are former CBD tenants, high profile office locations in core CBD are now mostly favoured by tenants in the financial, legal and professional services. Hence, paradoxically, as Shanghai's GDP has grown, increased downward pressures might be exercised on core CBD office capital returns over the period under study.

(Shanghai) in the optimal models embodies the changing nature of real estate risk post Global Financial Crisis as well as investors' concern about China's inflation risk (Lecomte, 2012).

- *Synthesis*

In sum, risk in the three sub-markets significantly differs[17]. Although replicating office market returns using macrovariables yields contrasting results (average Adj. $R^2$ over all periods: 0.886 for Beijing; 0.596 for Shanghai; 0.878 for Guangzhou), a pattern can be drawn. Beijing and Guangzhou are both macroeconomic plays, the former with a long-term perspective, the latter with a shorter term (and thus more volatile) focus. Guangzhou office market which is highly volatile is dominated by its larger peers. Investors looking for a stable macro bet on China's long term prospects as captured by national macroeconomic indicators (i.e. long term rate, private consumption, money supply) should select the Beijing office market over Shanghai. Conversely, investors looking for unique investment opportunities should select Shanghai office market which, overall, offered the best investment opportunities over the period under study. The city's idiosyncratic nature and resolutely local dimension might even add some diversification benefits to a portfolio of Chinese assets.

## 4. HEDGING CHINESE DIRECT REAL ESTATE RISK

Faced with risks which are largely macro, international investors have no easy way to hedge their investments in Chinese properties. Noticeably, although being part of the broader Chinese real estate market, each sub-market's risk structure is very different and, therefore, requires a specific hedge. The previous analysis shows that macrovariables can be successfully used to model and replicate real estate returns. Thus, they would provide efficient hedges against volatility in capital returns for the three sub-markets under study, albeit at different levels depending on the city. However, the market for macroeconomic derivatives is not currently functioning in the West, let alone in China. Likewise, the fledging property derivatives market developed in Europe and in the US over the last decade has hardly expanded in Asia yet, with the exception of Australia and Hong Kong. Hence, what can be the alternative for international investors looking for ways to hedge their exposure to direct property investments in China? The paper addresses this question by scanning the hedging effectiveness of an array of potential cross-hedging instruments listed on public markets. The approach described thereafter is designed mainly with US investors in mind.

[17] The question of differentiation among local real estate markets in a transitional economy like China is linked to the broader issue of 'law of one price'. When factor pricing differs widely from one region to another, one would expect very sharp contrast from one local real estate market to another. On the other hand, urban growth in Chinese megacities which stems from deliberate choices in terms of economic bases might ultimately foster the convergence of local property markets towards a national average.

**Potential Cross-Hedges**

The paper explores seven potential sources of cross-hedges for Chinese direct real estate. These instruments cover a wide range of market segments, from real estate in China to commodities in Latin America:

1- *ETFs traded on US markets focused on China or Chinese real estate markets*: The most focused ETF is the Guggenheim China Real Estate ETF which specialises in investing in listed companies whose activities are linked to China's real estate market. We also select RMR Asia Pacific Real Estate Fund, iShare FTSE NAREIT Asia ETF, as well as two ETFS on broader Chinese indices: iShare FTSE Xinhua China 25 Index ETF, SPDR S&P China.

2- *Chinese Real Estate Companies traded on US markets*: E-house (China) Holdings, China Housing & Land, XinYuan Real Estate, China HGS Real Estate.

3- *Country Index Funds*: Commodities play a big role in China's fixed asset investments, one fifth of which have involved real estate assets in 2011. Therefore, commodity producing countries such as Australia and Brazil are linked to Chinese real estate markets. This is the so called 'Chanos hedge' after hedge fund manager James Chanos who is famous for his bearish stance on China's economy and real estate markets. iShare MSCI Australia Index Fund and iShare MSCI Brazil Index Fund are included in the analysis.

4- *Commodity companies benefiting from Chinese demand for raw materials*: In addition to commodity rich country index funds, the analysis encompasses a selection of commodity companies: Rio Tinto (UK-Australia), Vale (Brazil), Peabody Energy (US) and Freeport-Mcmoran (US)[18].

5- *Hong Kong listed REITs*: Several REITs with direct investments in China are listed on the Hong Kong stock market. The paper selects two REITs whose activities are most related to the three sub-markets: Prosperity REIT and YueXiu REIT.

6- *Chinese companies listed on Hong Kong stock market (or Red Chips)*: China Overseas Land & Investment, Sino-Ocean Land Holdings, China Chengtong Development Group, Poly HK Investment, YueXi Property, Shanghai Industrial Holdings, Soho China, R&F.

7- *Singapore based property companies and REITS*: Capitaland and Ascendas REIT.

[18] This selection of companies aims to cover the full spectrum of commodities involved in China's economic growth story. As an illustration, Vale which is the world's largest iron ore producer derived 32% of its revenues from China in 2011.

Overall, 27 potential cross-hedging instruments from a wide range of sectors are included in the analysis. Appendix 3 presents a summary of these instruments.

**Data and methodology**

For all 27 identified potential cross-hedge underlying instruments, closing prices are collected from Bloomberg. We compute year on year quarterly returns in Chinese renminbi for the period Q12002-Q42010. When data are not available over the full period (i.e. in case of a listing start date posterior to Q12001), year on year quarterly returns are computed for the longest available sub-period over the full period under study. Office market capital returns for the three cities are computed as before. Table 5 summarizes the descriptive statistics.

**[INSERT TABLE 5]**

Given that not all 27 underlying instruments are traded over the full period Q12002-Q42010, the paper breaks down the analysis into 3 sub-periods. Any instrument whose year-on-year quarterly returns are available during the timeframe of the three periods is included into the corresponding analysis[19]:

- Q12003-Q42010 (8 year period- 12 cross hedging instruments),
- Q12007-Q42010 (4 year period- 16 cross hedging instruments),
- Q12009-Q42010 (2 year period- all 27 cross-hedging instruments).

For the three periods, the paper analyses three types of hedge after Lecomte (2007):

- single instrument hedge based on only one of the 27 cross-hedging instruments (*single hedge*);
- multiple instrument hedge based on up to three cross-hedging instruments selected from the 27 potential cross-hedges (*combination hedge*);
- hybrid hedge made up of one instrument from the sample of cross-hedging instruments (if relevant) along with one or several macrovariables used previously for modelling office property capital returns (*hybrid hedge*). This type of hedge is purely theoretical inasmuch as there are no economic derivatives available on China's macrovariables used in this paper.

Best hedges are identified according to Ederington (1979). For single hedges, the optimal hedge is the one that maximizes the coefficient of determination of the regression between office market capital

[19] The number of observations in our sample for each period is as follows: 32 (Q12003-Q42010); 16 (Q12007-Q42010); 8 (Q12009-Q42010). This analysis, although limited by data availability, puts us in the exact same position as an international investor looking for a cross-hedge. Most cross hedges selected in the paper have been trading for less than 4 years.

returns (dependent variable) and the cross hedging instrument, i.e. one of the 27 potential underlying instruments (independent variable). For combination and hybrid hedges, we apply a stepwise regression to determine the optimal model maximizing the coefficient of determination (Adj. $R^2$) of the regression between office market capital returns (dependent variable) and selected underlyings (independent variables), i.e. up to three cross-hedging instruments from our sample of cross hedges, or an hybrid selection of one cross-hedging instrument and macrovariables. The optimal model is selected so that all included cross-hedging instruments and macrovariables have their VIF coefficient inferior or close to 2.5.

