The London Commercial Property Price Index

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Abstract

Of the top ten global commercial property markets, London's has had the highest transaction turnover levels in the world. Its prime real estate is part of every major European and US institutional investor's portfolio and London's market has the most developed commercial property derivatives market outside of the US. Yet, no transaction-based index exists for the London office market. The aim of this study is to fill that gap. Using a comprehensive dataset of transactions from Estates Gazette interactive and Real Capital Analytics, this paper analyzes different repeat-sales estimation strategies and noise filters to produce a quarterly index series from the first quarter of 1997 to the fourth quarter of 2011. In addition, the index series is measured against IPD's London capital valuation series and the Moody's/RCA New York office market repeat sales index series. Results show that the market turn of the first financial crisis is clearly visible in the transactions-based indices, and that this index leads the capital valuation series by about a year. London's office market seems to have been affected by the crisis considerably earlier than New York's market and correlations between the two markets are low.

1. Introduction

The financial and credit crisis of 2008/09 has illustrated once again that the value of real estate assets can have a direct impact on national wealth and investments. Its ubiquitous role as collateral makes it pivotal for the health of the banking sector, and central banks all over the world are looking at real estate prices as a pillar for their policy-making on macro-prudential stability and bank solvency.

This illustrates the importance of reliable yardsticks of property value and underscores that transaction-based indices are very practical and useful tools, and not just for central bankers. They can be used for visualizing price changes and for depicting the capital valuation that real investors in the property markets face (Fisher, Geltner, and Webb, 1994; Geltner and Bokhari, 2008). For institutional investors, transaction-based metrics are important for risk management and for valuing commercial mortgage backed securities (Fabozzi, Shiller, and Tunaru, 2010). For private investors, these metrics are important as they represent an independent benchmark of financial performance. For banks, they can be an invaluable barometer of

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the market performance of collateral and signals of distress in their own loan portfolios. In aggregate, transaction-based indices provide, at a minimum, an invaluable resource of timely macro-level periodic returns.

Unfortunately, transaction-based property indices, which would be vital up-to-date yardsticks to measure the health of property markets, are only available in a very limited number of countries and when they are available, they usually incorporate house prices rather than the transactions of commercial real estate. Even for a market as important as London, a transaction-based index does not exist. The London commercial property sector is among the most significant property markets *globally* in terms of aggregate value, attractiveness to cross-border capital flows, and significance for the global financial industry.

London's commercial property sector is no stranger to price indices. However, they are mainly appraisal-based due to two features of the UK real estate industry. First, robust aggregate transaction data was absent until the early 2000s. The search costs within London's commercial property sector are significant, even from the national public record, and markets can be closed to those that are not deal stakeholders. Second, the 'appraisal' is the foundation of real estate valuation and decision making. It is a trusted part of the transaction process, can be frequently updated and is an alternative when transaction or data environments are dry. In the former case, data is becoming less of an impediment as independent agencies are increasingly collecting transaction information from the market and public records, but at a price. For the latter, appraisals are an instrumental tool for valuation and transactions themselves, but may not be the best tools for detecting aggregate volatility and market dynamics in a timely manner.

Given that new data providers have come on the market and competition for capturing market information has increased since 1990, sufficient transaction-based data is now available to create a transaction-based index for London commercial property. Fisher, Geltner, and Webb (1994) examine alternative price indices in the US commercial property markets. After an empirical look at un-smoothed appraisal based indices, ex-post transaction based indices and un-levered REIT share indices, they conclude that each index method can provide different insights and uses for investors and academics alike. More recent developments in the US transaction-based indices suggest that transaction-based indices can be complementary to appraisal-based indices and can indeed offer more timely information to investors on market turning points (Geltner and Fisher, 2007). Finally, two transaction-based indices, based on repeat-sales and hedonic techniques, are in existence for commercial real estate in the US (see MITs Center for Commercial Real Estate). We aim to utilize the strengthening data collection process within the UK commercial property sector coupled with recent advances in the real estate literature on commercial property index analysis to gain insight into London's commercial property sector with a transaction-based index.

However, a periodic index at the metro level poses a significant challenge for index construction. Primarily, is there consistent market liquidity to support an index? Without consistent liquidity, the random error will signal spuriously higher volatility to markets, which outweighs any benefits from a transaction-

based index itself. Thus, we will assess a metro level transaction-based index for London. Then, we will investigate whether a transaction-based index outperforms an appraisal-based index on the basis of delivering more timely information. Finally, in line with the most recent literature in residential real estate we will assess the relationship between the commercial real estate markets in two of the most prominent financial centers, New York and London (Holly, Pesaran, and Yamagata, 2011). Given the two cities auspicious growth in the financial services and real estate sector over the last decades, it is pertinent to assess the timing of trends between the two city's commercial real estate markets.

For our analysis, we combine two proprietary databases of commercial real estate transactions provided by data providers in the London market: Estates Gazette Interactive (EGi) and Real Capital Analytics (RCA). Combined, their London commercial property databases have transactions stretching from 1976 to date. Coverage of transactions and building specific characteristics enhanced over the last decade, and is sufficient for creating an index from the late 1990s. The data has strong coverage in London City, Midtown and the West End.

We find that there is sufficient liquidity for a repeat sales transaction-based index at the metro level even if we have to discard speculative transactions and portfolio sales. In addition, we find that the transaction-based index is more timely than the appraisal-based index in showing the market turnaround of the first financial crisis, and also reflects the fundamental underlying volatility that the market has experienced since then. Interestingly, London's office market seems to have suffered the adverse consequences of the financial crisis quite a lot earlier than New York's market, where the London transaction-based index starts falling from 2007 and that of New York continues to rise until 2008. The operationalization of a repeat sales transaction-based index in European markets is mainly a data issue and nothing further.

The remainder of the paper is as follows. In Section 2, we present a review of the literature on commercial property index construction methods, including repeat-sales and hedonic techniques. In Section 3, we present our estimation strategy for our transaction-based index, strategies for noise reduction and high frequency conversion. In Section 4, we introduce our data. In Section 5, we report results for the repeat-sales estimation and contextualize our results with a comparison with other yardsticks of commercial property performance. In Section 7, we provide a discussion of the relationship between the London and New York property markets on the basis of our new index, and in Section 8 we conclude.