**Results**

- *Correlations*

Pairwise correlations between the three cities' office property market returns and cross-hedging instruments over the full period of availability for each time series (as reported in table 5 above) show that Shanghai office market records the largest correlations with the selection of underlyings. The correlation of the city's office market is at 0.495 (significant at 1% level) with iShare Brazil and 0.735 (significant at 5% level) with iShare FTSE NAREIT Asia. Likewise, Beijing is correlated to China Chengtong (0.412 significant at 5% level) and Guangzhou with Rio Tinto (0.372 at 5% level). Apart from these few correlations, all others are not significant. Surprisingly, with the exception of iShare FTSE NAREIT Asia, securities supposed to track Chinese real estate markets (e.g. Guggenheim China Real Estate ETF) are not correlated with direct markets as proxied by CBRE capital return indices. A further analysis of Guggenheim China Real Estate ETF shows that its returns are overwhelmingly linked to the Chinese stock market (correlation of 0.977 significant at 1% level with iShare FTSE Xinhua China 25 Index)[20]. Thus, it appears that Guggenheim China Real ETF is not a good proxy for Chinese direct real estate markets. By the same token, securities listed on US markets (Chinese real estate companies) and on peripheral Asian markets (Hong Kong REITs, Red Chips and Singapore companies) are not significantly correlated with Chinese direct returns. Furthermore, only Shanghai shows correlations with commodity companies or commodity rich country ETFs. Beijing's market, in particular, is not linked to commodities.

The lack of correlation between direct capital returns at the city level and our selection of instruments is in sharp contrast with very large across-the-board pairwise correlations between

[20] The MVM framework described in section 3 applied to Guggenheim China Real Estate returns (dependent variable) confirms this finding. Over the period Q42008-Q42010, Guggenheim's Y/Y quarterly returns (TAO) are optimally explained with an adjusted $R^2$ of 0.967 by a two factor model where FTSE Xinhua A50 index dominates: β (FTSE Xinhua A50)= 1.06 *(15.24)****, β (Gross Output-Beijing)=1.29 *(2.81)***

cross-hedging underlying instruments. Among the notable correlations (significant at 1% level), we identify:

- China real estate ETFs and China country funds (e.g. RMR Asia Pacific Real Estate/SPDR S&P China: 0.904)
- China country funds and commodity companies (e.g. iShare FTSE Xinhua A25 Index/Vale: 0.922; SPDR S&P China/Freeport-Mcmoran:0.881)
- Commodity companies/commodity rich country ETFs and China real estate funds or related companies (e.g. iShare MSCI Australia/iShare FTSE NAREIT Asia: 0.981; Vale/Poly Honk Kong Investment: 0.766)
- China real estate ETFs and Red Chips (e.g. Guggenheim China Real Estate/China Chengtong: 0.963; Guggenheim China Real Estate/Shanghai Industrial Holdings: 0.914).

As explained in the previous section, Chinese direct real estate which mirrors strong fundamentals and local market dynamics is largely driven by macrovariables, either national or local. This is all the more true for first tier cities' office markets which are at the forefront of China's new economic geography. Weak correlations of direct property returns with a broad range of listed securities, especially China real estate ETFs and China country funds, indicate that these cross-hedging instruments which are dominated by highly volatile stock market factors may fail to fully capture the Chinese economy's macro-trends as reflected in direct real estate markets[21].

- *Single hedges*

Best single hedges' effectiveness and component over the three periods are reported in table 6.

**[INSERT TABLE 6]**

Hedging effectiveness is low over the long period Q12003-Q42010 (0.136 for Beijing, 0.333 for Shanghai, 0.092 for Guangzhou). Peabody Energy and Rio Tinto provide the best hedges for Shanghai and Guangzhou respectively, underlining the link between global commodity companies and Chinese direct real estate markets[22]. Thanks to its connection with commodities, Shanghai's office property market should be easier to hedge than Beijing's and Guangzhou's. In recent years, a broader universe of available securities (e.g. new listings of Hong Kong Reits and Red Chips) makes it possible to

[21] This finding is consistent with the international real estate literature which has repeatedly noted that publicly traded real estate companies are not representative of private real estate markets in a wide range of developed and developing countries (e.g. Eichholtz and Hartzell, 1996; Ling and Naranjo, 2002). To our knowledge, this is the first time the discrepancy between public and private real estate markets is empirically tested for China.

[22] Peabody Energy is the world's coal largest producer. In 2011, China accounted for 65% of the global coal consumption. Rio Tinto is a global diversified mining group, with leading positions in aluminium, copper, thermal coal and iron ore.

significantly increase the hedging effectiveness over the shorter period Q12009-Q42010 (0.363 for Beijing/Sino-Ocean, 0.769 for Shanghai/Prosperity REIT, 0.551 for Guangzhou/Prosperity REIT). Nevertheless, as exemplified by their lack of consistency over the three periods under study, single hedges do not seem very efficient at capturing direct real estate risk.

- *Combined hedges*

In an attempt to foster hedging effectiveness, we test the combination of up to three cross-hedging instruments within one hedge called combined hedge. Optimal models are reported in table 7.

**[INSERT TABLE 7]**

Strong multicollinearity between cross-hedging instruments limits the choice of optimal models, thereby imposing a large constraint on combined hedges' overall effectiveness. Nonetheless, the combination of several cross-hedging instruments translates into improved hedging effectiveness compared with single hedges. On average over the three periods, large levels of hedging effectiveness are achieved in Shanghai (Adj. $R^2$=0.683), followed by Guangzhou and Beijing (Adj. $R^2$= 0.559 and 0.440 respectively). This confirms our previous finding that Shanghai office property market, albeit highly idiosyncratic, would be easier to hedge based on listed instruments owing to the city's link with commodity companies (Peabody Energy, and Rio Tinto)[23]. Conversely, Beijing office property market with its strong macro dimension does not answer as well to the selection of cross-hedging instruments.

- *Hybrid hedges*

We combine the above-mentioned 27 cross-hedging instruments with macrovariables used in the MVM section of this paper. Given that overall $R^2$ achieved by optimal macrovariable models are higher than those obtained with cross-hedging instruments (Appendices 1 and 2), hybrid hedges should spur investors' ability to cover direct real estate risk. The analysis is carried out for each city over the three periods. This approach is purely theoretical inasmuch as there is no functioning market for economic derivatives in the world, let alone in China[24]. It follows Riddiough (1995) which replicates US commercial real estate returns by combining traded and over-the-counter instruments

[23] Over the period Q12003-Q42010, an investor being long office property in Shanghai would have achieved a hedging effectiveness of 0.527 by going short Peabody Energy and Rio Tinto and long Capitaland (see Table 7-Panel B).

[24] Orlik (2012) explains that the release of economic indicators in China is marred by leaks and rumours. For instance, the quarterly GDP is announced to the financial press 15 minutes ahead of the public announcement (under embargo). In practice, Chinese news organizations break the embargo with impunity in order to gain a competitive advantage. Any market on economic derivatives (e.g. a parimutuel auction market as described in Barrau, Zerda, Wang, and Argaiz, 2005) would suppose that the way Chinese economic indicators are released be sorted.

(up to 3 instruments in each hedge including economic variables such as the CPI and change in national office construction spending). Results of our analysis are reported in table 8.

**[INSERT TABLE 8]**

Apart from a few cases, optimal hedges are truly hybrid, i.e. combining one cross-hedging instrument with at least one macrovariable. On average over the three periods, hedging effectiveness is significantly improved by the use of hybrid hedges. The case of Beijing is striking. Over the long period Q12003-Q42010, hedging effectiveness reaches 0.867 (vs. 0.313 for combined hedge). Interestingly, macrovariables, both national (long term rate) and local (population, per capita disposable income), are the most significant in the optimal models. On average for the three cities, optimal hedges contain 3.11 instruments.

Table 9 summarizes the levels of hedging effectiveness achieved by the three types of hedge analysed in the paper: single, combined and hybrid.