2. Commercial Indices

The development of transaction based indices has been limited mainly by a lack of data on commercial property transactions (Miles, Hartzell, Guilkey, and Shears, 1991), an ubiquitous problem in commercial real estate. Data on transactions in the UK and the rest of Europe tend to be proprietary and information is mainly owned by property managers, brokers and professional service firms such as Jones Lang

LaSalle (JLL), CB Richard Ellis (CBRE), and by independent data providers such as the Investment Property Databank (IPD). Yet, the main return series reported by these groups are appraisal-based, with the first transaction based indices currently under development at IPD using the *appraisal based transaction index method*, where the transaction price is regressed on the appraisal valuation in the most recent period (Devaney and Diaz, 2011).

From an index construction standpoint, the extant literature on indices has shown that appraisal-based capital valuation indices may have some drawbacks. First, a valuation is a property's price, given that the real estate markets are in equilibrium. This assumption does not always hold. Secondly, individual appraisals can introduce measurement error into an index through potentially subjective evaluations on behalf of appraisers. Thirdly, when the appraisal is used for an index, index smoothing can arise from the valuation updating process, i.e., updated appraisals are based on a mixture of previous appraisals, "new" comparable property information and current market conditions. Lee, Lizieri, and Ward (2000) found that the IPD and Jones Lang LaSalle annual and categorical appraisal based indices display consistent and statistically significant autocorrelation for lags up to 13 months. For an index this indicates that the relationship in values from one period to the next contains marginally new information, which can have the drawback of drowning out market volatility. Lastly, Chau, Wong, Yiu, and Leung (2005) find that the frequency of appraisal updates can further compound the index smoothing problem, i.e., updates every three months or daily are not likely to possess "new" information, which causes temporal aggregation effects at the index level.

However, information markets are changing. Since the early 1990s, there has been an increased effort by the markets to track and capture pertinent real estate information at the transaction level. Concurrently, transaction based indices have started being developed in the real estate literature, based on various techniques aimed at coping with scarce and illiquid data environments. An assessment of the extant literature shows two main construction methods for transaction-based indices: repeat-sales and hedonic. These methods have been applied in both the residential and the commercial sector, but we will restrict our review to the commercial property literature as much as possible.

The repeat sales method is the search for multiple transacted observations for the same object. Bailey, Muth, and Nourse (1963) and Case and Shiller (1987) were the first to employ the repeat sales methodology in residential real estate. These models are mainly applied in housing indices, such as The US Office of Federal Housing Enterprise and Oversight. Gatzlaff and Geltner (1998) constructed a repeat sales analysis of Florida commercial properties from 1975 to 1997. They found that the repeat sales index registers more price movements than the NCREIF appraisal based index. Chau, Wong, Yiu, and Leung (2005) constructed a repeat sales analysis for Hong Kong over the 1992 to 2001 period. The index takes advantage of the substantial data available for repeat sales analysis in Hong Kong due to transaction transparency in the city. More recently, in an effort to create a commercial property index for tradable property derivatives

in the US, Geltner and Pollakowski (2007) and Geltner and Bokhari (2008) created a national index for the US and 15 sub-regions, estimated from 2001 to the present. Wheaton, Baranski, and Templeton (2009) constructed a repeat sales index of 86 properties in Manhattan over a 100 year period. This study found that for any given decade properties appreciated by as much as 20 to 50 percent, but then faced the same decline. Ultimately, in real terms, real estate in the late 2000s is worth what it was at the turn of the 19th century.

The hedonic model, originally employed by Rosen (1974), was created for the purpose of creating a constant-quality price index for products. The method relates the price of a product to the product's individual components. As it applies to real estate, the price of a transacted building relates to the individual building characteristics, the building's neighborhood characteristics and time. In its first application to commercial real estate, Fisher, Geltner, and Webb (1994) compare commercial property index construction methods through three methods: unsmoothing the US Russell-NCREIF Index, generating an ex-post transaction-based cap rates hedonic index and an index based on unlevered REIT shares. Results indicated that the ex-post transaction-based indices lag behind the other series in time, and are consistent with the idea that institutional investors attempt to hold onto properties until they can sell them for a price at least equal to the current appraised value, in effect trading off liquidity for reduced volatility. Colwell, Munneke, and Trefzger (1998) apply a hedonic model to Chicago office property utilizing 427 observations over the 1986 to 1993 period. The index includes building characteristics, e.g., age, lot area, size and height, and many aspects of neighborhood characteristics, e.g. distances to airport, rail and road facilities, parks and golf course access, as explanatory variables. The results depict a contrary result to general market belief that there was a nominal expansion in Chicago office transaction prices over the course of the 1980s. In an additional study on commercial property markets, Fisher, Geltner, and Pollakowski (2007) constructed a quarterly transactions based index of property level investment performance for US institutional real estate, which indicates that investment periodic returns and capital appreciation or price changes for the major property types included in the NCK Property Index.

Each model has been shown to display relative strengths and weaknesses. For a metro level transaction-based index, the primary strength of the repeat sales index is the reflection of capital gains or depreciation in the market. Essentially, this type of index is a reflection of the market conditions in any given period (Geltner and Pollakowski, 2007). Given that a key metric of financial performance today is marking currently held assets to market, this type of index can go a long way in measuring macro-level capital gains and losses. However, the repeat sales index method has several drawbacks. First, repeat sales only capture the set of properties that are transacting in multiple since the beginning of index construction. Thus, for repeat sales there is a significant amount of time required for indexes to mature in data scarce environments. Second, there is an inefficient use of data. Chau, Wong, Yiu, and Leung (2005) compared 11 studies using the repeat sales method and found that at most 32 percent of total transactions available in the pop-

ulation were used. Third, there are periods of higher turnover that can influence the index. Dorsey, Hu, Mayer, and Wang (2010) find that 20 percent of transactions in Los Angeles County between 2003 and 2006 were repeat sales and in this case the sample was catching mostly 'flips'. Lastly, indices based on repeat sales can have long lags between transactions, which may reflect new capital expenditures or changes in building techniques. If this is expansive, it may introduce a bias into the index regardless of any weighting correction (Quigley, 1995).

As an alternative, hedonic methods offer a different pricing mechanism that can enhance a metro-level transaction-based index. The primary strength of the hedonic technique when markets may be subject to illiquidity is that it utilizes the full cross section of data, thus combating noise in the index. However, just like in other techniques, the hedonic method has some drawbacks. To capture the economically significant components for explaining price, data must be flush, robust and extensive in measuring the heterogeneity between and within a building. Moreover, within the context of a dynamic built environment, where commercial real estate is shifting in terms of building quality, sustainability and usage (Chegut, Eichholtz, and Kok, 2012), the market price of different building quality attributes may change, while most studies based on hedonic regression allow the regression coefficients to remain constant, implicitly assuming constant prices for all building characteristics.

In summary, each method has its advantages and drawbacks for a metro-level transaction-based index. Clearly from a data perspective, repeat sales methodologies are highly contingent upon the existence of multiple transaction events, quantity and flushness of basic data, including some building characteristics, and the number of transactions across all time cohorts. Within the context of London, where transaction volume is at its highest within Europe, an estimation may be possible. Hedonic models, on the other hand, have the benefits of incorporating more data, but require a complete cross section of building quality data, which is not readily available in London. We therefore continue this paper using the repeat sales approach.

3. Estimation Strategy

From our review of the academic literature on commercial property indices we can start by applying a repeat sales estimation strategy. The method does not use multi-variate controls for hedonic, location or neighborhood characteristics in a transaction event. Instead, a repeat sale measure specifies the periodic returns. The periodic return captures the capital gain or loss between two transaction events, given the criteria that the hedonic, location or neighborhood characteristics remain constant from one transaction to the next. Otherwise, the model is misspecified and can result in upward bias (Case, Pollakowski, and Wachter, 1991).

Following Geltner and Bokhari (2008), we employ an ex-post transaction based repeat sales model to estimate our periodic returns. The original repeat sales model by Bailey, Muth, and Nourse (1963) forms

the basis of the analysis. The empirical model is specified as follows:

$$\log\left(\frac{P_{i,(t+\tau)}}{P_{i,t}}\right) = \sum_{t=1}^{T} d_{i,t}\beta_t + \epsilon_i \tag{1}$$

where $P_{i,(t+\tau)}$ and $P_{i,t}$, are transaction prices for the same object observed at $t+\tau$ and t, respectively. The parameter estimates (β_t) give the average periodic return. $d_{i,t}$ is a dummy variable taking on values of unity during the investor holding period, but the holding period's first and last year of ownership in $d_{i,t}$ is the fraction of time owned within that year (Bryan and Colwell, 1982). ϵ_i denotes a stochastic error term. We denote by y the $N \times 1$ vector that collects all observed repeat sales transactions returns, X denotes a $N \times T$ matrix that collects all dummies $d_{i,t}$ and the $T \times 1$ vector β collects all parameter estimates. We denote by N the number of observed repeat sales and by T the number of years. Given the above variable definitions, we can rewrite Equation (1) as follows:

$$y = X\beta + \epsilon \tag{2}$$

Different estimation procedures have been proposed in the literature. These procedures take into account different assumptions concerning the distribution of the error term or the ability to incorporate prior information. For the base case, we assume that the error term is independently and identically distributed, which results in an error covariance matrix given by $\Omega = \sigma^2 I_N$, where I_N denotes the identity matrix of dimension N. The resulting OLS estimator is given by:

$$\beta_{OLS} = \left(X'X\right)^{-1} X'y \tag{3}$$

However, the error term, ϵ_i is generally found to be heteroskedastic. Heteroskedasticity in this context arises because of the varying holding periods for investors, which can have the effect of over or under weighting the return series. In the case of heteroskedastic errors, the error covariance matrix is given by $\Omega = \text{diag}\{\omega_i\}$, i.e., a diagonal matrix with elements ω_i on the main diagonal. The resulting optimal estimator is given by the weighted least squares estimator:

$$\beta_{WLS} = \left(X'\Omega^{-1}X\right)^{-1} X'\Omega^{-1}y \tag{4}$$

In order to make this estimator feasible, two assumptions have been proposed in the literature. First, the variance of each observation is proportional to the holding period, and second, the variance grows linearly with the holding period but contains an unrelated constant term. For the first case, we set the ω_i equal to the holding period of the observation I_i. In the second case, we employ a three stage estimation procedure. First, the errors are estimated from a OLS regression, i.e., $\widehat{\epsilon} = Y - X\widehat{\beta}$. Second, the squared

errors are regressed on a constant and the holding period, i.e., $\widehat{\epsilon}_i^2 = \alpha + I_i\gamma + \eta_i$, where η_i is the i.i.d. error term for this regression. Third, the estimated squared errors $\left(\widehat{\widehat{\epsilon}}_i^2 = \widehat{\alpha} + l_i\widehat{\gamma}\right)$ are used as weight ω_i.

The London commercial property market has high transaction turnover, but low volume in single or repeat transactions relative to national data samples. Consequently, the impact of transaction price noise on the estimation of the price trend is potentially high. Moreover, this noise may vary over the course of the price trend as turnover and volume fluctuate. To alleviate transaction price noise, Goetzmann (1992) proposes to incorporate prior information concerning the distribution of the vector β into the estimation. Since this parameter vector represents a time series of asset returns, it should be uncorrelated if the market efficiency hypothesis holds. In order to incorporate this prior belief into the estimation, Goetzmann (1992) augments the likelihood function by a prior distribution concerning the β vector, specifically this prior distribution is a product of univariate normals for each β_i. The resulting maximization of this likelihood function gives (in case the prior is centred at zero):

$$\beta_{GOETZ} = \{I + k(X'\Omega^{-1}X)^{-1}\}^{-1}\beta_{WLS} \tag{5}$$

where $\kappa = \sigma^2/\sigma_\beta^2$, i.e., the ratio of the prior and posterior variances. The estimation of the parameter κ employed in this paper follows the two stage procedure proposed in Section 2.6.1 in Goetzmann (1992), i.e., we estimate σ^2 and σ_β^2 from a first stage WLS regression.