**[INSERT TABLE 9]**

Without a doubt, hybrid hedges deliver superior hedging effectiveness and dominate the two other types of cross-hedge. In the context of the Chinese economy which has been changing very rapidly over the last decade, this concept applied to real estate is very relevant, by encompassing national macro trends, local characteristics and property markets' idiosyncrasies.

**Comparison of Cross-Hedges with Index-Based Derivatives**

Finally, the paper explores how index-based derivatives would compare to cross-hedges analysed before. Derivatives on Chinese real estate market or sub-markets do not exist yet but as China's commercial real estate indices become more robust, they are bound to appear, starting with OTC swaps. The study deals with office capital returns and is therefore concerned about capital return swaps. To design such instruments, an index is needed. IPD has recently launched a series of annual indices on the Chinese real estate market at the national level with sub-indices by property type and return type. IPD indices' time series go back to 2007. We select the China Office Capital Growth Index as underlying to Capital Return Swaps (CRS). We assume the swap is structured with two legs following the traditional UK model of property swaps as symbolized on Figure 1: on the one hand the IPD China Office Capital Growth annual index, on the other hand a fixed rate.

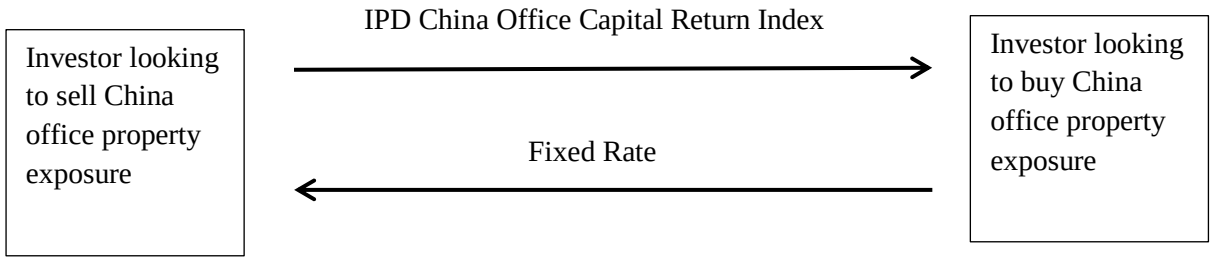


**FIGURE 1: Capital Return Swap on IPD China Office Index**

Pricing accurately the fixed rate on a China property swap is a complex theoretical question. This study aims to come up with a reasonable approximation. As mentioned by the Investment Property Forum (2010), given that the underlying index is not investable, pricing cannot be a small margin over Libor[25]. It is primarily determined by investor expectations of returns. In the UK, on average, the risk premium for holding property is in the order of 2-3% over risk free rate. We decide to price the fixed leg of the swap by applying a 3% spread over China's 1-year T Bill rate.

Table 10 presents the CRS' fixed rate for each year as well as annual hedged returns for the three cities' office markets (under a naïve hedging strategy).

**[INSERT TABLE 10]**

Thanks to strong correlation between IPD China Capital Growth index and the Beijing office market, a hedging strategy based on a CRS significantly improves the risk/return trade-off for office properties in Beijing (e.g. capital returns' coefficient of variation= 0.35 hedged vs. 0.66 unhedged). However, the index-based swap does not work for Shanghai and Guangzhou whose capital returns show none or weak correlation with the underlying index's returns. This finding raises questions about the concept of national property market in a gigantic and diverse country. In a nascent property market such as China's where discrepancies among cities are very significant (as embodied by the fact the law of one price does not hold), using a national index as underlying for a hedge at the city level is not efficient. As China' economic geography is in the process of being defined, relying on index-based derivatives can only be second best until highly specific city level sub-indices are developed. Short of that, cross-hedges including economic derivatives are better alternatives for investors.

[25] Patel and Pereira (2007) explain that in the case of a leg based on Libor + Spread (i.e. the initial model of UK index-based property swap), pricing the spread depends on two variables: volatility of returns (the higher volatility of the underlying, the higher the spread) and counterparty risk. They propose guidelines based on IPD UK index series. Following their criteria, we compute the volatility of IPD China Office Capital Growth Index and compare it with that of UK Capital Growth indices reported by the authors to estimate the spread of a 5 year swap. The index's average return from 2007 to 2010 is 4.9% with a volatility of 6.9% (CV=1.42). This compares with the IPD UK Other Property Capital Growth Index (CV=1.76). Hence, if we select the same level of spread as that reported in Patel et al., the spread over Libor would be 14 bps. This is not commensurate with the level of risk involved in the three sub-markets.

## 5. CONCLUSION

Due to their intricate link with Chinese rapid growth over the last 20 years, CBDs and grade A office buildings in Beijing, Shanghai and Gangzhou mirror China's new status on the global economic scene. They embody the country's shift to a capitalist economy and the authorities' decision to make it evolve at headlong pace towards higher added-value activities. Their significance, akin to a political statement, goes way beyond that of their western counterparts. To what extent this unusual position for a property market could shelter international investors from the risk of investing in these sub-markets remains to be seen.

Both single factor and multifactor models applied in this paper identify huge discrepancies in the risk structure of the three megacities' office markets. While Beijing and Guangzhou are national macro plays, Shanghai is strongly impacted by local variables such as GDP and employment. As a result of its sensitivity to more stable longer term macrovariables, Beijing might be expected to be less prone to speculation and to lag Shanghai and Guangzhou in the property cycle. The paper also analyses 27 cross-hedging instruments stemming from seven potential sources of cross-hedges. The findings show that listed instruments supposed to replicate Chinese real estate markets have little relevance with direct real estate returns[26]. Likewise, the representativeness of national property indices in a gigantic transitional economy like China is questionable. Hence, China's unique property markets make it necessary to redefine the way investors envision property hedging. Among the three types of cross-hedges tested in this study, hybrid hedges combining several underlying instruments (one listed cross-hedging instrument and a selection of unlisted macrovariables) are most efficient, by successfully encapsulating national macro trends, local characteristics and property markets' idiosyncrasies. It makes no doubt that a market for derivatives on China's macroeconomic indicators would be extremely useful for international investors willing to replicate and/or hedge investments in direct real estate. Interestingly, comparable instruments on US economic indicators introduced in 2006 by the Chicago Mercantile Exchange failed to succeed. It is therefore unlikely that economic derivatives appear anytime soon in China where the construction and release of economic indicators are not exempt from controversy. That said, the sheer volume of foreign direct investments in Chinese direct real estate markets along with these markets' untested liquidity in case of crisis might eventually be a catalyst to introduce new hedging tools such as customizable hybrid hedges or, more prosaically, instruments based on narrow sub-indices, thereby enabling investors to deal with risks whose significance can reasonably be expected to grow, in size and intensity, in the coming years. As a first

[26] Our findings can also help shed some light on the rationale behind US hedge funds' recent interest in Chinese direct real estate. Macro investors like Soros have identified that direct real estate does offer a macro bet on China's economy whereas other investment vehicles (e.g. listed real estate companies, commodities…) are influenced by exogenous factors which interfere with their ability to track the Chinese economy. Hence, in the absence of economic derivatives or renminbi currency plays, direct real estate has become a vehicle of choice for savvy macro investors willing to bet on China's real economy.

step towards achieving this goal, we suggest that further research focus on pricing the fixed leg of a total return swaps based on China direct real estate indices, a point mentioned but not thoroughly analysed in this paper.