In a second strategy, Bokhari and Geltner (2010) employ a generalized inverse estimator to a series of staggered yearly returns to estimate a quarterly index. The yearly returns are constructed via index estimations where the year is measured using a calendar and a fiscal year approach, where the fiscal years start in April, July and October. In the first stage, yearly indices are estimated for the calendar and fiscal years. In the second stage regression, these individual indices are staggered, leaving the first three quarters of the fiscal year indices blank and the system of equations is under identified. However, utilizing the Moore-Penrose pseudo-inverse matrix the generalized inverse estimator is achieved, where:

$$\beta_{GI} = X^T(XX^T)^{-1}y \tag{6}$$

where $X^T(XX^T)^{-1}$ gives the Moore-Penrose inverse and the parameter vector β gives us an estimator of quarterly returns.

Finally, to generate the index we calculate the exponential value of the return series. 1996 is used as the base period and the index is estimated as:

$$I_t = I_{t-1} * e^{\beta_t} \tag{7}$$

where I is the index value in period t and $t-1$.

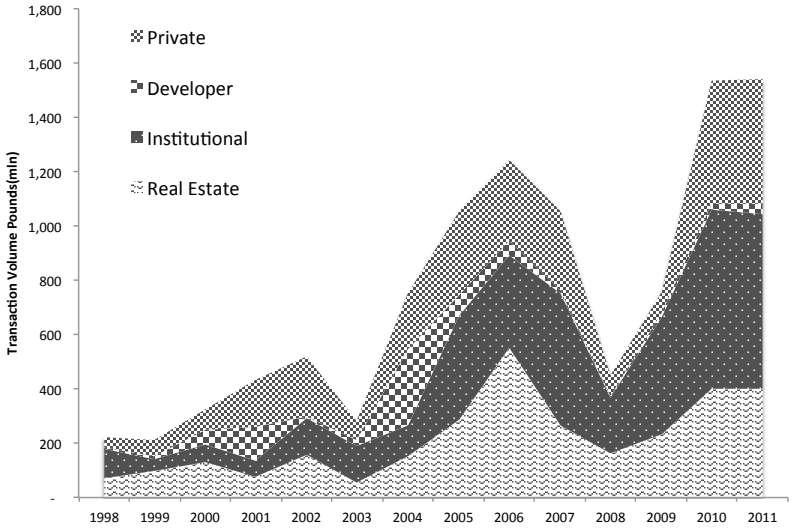
4. London Data

At the metro level, data scarcity in some periods may become an issue. Thus, we utilize two data providers for a comprehensive collection of *ex-post* transactions. We first collect data from Estates Gazette interactive (EGi). EGi is a commercial property database covering news, building reports, deal information, auctions, availability and occupier data, and ratable value analysis. For our analysis, we accessed the London Building Reports database to collect detailed building information. EGi began covering market information in 1976, but their coverage of transactions substantially increased in the last decade. Secondly, we incorporate the Real Capital Analytics (RCA), transaction data for the London market. RCA is a relatively recent provider for the UK market, but they are a part of the growing group of independent transaction data providers. Their London data set covers transactions from 2000 to the present.

After aggregating the datasets, the total cross-section of observations available over the 1996 to 2011 period with information on price and a transaction date amounts to 4,760 transactions for 2,701 buildings, with an average of 320 transactions in every year. One interesting aspect of both datasets is that they provide knowledge of the buyer at the time of sale. This allows us to see the type of investors that are buying in the market in any given period. Within the market, there are four significant buyers to monitor, real estate, institutional and private investors and developers. Real estate investors primarily invest in diversified portfolio of commercial and residential real estate. This category also includes the newly formed UK-REIT regime structure for the UK property markets. Institutional investors, like pension funds or asset managers, focus on multiple asset classes, like equities and bonds, and real estate is just another asset class. Private investors are generally owner occupied purchasers in the market or foreign direct investment from non-institutional investors. Lastly, developers are buyers of land or a building that will undergo construction or redevelopment for resale. Overall, these investors have varying shareholders and earnings targets that make their real estate selections unique in any given market. However, in London with a sampling of investments ranging from institutional grade trophy properties to speculative grade industrial parks in the outer rim, there is something for all investor types.

Figure (1) depicts the investor activity over the 1997 to 2011 period. Real estate and institutional investors have the most dominant presence in the transaction sample over the whole period. Private investors and developers enter the market more periodically. In aggregate, the core of the market is dominated by specialized real estate investors within the UK and by domestic and international pension funds. Regardless of market period, their activity is crucial in supplying liquidity. Within the sample, mainly domestic developers are present. From the figure, we can see that their presence is sporadic, which may be evidence of a cyclical pattern as suggested by Wheaton, Torto, and Evans (1997). Private investors are mainly local owner occupiers and sovereign wealth investors. These investments are also not dominant and consistent across all investment periods.

Figure 1: Market Activity 1998 to 2011



Notes: Figure (1) displays overall the transaction activity for London commercial property over the 1998 to 2011 period, excluding sales in which the buyer type is unknown

Subsequent reductions on the full sample must be made separately before we can estimate a repeat sales index. Geltner and Pollakowski (2007) outline and motivate the removal of certain transaction events for a repeat sales analysis. However, our technique deviates from Geltner and Pollakowski (2007) in two respects, but is in line with the first Moody's/RCA Commercial Property Price Indices (Philipp, Fagan, and Levidy, 2012).

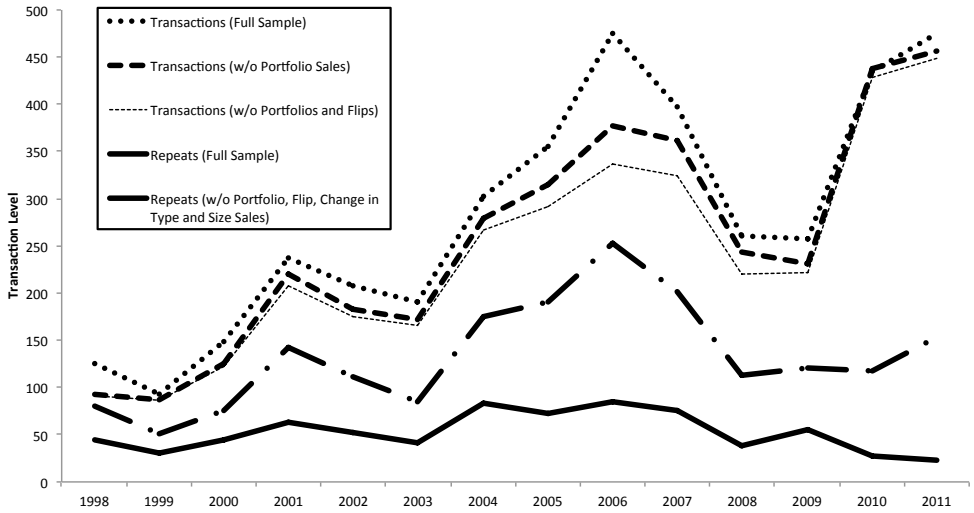
First, flips, buildings that transact within 6 quarters are removed in the US indices so as not to bias the sample with speculative activity. We also remove flips, but we only regard transactions that took place within 4 quarters as flips. Francke (2010) motivates this more limited exclusion in a sample of Dutch housing transactions by adding an investor period dummy for index estimation. Results do not significantly differ and more transaction events are viably added. For sample comparability and transparency, we employ the same filters across all estimation strategies.