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**Table 1: Office property returns at the city and national levels**

| | PANEL A | | | PANEL B | |
|---|---|---|---|---|---|
| **Q12002-Q42010** | **BEIJING** | **SHANGHAI** | **GUANGZHOU** | **MARKET INDEX 1** | **MARKET INDEX 2** |
| Average Y/Y % Return | 2.33 | 9.01 | 3.42 | 5.77 | 4.89 |
| Min Y/Y % Return | -3.72 | -1.03 | -16.26 | -0.68 | -2.89 |
| Max Y/Y % Return | 12.71 | 24.88 | 17.65 | 15.51 | 15.51 |
| Standard Deviation Y/Y % Return | 5.03 | 6.77 | 8.42 | 4.80 | 5.28 |
| Sharpe Ratio * | -0.073 | 0.897 | 0.082 | 0.648 | 0.585 |
| Number of Observations | 36 | 36 | 36 | n.a | n.a |

** Risk free rate= 3 Month T Bill (average= 2.66%)*

*source: CBRE Y/Y % Capital Returns (in Chinese RMB)*

## Table 2: Macroeconomic factors (MVM Analysis)

| Q12002-Q42010: Y/Y % VAR | AVERAGE | MIN | MAX | STD. DEV |
|---|---|---|---|---|
| **National Factors** | | | | |
| Long Term Rate (Lending Rate 5Y+) | 6.3 | 5.76 | 7.83 | 0.7 |
| 3 Month T Bill Rate | 2.66 | 1.2 | 4.94 | 0.96 |
| Private Consumption | 11.51 | 4.78 | 16.45 | 2.99 |
| Jones Lang Lasalle Transparency Index (1st Tier Cities): standardised score (1) | 29.52 | 25.8 | 37.2 | 4.3 |
| Monetary Supply M2 | 18.55 | 14.14 | 29.26 | 3.8 |
| FTSE Xinhua A50 Index | 21.74 | -63.53 | 288.44 | 73.14 |
| **Local Factors** | | | | |
| PerCapita Disposable Income | Beijing: 10.91 | 7.07 | 17.54 | 2.34 |
| | Shanghai: 11.33 | 1.64 | 18.41 | 3.61 |
| | Guangzhou: 11.40 | 9.06 | 14.54 | 1.99 |
| Projects under Construction | Beijing: 19.38 | -71.44 | 177.68 | 65.46 |
| | Shanghai: 16.51 | -20.6 | 144.6 | 33.35 |
| Real Estate- Foreign Investments | Beijing: 45.42 | -82.82 | 1067.94 | 206.1 |
| | Shanghai: 46.61 | -68.58 | 713.67 | 143.42 |
| GDP | National: 5.04 | -29.21 | 33.71 | 18.87 |
| | Beijing: 15.67 | 7.46 | 21.3 | 3.24 |
| | Shanghai: 13.95 | 6.58 | 20.59 | 3.63 |
| Population | Beijing: 3.59 | 2.16 | 11.79 | 2.05 |
| | Shanghai: 3.28 | -1.07 | 19.87 | 4.09 |
| | Guangzhou: 1.39 | 0.63 | 1.74 | 0.28 |
| Investments | Beijing: 17.82 | -12.37 | 49.24 | 11.5 |
| | Shanghai: 13.99 | -8.75 | 37.83 | 10.76 |
| Entrepreneur Index (2) | Beijing: 12.23 | -40.16 | 48.07 | 19.81 |
| Business Climate (3) | Beijing: 1.49 | -31.88 | 20.03 | 14.05 |
| | Shanghai: 0.46 | -30.59 | 27.66 | 14.31 |
| Gross Output of Industry | Beijing: 18.74 | 6.01 | 41.15 | 9.61 |
| | Shanghai: 17.45 | -4.1 | 33.62 | 8.64 |
| Employed Persons | Beijing: 4.57 | 0.13 | 10.69 | 3.26 |
| | Shanghai: 1.46 | -3.69 | 10.45 | 3.73 |

Table 2 (cont'd)

| Q12002-Q42010: Y/Y % VAR | AVERAGE | MIN | MAX | STD. DEV |
|---|---|---|---|---|
| **Local Factors (cont'd)** | | | | |
| Expected Inflation (4) | Beijing: -4.43 | -8.69 | -1.33 | 2.1 |
| | Shanghai: 4.59 | 2.82 | 5.78 | 0.71 |
| | Guangzhou: -6.42 | -8.06 | -5.35 | 0.62 |
| Unexpected Inflation (4) | Beijing: 4.54 | 0.33 | 6.97 | 1.79 |
| | Shanghai:-4.13 | -10.85 | -0.66 | 2.48 |
| | Guangzhou: 6.94 | -1.78 | 12.89 | 3.18 |
| Exports | Guangzhou: 18.27 | -20.37 | 50.29 | 13.79 |
| Imports | Guangzhou: 21.95 | -29.71 | 82.48 | 19.26 |
| Seaport Cargo | Guangzhou: 13.92 | 1.09 | 25.21 | 6.62 |

Source: National Bureau of Statistics

(1) JLL index scores are standardised as follows: 1- (score/5). The % reflects the Y/Y change in the standardised JLL scores.

(2) Beijing: Q42004-Q42010

(3) Beijing: Q42004-Q42010. Shanghai: Q12004-Q42010

(4) based on ARIMA (1,0,3)

**Table 3: Systematic risk vs. idiosyncratic risk in the three cities (CAPM analysis)**

| Q12002-Q42010 | BEIJING | SHANGHAI | GUANGZHOU |
|---|---|---|---|
| ***National office market index 1*** | | | |
| Beta ($\beta_i$) | 0.6034 | 0.6102 | 0.4300 |
| Systematic risk (βiδm) | 2.89% | 2.93% | 2.06% |
| Unsystematic risk (δξi) | 4.12% | 6.10% | 8.16% |
| ***National office market index 2*** | | | |
| Beta ($\beta_i$) | 0.7019 | 0.5726 | 0.5758 |
| Systematic risk (βiδm) | 3.70% | 3.02% | 3.04% |
| Unsystematic risk (δξi) | 3.41% | 6.06% | 7.85% |

Note: National office market index #1 is based on relative GDP weights: Beijing 4, Shanghai 5, Guangzhou 1. National office market index #2 is based on equal (neutral) weights.

## Appendix 1: Optimal Macrovariable Models: Full period and two sub-periods from WTO to Sub-Prime.

Optimal models are based on the following total number of observations: 36 (Q12002-Q42010), 28 (Q12002-Q42007), 12 (Q12008-Q42010). Degrees of freedom of the t-statistics in the optimal models are reported in the table below underneath the period (d.f.). (***), (**) and (*) denote significance at 1%, 5% and 10% levels respectively.

**PANEL A: BEIJING**

| Period | Adj. $R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42010 | 0.893 | Constant | | -1.964 | * | |
| (d.f.= 30) | | Long Term Rate | 0.382 | 5.282 | *** | 1.71 |
| | | Population- Local | 0.628 | 10.97 | *** | 1.072 |
| | | FTSE Xinhua A50 | 0.393 | 5.927 | *** | 1.437 |
| | | M2 | -0.366 | -4.789 | *** | 1.918 |
| | | Gross Output of Industry- Local | -0.279 | -3.947 | *** | 1.639 |
| Q12002-Q42007 | 0.896 | Constant | | -4.658 | *** | |
| (d.f= 24) | | Long Term Rate | 0.842 | 12.268 | *** | 1.043 |
| | | Gross Output of Industry- Local | -0.35 | -4.641 | *** | 1.259 |
| | | M2 | -0.219 | -2.882 | *** | 1.274 |
| Q12008-Q42010 | 0.857 | Constant | | 11.479 | *** | |
| (d.f = 10) | | Expected Inflation- Local | 0.933 | 8.19 | *** | 1 |

**PANEL B: SHANGHAI**

| Period | Adj. $R^2$ | Factors | Beta | T | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42010 | 0.193 | Intercept | | -0.48 | | |
| (d.f.= 33) | | Expected Inflation- Local | 0.306 | 1.596 | | 1.228 |
| | | Employed Persons- Local | 0.289 | 1.51 | | 1.228 |
| Q12002-Q42007 | 0.647 | Intercept | | 5.608 | *** | |
| (d.f.= 24) | | GDP- Local | -1.198 | -5.257 | *** | 2.208 |
| | | PerCapita Disposable Income- Local | 0.382 | 1.872 | * | 1.775 |
| | | Gross Output of Industry- Local | 0.333 | 1.609 | | 1.824 |
| Q12008-Q42010 | 0.947 | Constant | | 2.326 | ** | |
| (d.f.= 9) | | Employed Persons- Local | 0.775 | 10.541 | *** | 1.123 |
| | | Business Climate- Local | 0.393 | 5.346 | *** | 1.123 |

**PANEL C: GUANGZHOU**

| Period | Adj. $R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42010 | 0.948 | Intercept | | -5.094 | *** | |
| (d.f.= 33) | | 3 month T Bill | 0.937 | 12.245 | *** | 1.017 |
| | | FTSE Xinhua A50 | 0.434 | 5.675 | *** | 1.017 |
| Q12002-Q42007 | 0.932 | Intercept | | -12.332 | *** | |
| (d.f.= 23) | | Population- Local | 0.715 | 11.117 | *** | 1.392 |
| | | Private Consumption- China | 0.5 | 8.382 | *** | 1.198 |
| | | Imports- Local | 0.092 | 1.528 | | 1.208 |
| | | Exports- Local | 0.071 | 1.242 | | 1.104 |
| Q12008-Q42010 | 0.948 | Intercept | | -5.094 | *** | |
| (d.f.= 9) | | 3 Month T Bill | 0.937 | 12.245 | *** | 1.017 |
| | | FTSE Xinhua A50 | 0.434 | 5.675 | *** | 1.017 |

## Appendix 2: Optimal Macrovariable Models: 5-Year Rolling Periods (Panels A, B, C)

Optimal models are based on 20 observations. Degrees of freedom of the t-statistics in the optimal models are reported in the table below underneath the period (d.f.). (***), (**) and (*) denote significance at 1%, 5% and 10% levels respectively.

**PANEL A: BEIJING**

| Period | Adj. $R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42006 | 0.920 | Intercept | | -9.098 | *** | |
| (d.f. =17) | | Long Term Rate | 1.063 | 9.246 | *** | 1.328 |
| | | Real Estate- Foreign Investments- Local | -0.229 | -1.988 | * | 1.328 |
| Q12003-Q42007 | 0.935 | Intercept | | -8.081 | *** | |
| (d.f. =17) | | Private Consumption-China | 0.794 | 8.788 | *** | 1.512 |
| | | Entrepreneur Index- Local | 0.265 | 2.936 | ** | 1.512 |
| Q12004-Q42008 | 0.879 | Intercept | | -4.344 | *** | |
| (d.f. =17) | | Private Consumption-China | 0.791 | 6.845 | *** | 1.759 |
| | | Gross Output of industry- Local | -0.214 | -1.85 | ** | 1.759 |
| Q12005-Q42009 | 0.883 | Intercept | | -8.643 | *** | |
| (d.f. =17) | | Private Consumption-China | 0.929 | 11.815 | *** | 1.007 |
| | | Gross Output of industry- Local | -0.275 | -3.506 | ** | 1.007 |
| Q12006-Q42010 | 0.829 | Intercept | | 5.619 | *** | |
| (d.f.= 15) | | Expected Inflation- Local | 0.833 | 6.747 | *** | 1.692 |
| | | FTSE Xinhua A50 | 0.356 | 3.212 | *** | 1.368 |
| | | Employed Persons- Local | -0.351 | -2.78 | ** | 1.767 |
| | | Population- Local | 0.255 | 2.139 | ** | 1.576 |
| *Average $R^2$* | *0.8892* | | | | | |
| *Std Dev $R^2$* | *0.0413* | | | | | |
| *Coefficient Variation $R^2$* | *0.0464* | | | | | |

**PANEL B: SHANGHAI**

| Period | Adj. $R^2$ | Factors | Beta | T | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42006 | 0.838 | Intercept | | 9.636 | *** | |
| (d.f.= 17) | | 3 month T Bill | -0.823 | -6.688 | *** | 1.031 |
| | | Projects under Construction- Local | -0.316 | -2.566 | ** | 1.031 |
| Q12003-Q42007 | 0.647 | Constant | | 5.608 | *** | |
| (d.f.= 16) | | GDP –Local | -1.198 | -5.257 | *** | 2.208 |
| | | PerCapita Disposable Income- local | 0.382 | 1.872 | * | 1.775 |
| | | Gross Output of Industry- Local | 0.333 | 1.609 | * | 1.824 |
| Q12004-Q42008 | 0.33 | Constant | | 4.445 | *** | |
| (d.f.= 17) | | GDP- Local | -0.812 | -3.373 | *** | 1.646 |
| | | Business Climate- Local | 0.519 | 2.156 | ** | 1.646 |
| Q12005-Q42009 | 0.317 | Constant | | -1.726 | * | |
| (d.f.= 18) | | Expected Inflation- Local | 0.594 | 3.131 | *** | 1 |
| Q12006-Q42010 | 0.847 | Constant | | 5.027 | *** | |
| (d.f.= 15) | | Employed Persons- Local | 0.579 | 4.994 | *** | 1.663 |
| | | Unexpected Inflation- Local | 0.560 | 4.408 | *** | 2.004 |
| | | Investments- Local | 0.272 | 2.29 | ** | 1.75 |
| | | FTSE Xinhua A50 | -0.222 | -1.634 | * | 2.295 |
| *Average $R^2$* | *0.5958* | | | | | |
| *Std Dev $R^2$* | *0.2611* | | | | | |
| *Coefficient Variation $R^2$* | *0.4383* | | | | | |

**PANEL C: GUANGZHOU**

| Period | Adj. $R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12002-Q42006 | 0.932 | Intercept | | -8.218 | *** | |
| (d.f.= 16) | | Population- Local | 0.615 | 7.383 | *** | 1.947 |
| | | Private Consumption- China | 0.528 | 7.269 | *** | 1.477 |
| | | 3 Month T Bill | -0.146 | -1.789 | * | 1.853 |
| Q12003-Q42007 | 0.939 | Intercept | | -14.168 | *** | |
| (d.f.= 17) | | Population- Local | 0.707 | 10.828 | *** | 1.337 |
| | | Private Consumption- China | 0.402 | 6.151 | *** | 1.337 |
| Q12004-Q42008 | 0.755 | Intercept | | -6.312 | *** | |
| (d.f.= 17) | | Long Term Rate | 0.582 | 5.029 | *** | 1.036 |
| | | Population- Local | 0.565 | 4.882 | *** | 1.036 |
| Q12005-Q42009 | 0.773 | Intercept | | -3.667 | *** | |
| (d.f.= 16) | | Unexpected Inflation- Local | 0.337 | 2.023 | * | 2.328 |
| | | Population- Local | 0.405 | 3.174 | *** | 1.363 |
| | | Long Term Rate | 0.424 | 2.838 | ** | 1.865 |
| Q12006-Q42010 | 0.802 | Intercept | | -3.526 | *** | |
| (d.f.= 17) | | 3 Month T Bill | 0.584 | 4.298 | *** | 1.586 |
| | | Population- Local | 0.426 | 3.132 | *** | 1.586 |
| *Average $R^2$* | *0.8402* | | | | | |
| *Std Dev $R^2$* | *0.0886* | | | | | |
| *Coefficient Variation $R^2$* | *0.1055* | | | | | |