Secondly, in the Geltner and Pollakowski (2007) and Geltner and Bokhari (2008) estimations, average yearly returns greater than 20 percent for investor periods greater than four years are removed but, given the nature of the market, we take 50 percent. The average returns of the London market are in the mid-thirties and the addition of the higher threshold only removes 6 observations. Appendix A outlines all filters to the data. Although our dataset does not have measures of capital expenditure and receipts (other than sales), our method reflects the realized gains for properties that have not undergone large capital expenditures: we remove properties that have changed in size.

Figure (2) displays the aggregate transaction activity in the London market over the 1998 to 2011 pe-

riod and illustrates how we go from the full transaction sample to "clean" repeat sales sample. The graph illustrates observations of five different sub-samples. The first line highlights the number of observations for the full sample and the subsequent reductions necessary for repeat-sales estimation. Transactions (Full Sample) indicates that the number of transactions reached local maximums in 2001, 2006, and 2011. This is similar across all sub-samples. In addition, the transaction levels clearly indicate the extent of portfolio sales, property flipping and building redevelopment during the 2005 to 2007 period. The peak of transaction activity occurred in 2006, where 98 observations are attributed to portfolio sales and 40 are flips, only 2007 comes in second in portfolio and flip activity. Moreover, the number of flips dramatically decreases after 2009. Finally, we see that the remarkable increase in transaction activity in 2010 and 2011 does not result in significant amounts of repeat sales.

Figure 2: Overall Transaction and Repeat Sales Activity for London Commercial Property 1998 to 2011



Notes: Figure (2) displays the transaction activity for London commercial property over the 1998 to 2011 period, including samples that exclude portfolio sales, flips (repeat transactions that occur within 12 months) and buildings that have changed in property type or size.

The resulting repeat sales sample is 797 multiple observations, culminating in 428 returns over the 1997 to 2011 period. On average, there are 30 observations in any given year, with at most 63 and as little as 3 observations (in the first year). As is expected of any repeat sales index, there is evidence here of a period of adolescence in the first years of index construction[1].

Table (1) highlights the descriptive statistics of the repeat sales sample. For the sample, the average return is about 37 percent with a standard deviation of approximately 61 percent, but the average yearly

[1]There is a loss of significant observations prior to the start of the index. Future research should delve into capturing these transactions for estimations.

Table 1: Descriptive Statistics

(a) Return Characteristics

Variable	Mean	(Std. Dev.)	N
Return and Transaction Characteristics			
Cumulative Return (percent)	37.1	(0.61)	428
Yearly Return (percent)	11.1	(0.18)	428
Investor Period (quarters)	17.5	(10.35)	428
Price Achieved (£mlns)	49.3	(86.9)	428
Size (Net Square M)	5,766	(10,206)	428
Building Age (years)	34.4	(38.0)	428
Stories	7.90	(4.76)	428
Amenities Present*	66.0	–	428
Buyer Holding Period (quarters)**			
Real Estate Investor	17.6	(10.5)	106
Institutional Investor	18.9	(10.3)	103
Developer	16.2	(9.62)	17
Private Investor	18.3	(11.2)	113
Unknown	15.1	(8.62)	88
Buyer Breakdown (percentage)**		n	N
Real Estate Investor	25.23	106	428
Institutional Investor	24.31	103	428
Developer	4.21	17	428
Private Investor	26.21	113	428
Unknown	21.13	88	428

(b) Markets and Time Distribution

Variable	Mean	N
Market (percentage)		
City Core	29.0	428
City Fringe	8.00	428
Docklands	1.00	428
Midtown	16.00	428
North Central	1.00	428
South Central	2.00	428
Southern Fringe	2.00	428
West Central	3.00	428
West End	37.0	428
Transaction (percentage)		
Quarter 1	70.0	428
Quarter 2	11.0	428
Quarter 3	11.0	428
Quarter 4	8.00	428
1996	0.03	428
1997	0.02	428
1998	1.00	428
1999	1.00	428
2000	3.00	428
2001	3.00	428
2002	5.00	428
2003	4.00	428
2004	11.0	428
2005	11.0	428
2006	13.0	428
2007	15.0	428
2008	7.00	428
2009	12.0	428
2010	6.00	428
2011	5.00	428

Notes: Table (1) highlights the return characteristics of the repeat-sales sample over the 1996 to 2011 period by buyer type, market and transaction period. *Amenities range from 24 hour building access to parking, elevators and air-conditioning. **Buyer is divided into five categories, where Real Estate Investors are solely dedicated to institutional real estate investment and Institutional Investors have a portfolio of assets and real estate is just one of them. Developers, include large development companies and local community organizations. Private Investors include local small investors as well as non-institutional foreign investors and sovereign wealth entities. Buyer's are broken down by holding period and percentage in the sample. n refers to the number of observations of each type and N refers to the total observations.

return is about 11 percent with a standard deviation of 18 percent. The average investor period is approximately in 17.5 quarters. Even across investors types variation across holding periods is rather stable, with the exception of developers. This observation in the data is important as it suggests that a majority of multiple investments, despite the removal of flips, are held for on average more than four years, with

a standard deviation of about 2 years. Thus, the consistent operationalization of a repeat sales index will become more feasible as time passes.