**Table 4: First and Second Factors in Optimal Macrovariable Models**

Panel A- First Factor and Coefficient of Determination (Adjusted $R^2$)

| | BEIJING | | SHANGHAI | | GUANGZHOU | |
|---|---|---|---|---|---|---|
| **Period** | **First Factor** | **Adj. $R^2$** | **First Factor** | **Adj. $R^2$** | **First Factor** | **Adj. $R^2$** |
| ***WTO-Subprime*** | | | | | | |
| Q12002-Q42010 | Long Term Rate | 0.453 | Expected Inflation- Local ** | 0.154 | 3 month T Bill | 0.746 |
| Q12002-Q42007 | Long Term Rate | 0.800 | GDP-Local | 0.506 | Population- Local | 0.718 |
| Q12008-Q42010 | Expected Inflation- Local | 0.857 | Employed Persons- Local | 0.801 | 3 month T Bill | 0.746 |
| ***5 Year Rolling*** | | | | | | |
| Q12002-Q42006 | Long Term Rate | 0.887 | 3 Month T Bill | 0.748 | Population- Local | 0.724 |
| Q12003-Q42007 | Private Consumption-China | 0.890 | GDP- Local | 0.506 | Population- Local | 0.816 |
| Q12004-Q42008 | Private Consumption-China | 0.859 | GDP- Local | 0.195 | Long Term Rate | 0.444 |
| Q12005-Q42009 | Private Consumption-China | 0.810 | Expected Inflation- Local | 0.317 | Unexpected Inflation- Local * | 0.617 |
| Q12006-Q42010 | Expected Inflation- Local | 0.595 | Employed Persons- Local | 0.669 | 3 Month T Bill | 0.693 |

***Note: All first factors reported above are significant at 1% level except those denoted ** (significant at 5% level) and * (significant at 10% and above).***

Panel B-Second Factor and Variation in Coefficient of Determination (Variation in Adjusted $R^2$)

| | BEIJING | | SHANGHAI | | GUANGZHOU | |
|---|---|---|---|---|---|---|
| **Period** | **Second Factor** | **Var Adj. $R^2$** | **Second Factor** | **Var Adj. $R^2$** | **Second Factor** | **Var Adj. $R^2$** |
| ***WTO-Subprime*** | | | | | | |
| Q12002-Q42010 | Population- Local | 0.295 | Employed Persons- Local * | 0.039 | FTSE Xinhua A50 | 0.202 |
| Q12002-Q42007 | Gross Output of Industry- Local | 0.060 | Per Capita Disposable Income- Local * | 0.098 | Private Consumption- China | 0.206 |
| Q12008-Q42010 | n/a | n/a | Business Climate- Local | 0.146 | FTSE Xinhua A50 | 0.202 |
| ***5 Year Rolling*** | | | | | | |
| Q12002-Q42006 | Real Estate-Foreign Investment- Local * | 0.033 | Projects under Construction- Local ** | 0.090 | Private Consumption- China | 0.199 |
| Q12003-Q42007 | Entrepreneur Index- Local ** | 0.045 | Per Capita Disposable Income- Local * | 0.098 | Private Consumption- China | 0.123 |
| Q12004-Q42008 | Gross Output of Industry- Local ** | 0.020 | Business Climate- Local ** | 0.135 | Population- Local | 0.311 |
| Q12005-Q42009 | Gross Output of Industry- Local ** | 0.073 | n/a | n/a | Population- Local | 0.062 |
| Q12006-Q42010 | FTSE Xinhua A50 Index | 0.150 | Unexpected Inflation- Local | 0.148 | Population- Local | 0.109 |

***Note: All second factors reported above are significant at 1% level except those denoted ** (5% level) and * (10% level and above).***

## Appendix 3: Selection of Cross-Hedging Instruments for Chinese Direct Real Estate

| Name | Market: Ticker | Description |
|---|---|---|
| **US Traded China ETFs** | | |
| Guggenheim China Real Estate ETF | NYSE:TAO | Tracks the Alphashares China Real Estate Index |
| iShare FTSE NAREIT Asia Index Fund | NASDAQ:IFAS | Tracks the FTSE EPRA/NAREIT Asia Index |
| RMR Asia Pacific Real Estate Fund | AMEX:RIF | Invests in Asia Pacific real estate companies |
| iShare FTSE China A25 | NYSE:FXI | Tracks FTSE China 25 index (large Chinese corp.) |
| SPDR S&P China | NYSE:GXC | Tracks S&P China BMI Index |
| **US Traded Chinese Real Estate Companies** | | |
| E-House (China) Holdings | NYSE:EJ | Real estate information and services provider |
| China Housing & Land | NASDAQ:CHLN | Residential development ($2^{nd}$ tier cities) |
| Xinyuan Real Estate Co Ltd | NYSE:XIN | Residential development ($2^{nd}$ tier cities) |
| China HGS Real Estate | NASDAQ: HGSH | Residential & office development |
| **Country ETFs** | | |
| iShare Australia Index Fund | NYSE:EWA | Tracks MSCI Australia Index |
| iShare Brazil Index Fund | NYSE:EWZ | Tracks MSCI Brazil Index |
| **Commodity Companies** | | |
| Rio Tinto plc ADR | NYSE:RIO | UK-Australia: Metals and mining |
| Vale S.A | NYSE:VALE | Brazil- Metals: iron ore (1)/ nickel (2) globally |
| Peabody Energy | NYSE:BTU | US: World's largest coal producer |
| Freeport-Mcmoran | NYSE: FCX | US: World's largest copper producer |
| **Honk Kong Listed REITs** | | |
| YueXiu REIT (aka GZI REIT) | HKEX:405 | Five commercial properties in Guangzhou |
| Prosperity REIT | HKEX:808 | Seven commercial properties in Hong Kong |
| **Hong Kong Traded Red Chips** | | |
| China Overseas Land & Investment | HKEX:688 | Residential Development in $1^{st}$ tier cities |
| Sino-Ocean Land Holdings | HKEX:3377 | Residential and commercial development |
| China Chengtong Development Group | HKEX:217 | Industrial and logistic properties- coal trading |
| Poly HK Investment | HKEX:119 | Dvlpt & invst res & com properties ($1^{st}$ tier) |
| YueXiu Property | HKEX:123 | Development in Guangzhou |
| R&F Properties | HKEX:2777 | Development in Guangzhou |
| Shanghai Industrial Holdings | HKEX:363 | Dvlpt & invst commercial prop. (Shanghai) |
| Soho China | HKEX:410 | Dvlpt & invst in Beijing's CBD |
| **Singapore Property Companies & REITs** | | |
| Capitaland | SGX:C31 | Integrated real estate company (global) |
| Ascendas REIT | SGX:A17U | Business space & industrial (Singapore) |

## Table 5: Cross-Hedging Instruments: Descriptive Statistics

| | Period | Descriptive Statistics % Average | % Std. Dev. | Coefficient of Correlation Beijing | Shanghai | Guangzhou |
|---|---|---|---|---|---|---|
| **US Traded China ETFs** | | | | | | |
| Guggenheim China Real Estate ETF | Q42008-Q42010 | 9.48% | 45.44% | -0.124 | 0.470 | 0.458 |
| iShare FTSE NAREIT Asia ETF | Q42008-Q42010 | -3.75% | 37.23% | 0.176 | **0.735**** | 0.651 |
| iShare FTSE Xinhua China 25 Index | Q42007-Q42010 | 13.75% | 42.67% | 0.373 | 0.174 | 0.439 |
| SPDR SP China | Q12008-Q42010 | 2.29% | 36.80% | -0.010 | 0.259 | 0.302 |
| RMR Asia Pacific Real Estate Fund | Q32007-Q42010 | -15.68% | 37.90% | 0.111 | -0.043 | 0.068 |
| **US Traded Chinese Real Estate Sector (Corporate)** | | | | | | |
| E-house (China) Holdings | Q32008-Q42010 | 28.00% | 94.57% | -0.422 | -0.008 | -0.009 |
| China Housing & Land | Q22007-Q42010 | 28.32% | 97.87% | -0.185 | 0.143 | 0.138 |
| Xinyuan Real Estate | Q42008-Q42010 | -18.33% | 54.33% | -0.498 | 0.027 | 0.108 |
| China HGS Real Estate | Q22007-Q42010 | 2079.86% | 5521.18% | -0.150 | 0.195 | -0.076 |
| **Country ETFs (Commodity Cross-Hedge)** | | | | | | |
| iShare MSCI Brazil ETF | Q12002-Q42010 | 29.35% | 49.71% | -0.072 | **0.495***** | 0.182 |
| iShare MSCI Australia Index Fund | Q12002-Q42010 | 12.93% | 28.44% | -0.089 | 0.197 | 0.005 |
| **Commodity Companies (Chanos Hedge)** | | | | | | |
| Rio Tinto | Q12002-Q42010 | 22.22% | 43.93% | 0.182 | 0.519 | **0.372**** |
| Vale | Q12003-Q42010 | 49.89% | 59.37% | 0.069 | 0.374 | 0.218 |
| Peabody Energy | Q22002-Q42010 | 35.77% | 56.31% | -0.259 | 0.614 | 0.319 |
| Freeport-Mcmoran | Q12002-Q42010 | 35.83% | 61.28% | -0.102 | 0.199 | -0.144 |
| **Hong Kong Traded REITs** | | | | | | |
| YueXiu REIT | Q42006-Q42010 | 3.21% | 32.53% | -0.004 | 0.208 | 0.158 |
| Prosperity REIT | Q42006-Q42010 | -5.09% | 31.79% | 0.028 | 0.347 | 0.234 |
| **Hong Kong Traded Red Chips** | | | | | | |
| China Overseas Land & Investment | Q12002-Q42010 | 51.28% | 77.18% | 0.108 | -0.021 | 0.231 |
| Sino-Ocean Land Holdings | Q32008-Q42010 | 16.36% | 90.55% | -0.586 | -0.350 | -0.231 |
| China Chengtong Development Group | Q12002-Q42010 | 53.24% | 152.41% | **0.412**** | -0.124 | 0.197 |
| Poly HK Investment | Q12002-Q42010 | 75.05% | 156.09% | 0.141 | 0.127 | 0.194 |
| YueXi Property | Q12002-Q42010 | 28.07% | 65.42% | 0.032 | -0.011 | 0.059 |
| Shanghai Industrial Holdings | Q12002-Q42010 | 17.90% | 47.91% | 0.121 | 0.048 | 0.192 |
| Soho China | Q42008-Q42010 | 10.46% | 39.78% | 0.096 | 0.373 | 0.457 |
| R&F | | | | | | |
| **Singapore Traded Companies** | | | | | | |
| Capitaland | Q42002-Q42010 | 29.19% | 50.33% | -0.040 | 0.110 | 0.262 |
| Ascendas REIT | Q42003-Q42010 | 18.49% | 35.76% | -0.221 | 0.063 | -0.021 |

*All data based on Y/Y % quarterly returns in Chinese Renminbi over the full reported period*

*Legend (correlation): ***: significant at 1% level /* *: significant at 5% level.*
source: Bloomberg, Datastream

## Table 6: Best Single Hedges for Beijing's, Shanghai's and Guangzhou's Office Markets

Optimal models are based on the following total number of observations for each sub-period: 32 (Q12003-Q42010), 16 (Q12007-Q42010), 8 (Q12009-Q42010).

| | **BEIJING** | | **SHANGHAI** | | **GUANGZHOU** | |
|---|---|---|---|---|---|---|
| **Period** | ***Best Hedge*** | ***Adj. $R^2$*** | ***Best Hedge*** | ***Adj. $R^2$*** | ***Best Hedge*** | ***Adj. $R^2$*** |
| **Q12003-Q42010** | China Chengtong | 0.136 | Peabody Energy | 0.333 | Rio Tinto | 0.092 |
| **Q12007-Q42010** | Rio Tinto | 0.122 | Peabody Energy | 0.489 | Rio Tinto | 0.432 |
| **Q12009-Q42010** | Sino-Ocean | 0.363 | Prosperity REIT | 0.769 | Prosperity REIT | 0.551 |

## Table 7: Best Combined Hedges for Beijing's, Shanghai's and Guangzhou's Office Markets

Optimal models are based on the following total number of observations for each sub-period: 32 (Q12003-Q42010), 16 (Q12007-Q42010), 8 (Q12009-Q42010). (***), (**) and (*) denote significance at 1%, 5% and 10% levels respectively. Degrees of freedom of the t-statistics in the optimal models are reported in the table below underneath the period (d.f.)

**PANEL A: BEIJING**

| Period | Adj.$R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.313 | Intercept | | 1.872 | * | |
| (d.f.= 28) | | China Chengtong Development Group | 0.525 | 3.3 | *** | 1.14 |
| | | iShare MSCI Australia ETF | -0.708 | -3.072 | *** | 2.395 |
| | | Rio Tinto | 0.571 | 2.579 | ** | 2.215 |
| Q12007-Q42010 | 0.122 | Intercept | | 4.371 | *** | |
| (d.f.= 14) | | Rio Tinto | 0.425 | 1.757 | * | 1 |
| Q12009-Q42010 | 0.886 | Intercept | | 4.476 | *** | |
| (d.f.= 5) | | Sino-Ocean Land Holding | -1.169 | -7.4 | *** | 1.527 |
| | | China Overseas Land & Investment | 0.842 | 5.331 | *** | 1.527 |
| *Average $R^2$* | *0.440* | | | | | |
| *Std Dev $R^2$* | *0.398* | | | | | |
| *Coefficient Variation $R^2$* | *0.903* | | | | | |

**PANEL B: SHANGHAI**

| Period | Adj.$R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.527 | Intercept | | 7.886 | *** | |
| (d.f.= 28) | | Peabody Energy | 0.599 | 3.219 | *** | 2.053 |
| | | Capitaland | -0.481 | -2.978 | *** | 1.545 |
| | | Rio Tinto | 0.372 | 1.982 | ** | 2.081 |
| Q12007-Q42010 | 0.752 | Intercept | | 10.736 | *** | |
| (d.f.= 13) | | Peabody Energy | 1.028 | 6.864 | *** | 1.356 |
| | | YueXi Property | -0.596 | -3.977 | *** | 1.356 |
| Q12009-Q42010 | 0.769 | Intercept | | 5.332 | | |
| (d.f.= 6) | | Prosperity REIT | 0.896 | 4.93 | *** | 1 |
| *Average $R^2$* | *0.683* | | | | | |
| *Std Dev $R^2$* | *0.135* | | | | | |
| *Coefficient Variation $R^2$* | *0.198* | | | | | |

**PANEL C: GUANGZHOU**

| Period | Adj.$R^2$ | Factors | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.694 | Intercept | | 3.776 | *** | |
| (d.f.= 29) | | Rio Tinto | 1.272 | 6.645 | *** | 2.707 |
| | | FreePort McMoran | -1.161 | -6.066 | *** | 2.707 |
| Q12007-Q42010 | 0.432 | Intercept | | 5.519 | *** | |
| (d.f.= 14) | | Rio Tinto | 0.688 | 3.414 | *** | 1 |
| Q12009-Q42010 | 0.551 | Intercept | | 3.019 | | |
| (d.f.= 6) | | Prosperity REIT | 0.791 | 2.893 | ** | 1 |
| *Average $R^2$* | *0.559* | | | | | |
| *Std Dev $R^2$* | *0.131* | | | | | |
| *Coefficient Variation $R^2$* | *0.235* | | | | | |

## Table 8: Best Hybrid Hedges for Beijing's, Shanghai's and Guangzhou's Office Markets

Optimal models are based on the following total number of observations for each sub-period: 32 (Q12003-Q42010), 16(Q12007-Q42010), 8 (Q12009-Q42010). (***), (**) and (*) denote significance at 1%, 5% and 10% levels respectively. Degrees of freedom of the t-statistics in the optimal models are reported in the table below underneath the period (d.f.). In bold: cross-hedging instrument.