The average price of the properties is approximately £49.3 mln with high variation. The average building size is 6,336 square meters, also with high variation; average building age is 34 years; the average building height is 8 stories; and more than 60 percent of buildings have amenities present. The repeats sample is largest in London City, approximately 37 percent and in the West End an additional 40 percent of the sample. With the exception of Midtown, the other London boroughs do not play a very important role in the dataset. [2] Even, the Docklands as a primary district for office demand is marginally reflected in the dataset. This may be attributed to the control of the Docklands investment via a trust, where transactions are not published publicly. In addition, there are very few transactions to undergo repeat transactions within this area. Finally, there is a higher percentage of transactions occurring in the years from 2004 to 2009, with the highest returns accruing in 2006 and 2007, and a sudden drop in transaction activity in 2008.

5. Repeat Sales Index Estimation and Performance

Table (2) presents the results for the repeat sales empirical model in Equation (1), relating the logarithmic returns of commercial property to weighted time dummies. Results are presented for ordinary least squares, weighted least squares, three stage weighted least squares and Goetzmann estimation procedures. The estimated coefficients and standard deviations are the smallest for the Goetzmann estimation. The time weighted dummies explain 12 to 15 percent of the variation in logarithmic returns. The mean absolute error is on average 24 percent and the sum of squared errors (SSE) is highest with the Goetzmann procedure, but the difference with the other procedures' SSE is not substantial.

Figure (3) depicts the yearly index values for the The London Commercial Property Price Indices over the 1996 to 2011 period. On the left axis, index levels are reported with 2001 as the base year. We can observe the following from the graph. First, the four index estimation methods show very similar levels. Second, the market turning points are well synchronized. Third, the main difference is in the magnitude of the turning points, i.e., the Goetzmann index seems less volatile than the others and, in aggregate, the OLS index's movements look most pronounced.

Index levels in general over the 1998 to 2011 period have substantially risen. From 2001 to 2005, there is a distinct trough in index levels, which coincides with the dot com recession. Subsequently, from 2002 to 2006, index values increased by 179 percent, clearly reflecting the long property boom. However, that boom ended abruptly after the peak of 2006. In 2007 and 2008, there is a sharp decline in index values but, despite the fact that the financial crisis is far from over, the London market has shown a very remarkable

[2]The original intention of this paper was to estimate sub-market indices for the London metro area. However, due to the number of repeat transactions this is not yet possible at this level. Future research should work towards these types of meaningful results.

Table 2: Repeat Sales Estimation

	R-OLS	**R-WLS**	**R-WLS2**	**R-Goet.**
1996	-0.15	0.02	0.02	-0.00
	(0.20)	(0.21)	(0.21)	(0.10)
1997	-0.26	-0.12	-0.18	-0.05
	(0.16)	(0.14)	(0.15)	(0.09)
1998	0.46***	0.34**	0.37**	0.19**
	(0.17)	(0.16)	(0.16)	(0.09)
1999	-0.22	-0.28*	-0.27*	-0.10
	(0.17)	(0.15)	(0.16)	(0.09)
2000	0.28*	0.44***	0.40***	0.32***
	(0.15)	(0.14)	(0.14)	(0.08)
2001	0.20	0.17	0.18	0.19**
	(0.14)	(0.13)	(0.13)	(0.08)
2002	-0.18	-0.19	-0.18	-0.14*
	(0.13)	(0.11)	(0.12)	(0.08)
2003	0.09	0.12	0.11	0.08
	(0.12)	(0.09)	(0.10)	(0.07)
2004	0.16	0.12	0.13	0.13*
	(0.11)	(0.08)	(0.09)	(0.07)
2005	0.06	0.16**	0.12	0.16**
	(0.10)	(0.08)	(0.09)	(0.06)
2006	0.45***	0.33***	0.36***	0.30***
	(0.10)	(0.07)	(0.08)	(0.06)
2007	-0.17	-0.08	-0.11	-0.09
	(0.13)	(0.10)	(0.11)	(0.07)
2008	-0.38**	-0.30**	-0.31**	-0.24***
	(0.15)	(0.12)	(0.13)	(0.08)
2009	0.29	0.13	0.17	0.10
	(0.18)	(0.15)	(0.16)	(0.09)
2010	0.03	0.18	0.13	0.17*
	(0.22)	(0.19)	(0.20)	(0.09)
2011	0.13	0.16	0.16	0.12
	(0.23)	(0.20)	(0.21)	(0.10)
R^2	0.15	0.13	0.14	0.12
MAE	0.25	0.26	0.26	0.24
SSE	133.18	136.66	135.15	137.30
No. of Obs.	428	428	428	428

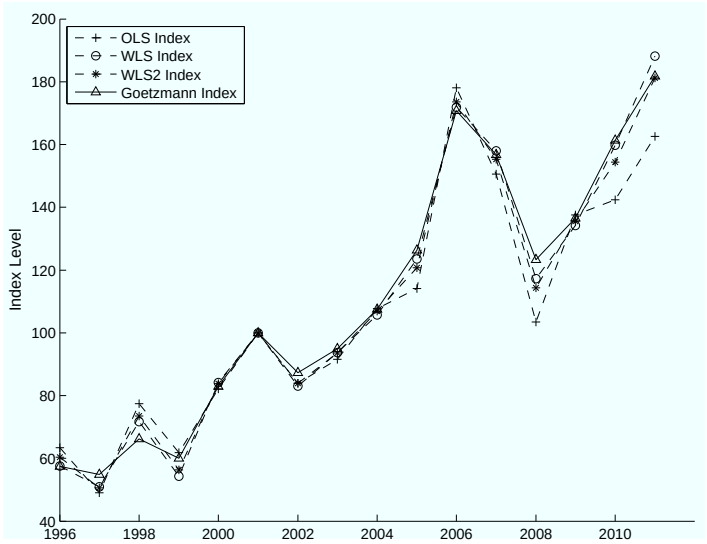
Notes: This table reports the estimates of Equation (1) for time weighted dummies over the period 1998 to 2011. This table also reports the R^2, median absolute error (MAE) and sum of squared error (SSE). The dependent variable is the logarithmic returns. *p value is 10%; **p value is 5%; and *** p value is 1%

recovery, with the 2011 index level that has reached levels of 2006. This is in line with market reports indicating strong take-up and recovery in 2011 (CBRE, 2011). However, turnover and transaction volume are low for the first two quarters of 2012 relative to previous years, which suggests the European debt crisis is now having an impact on credit liquidity.