**PANEL A: BEIJING**

| Period | Adj. $R^2$ | Variables | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.867 | Intercept | | -9.71 | | |
| (d.f.= 27) | | Long Term Rate | 0.605 | 8.623 | *** | 1.15 |
| | | Population- Local | 0.635 | 9.497 | *** | 1.046 |
| | | ***China Chengtong Development Group*** | 0.248 | 3.184 | *** | 1.423 |
| | | Projects under Construction- Local | 0.153 | 2.001 | * | 1.369 |
| Q12007-Q42010 | 0.981 | Intercept | | -11.547 | | |
| (d.f.= 11) | | Gross Output of Industry- Local | 0.858 | 21.931 | *** | 1.19 |
| | | PerCapita Disposable Income- Local | 0.304 | 8.211 | *** | 1.063 |
| | | ***Rio Tinto*** | 0.176 | 4.454 | *** | 1.221 |
| | | Real Estate- Foreign Investments- Local | 0.062 | 1.69 | * | 1.03 |
| Q12009-Q42010 | 0.997 | Intercept | | -5.506 | *** | |
| (d.f.= 4) | | Population- Local | 0.909 | 34.145 | *** | 1.902 |
| | | ***Rio Tinto*** | 0.135 | 6.791 | *** | 1.067 |
| | | PerCapita Disposable Income- Local | 0.085 | 3.235 | ** | 1.839 |
| *Average $R^2$* | *0.948* | | | | | |
| *Std Dev $R^2$* | *0.071* | | | | | |
| *Coefficient Variation ($R^2$)* | *0.075* | | | | | |

**PANEL B: SHANGHAI**

| Period | Adj. $R^2$ | Variables | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.672 | Intercept | | -0.679 | | |
| (d.f.= 27) | | ***Peabody Energy*** | 0.763 | 7.072 | *** | 1.1 |
| | | Employed Persons- Local | 0.519 | 3.651 | *** | 1.91 |
| | | Real Estate- Foreign Investment- Local | 0.191 | 1.681 | * | 1.226 |
| | | Long Term Rate | 0.167 | 1.255 | | 1.684 |
| Q12007-Q42010 | 0.902 | Intercept | | 1.004 | | |
| (d.f.= 12) | | Unexpected Inflation- Local | 0.913 | 6.595 | *** | 1.751 |
| | | Private Consumption- China | 0.491 | 3.716 | *** | 1.597 |
| | | ***YueXiu REIT*** | 0.227 | 1.394 | | 2.419 |
| Q12009-Q42010 | 0.978 | Intercept | | 17.841 | *** | |
| (d.f.= 5) | | Unexpected Inflation- Local | 1.283 | 15.028 | *** | 2.334 |
| | | Population- Local | -0.44 | -5.178 | *** | 2.334 |
| *Average $R^2$* | *0.851* | | | | | |
| *Std Dev $R^2$* | *0.159* | | | | | |
| *Coefficient Variation ( $R^2$)* | *0.187* | | | | | |

**PANEL C: GUANGZHOU**

| Period | Adj. $R^2$ | Variables | Beta | t | Sig | VIF |
|---|---|---|---|---|---|---|
| Q12003-Q42010 | 0.883 | Intercept | | -10.198 | *** | |
| (d.f.= 27) | | Population- Local | 0.888 | 13.609 | *** | 1.052 |
| | | 3 Month T Bill | 0.33 | 5.029 | *** | 1.063 |
| | | ***Yuexi Property*** | 0.204 | 3.06 | *** | 1.096 |
| | | JLL Transparency | 0.148 | 2.297 | ** | 1.021 |
| Q12007-Q42010 | 0.922 | Intercept | | -2.951 | ** | |
| (d.f. = 13) | | 3 month T Bill | 0.747 | 8.803 | *** | 1.204 |
| | | ***Rio Tinto*** | 0.378 | 4.455 | *** | 1.204 |
| Q12009-Q42010 | 0.966 | Intercept | | -5.757 | *** | |
| (d.f.= 5) | | Cargo Seaports- Local | 0.907 | 10.692 | *** | 1.05 |
| | | GDP- China | 0.244 | 2.88 | * | 1.05 |
| *Average $R^2$* | *0.924* | | | | | |
| *Std Dev $R^2$* | *0.042* | | | | | |
| *Coefficient Variation ($R^2$)* | *0.045* | | | | | |

## Table 9: Comparative Hedging Effectiveness of the Three Types of Cross-Hedges

| Adj. $R^2$ | PANEL A: BEIJING | | | PANEL B: SHANGHAI | | | PANEL C: GUANGZHOU | | |
|---|---|---|---|---|---|---|---|---|---|
| **Period** | **Single** | **Combined** | **Hybrid** | **Single** | **Combined** | **Hybrid** | **Single** | **Combined** | **Hybrid** |
| **Q12003-Q42010** | 0.136 | 0.313 (3) | 0.867 (4) | 0.333 | 0.527 (3) | 0.672 (4) | 0.092 | 0.694 (2) | 0.883 (4) |
| **Q12007-Q42010** | 0.122 | 0.122 (1) | 0.981 (4) | 0.489 | 0.752 (2) | 0.902 (3) | 0.432 | 0.432 (1) | 0.922 (2) |
| **Q12009-Q42010** | 0.363 | 0.886 (2) | 0.997 (3) | 0.769 | 0.769 (1) | 0.978 (2) | 0.551 | 0.551 (1) | 0.966 (2) |
| ***Average 3 periods*** | ***0.207*** | ***0.440 (2)*** | ***0.948 (3.7)*** | ***0.530*** | ***0.683 (2)*** | ***0.851 (3)*** | ***0.358*** | ***0.559 (1.3)*** | ***0.924 (2.7)*** |

*Note: Reported hedging effectiveness are based on best underlying (single) and optimal stepwise models (combined and hybrid). Numbers in parenthesis represent the number of variables in the optimal models.*

## Table 10: Capital Return Swap: Hedged Returns for the Three Office Markets

| % p.a | Fixed | IPD China | Short Office | UNHEDGED RETURNS | | | HEDGED RETURNS | | |
|---|---|---|---|---|---|---|---|---|---|
| **YEAR** | **Rate** | **Office CR** | **CRS- Net Return** | **Beijing** | **Shanghai** | **Guangzhou** | **Beijing** | **Shanghai** | **Guangzhou** |
| **2007** | 7.55 | 4.1 | 3.45 | 9.22 | 20.22 | 17.78 | 12.67 | 23.67 | 21.23 |
| **2008** | 4.9 | 1.9 | 3 | 3.95 | 2.97 | -0.04 | 6.95 | 5.97 | 2.96 |
| **2009** | 4.91 | -1.2 | 6.11 | 2.62 | 9.54 | 6.99 | 8.73 | 15.65 | 13.1 |
| **2010** | 7.94 | 14.8 | -6.86 | 12.71 | 8.38 | 10.12 | 5.85 | 1.52 | 3.26 |
| ***Average*** | ***n/a*** | ***4.90*** | ***1.43*** | ***7.13*** | ***10.28*** | ***8.71*** | ***8.55*** | ***11.70*** | ***10.14*** |
| ***Volatility*** | ***n/a*** | ***6.95*** | ***5.69*** | ***4.69*** | ***7.22*** | ***7.39*** | ***2.99*** | ***9.92*** | ***8.77*** |
| ***Corr (IPD index)*** | ***n/a*** | ***1.00*** | ***-0.99*** | ***0.93*** | ***0.00*** | ***0.28*** | ***-0.42*** | ***-0.57*** | ***-0.40*** |

*Note: Hedged returns are based on a naïve hedging strategy.*