Figure (4) displays the quarterly index for the The London Commercial Property Price Index over the 1998 to 2011 period as estimated by Equation (7). This index reflects the full estimation strategy, incorporating bayesian smoothing and generalized inverse techniques. Here also the four estimation techniques display a similar performance in terms of the timing of the index movements, but differences in magnitude. Again, the Goetzmann index creates a more stable specification.

Return levels increased over the 2002 to 2006 period with a slight trough over the year of 2006 to 2007, an additional peak in 2007 and then a steep decline into 2008 and 2009. The latter portion of the index depicts a remarkable rebound in markets. Again, this is in line with market activity, there is significant market activity, which were considerable in 2010 and 2011 (See Figure (1)). However, this fact is difficult to reconcile in the current period, where the European debt crisis is decreasing liquidity from the markets.

Figure 3: The London Commercial Property Price Index - Annual Frequency



Notes: Figure (3) displays the annual index values for The London Commercial Property Price Index over the 1998 to 2011 period. The left vertical axis is the index level. 2001 is the base index period for all indices. The horizontal axis is the time period measured in years.

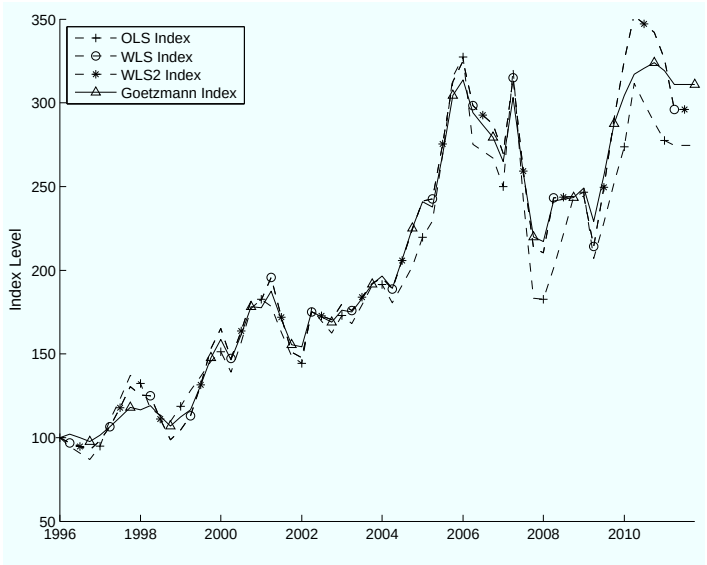
Digging further by buyers and sellers in the market[3], we find that private and institutional investors have the highest annual and cumulative returns over the 2006 to 2007 period, whereas real estate Investors have higher mean cumulative and yearly returns in 2007 and 2008. In the repeat sales sample, real estate

[3]The underlying repeat sales data has information on buyers and sellers at the time of sale.

investors are less active in the market over the downturn and institutional and private investors appear to have more activity at that time in the market. This also corresponds with the larger sample of transactions (See Figure (1)).

Over the sample period there is a significant institutional change in commercial property ownership: the UK-REIT structure. The introduction of the company structure could explain the fact that the markets rebounded in the first two quarters of 2007. As of January 1, 2007, the UK-REIT operational vehicle has been in effect. Since that time, approximately 31 property companies have undergone this regime formation, with the highest proportion in 2007[4]. Within the total sample, 45 percent of UK-REITs appear in both the RCA and EGi data sets as of their start dates, and are responsible for £3.9 bln in purchases and 63 transactions overall. Theoretically, these investors may be taking advantage of the tax shield inherent in the REIT structure. However, within the repeat sample, the UK-REIT companies do not play a significant role in buying or selling their properties. Seven properties were sold by UK-REITS, with an average cumulative return of 67 percent and a yearly return of 9 percent. These expected cumulative returns are on average higher than other real estate investor's cumulative returns. However, the small sample properties of these UK-REIT transactions make it difficult to infer any causality from returns at the descriptive level.

Figure 4: The London Commercial Property Price Index - Quarterly Frequency



Notes: Figure (4) displays the quarterly index values for The London Commercial Property Price Index over the 1998 to 2011 period. The left vertical axis is the index level. 2001 is the base index period for all indices. The horizontal axis is the time period measured in years.

Earlier empirical literature concerning London office real estate cycles suggests that our index is in line

[4]UK-REIT regime changes can be found on the London Stock Exchange, detailing the entities and regulatory changes for property companies

with overall trends that influence the London commercial property market. Wheaton, Torto, and Evans (1997) find that the primary driver of office demand in London's office sector is financial and business services employment, which grew by one third over the 1998-2007 period and declined over the 2007-2010 period by 10 percent (National Office of Statistics). Targeted employment shifts over the 2000 to 2011 period correspond to turning points with the Quarterly London Commercial Property Index. Volatility in business services employment affects rental demand for the office space in the short run, but prices can be sticky and dependent upon rental contracts. Even so, expectations and signals from rental demand can still adjust capital market demand for real estate assets. In turn, these short run dynamics can influence the supply of new and redeveloped stock in the long run.

Given the latter, prior literature has empirically tested these outcomes for the real rental and space markets in London City. Hendershott, Lizieri, and Matysiak (1999) and Hendershott, Lizieri, and MacGregor (2010) find that real rents in London City reach low levels in 2003 and 2004, but expand again until 2006. In addition, they find that market vacancy rates peak in 2003 to 2004 and decrease until 2006.

This cycle in employment-driven demand for space, rental rates and supply would forecast that capital market returns for real estate assets would increase until approximately 2002 and then subsequently decrease until 2003 to 2004 and in the long run lead to a potential expansion of the building supply and redevelopment. According to CBRE, peaks and troughs in prime rents in the City of London should correspond with turning points in the annual series in 2006 and 2010 (CBRE, 2011). In line with the academic literature and market reports, our index reflects an initial trough in capital returns followed by an expansionary period in investment over the same periods.

Moreover, literature on the performance of transaction-based index techniques suggests that a primary point of comparison is with an appraisal based index. Fisher, Geltner, and Webb (1994) find that the levels produced by the appraisal-based indices are smoothed, but should generally reflect the trends in the market. *Ex-ante* we can turn to IPD's Yearly London Property Capital Growth Index to get an idea of market movements over the 1998 to 2010 period. The index averages the appraisal values of approximately 1,700 properties in any given year over this time period with high proportions of the sample coming from London City, West End and Midtown.

Geltner and Fisher (2007) suggest that index noise is signaled by short-run volatility and negative autocorrelation, whereas a lag is generally denoted by low volatility and positive autocorrelation. Fisher, Geltner, and Pollakowski (2007) do not find substantial noise or lag in their hedonic index of US commercial property over the 1984-2007 period, while the index has autocorrelation in the returns of about 35 percent and advances the appraisal-based index by 1 to 3 years. However, their index differs substantially from ours in regional aggregation and data use: it covers the whole US rather than one city and it utilizes appraisals (just prior to transactions) as the primary independent variables in the specifications, rather than

Table 3: The London Commercial Property Price Indices - Annual & IPD London Commercial Property Annual Capital Growth Index

	R-OLS	R-WLS	R-WLS2	R-Goet.	IPD
Return Characteristics:					
Mean Return	8.56	9.33	9.11	8.56	2.33
Std. Deviation	24.98	22.59	22.68	16.60	12.36
Autocorrelation (1st lag)	-37.81	-29.90	-32.74	-7.03	29.54
Nominal Property Value Levels:					
% Fall 1st Peak to Trough	-17.51	-18.61	-17.52	-13.65	-11.61
% Rise 1st Trough to Peak	75.21	72.77	72.65	67.18	38.91
Year of penultimate Peak	2001	2001	2001	2001	2002
Year of last Peak	2006	2006	2006	2006	2007
Year of penultimate Trough	2002	2002	2002	2002	2004
Year of last Trough	2008	2008	2008	2008	2010
Correlations:					
R-OLS	–	–	–	–	–
R-WLS	92.16	–	–	–	–
R-WLS2	96.03	99.29	–	–	–
R-Goet.	89.92	96.63	95.96	–	–
IPD	-2.65	8.14	5.49	8.99	–

Notes: Table (3) provides the descriptive statistics for The London Commercial Property Price Indices - Annual and the IPD London Capital Growth Index over the 1997 to 2011 period. Included are return statistics, index turning points and correlations.

previous transactions.

Table (3) and Figure (5) compare the Annual The London Commercial Property Price Index indices to IPD's London Commercial Property Annual Capital Growth Index for the 1997 to 2011 period. We can visualize price trends and turning points. As do Fisher, Geltner, and Webb (1994) and Fisher, Geltner, and Pollakowski (2007), we compare indices on the basis of appreciation returns (geometric mean, standard deviation and first order autocorrelation) and contemporaneous cross correlation with other index methods and other financial price indices, and on the basis of Nominal Property Value Levels (percent rise trough to peak, fall to peak, year of first and second troughs and peaks).

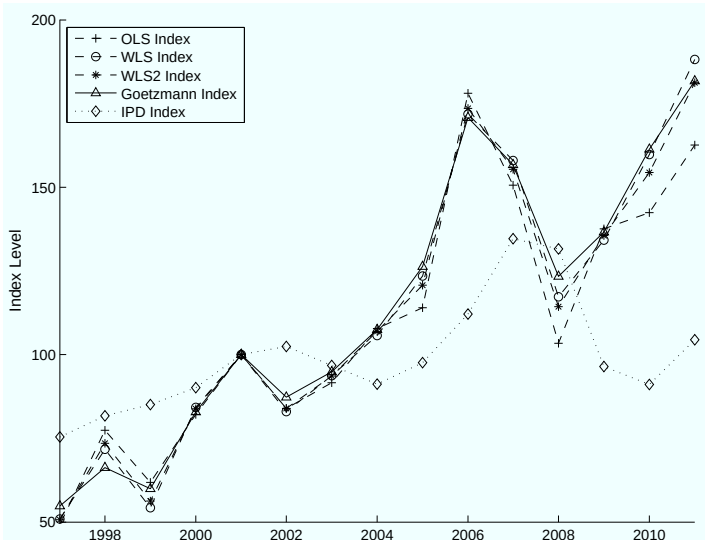
In general, all repeat sales indices display higher geometric mean returns than the appraisal-based index. This is mainly due to the fact that the transaction-based indices show strong value growth after the market low of 2008, while the IPD index's value had not yet recovered from its 2008-2011 fall by the end of 2011. *Ex-Ante* we anticipated that the transaction indices would be noisier and more timely than the appraisal-based index. Aggregate results suggest that indeed, variation for indices estimated without proper care for "prior" volatility are indeed more varying. However, noise filtering decreases index volatility and increases autocorrelation. All transaction-based indices display greater volatility than the appraisal-based index, but not substantially. First-order autocorrelation is highest for the IPD Index, approximately 30 percent. This contrasts sharply with the transaction-based indices: the Goetzmann specifi-

cation results in the highest autocorrelation, but it is only -7 percent. The other repeat sales indices have negative autocorrelation. However, due to the limited number of time periods, the statistical significance of autocorrelations are insignificant.

Furthermore, the returns stemming from the IPD Index are not highly correlated with the returns given by the repeat sales indices over the 1997 to 2011 period. The bottom of Table (3) presents correlations. Clearly the repeat-sales indices are highly correlated across the period. However, the IPD series are not highly correlated, the Goetz represents approximately 9 percent correlation with the IPD series.

Figure (5) depicts the transaction and appraisal based annual indices over the 1998 to 2010 period. The two indices share a similar long-run pattern, but are distinctly different in highlighting peaks and troughs over the period. Both indices suggest that index values were rising over the 2002 to 2006 period. However, there is significant variation in when the rise began. The repeat-sales index suggests that the local trough occurred in 2002, but the IPD index suggests that the trough occurred in 2004. Afterwards, there is expansion in both indices and index levels, until 2006 and 2007, respectively. From 2005 to 2008, the indices suggest a local maximum. In 2006, the repeat-sale indices indicate a local maximum, but the IPD index realizes the local maximum a year later. In general, the annual repeat-sales index consistently leads the IPD index by one year.

Figure 5: The London Commercial Property Price Index - Annual
& IPD London Commercial Property Annual Capital Growth Index



Notes: Figure (5) displays the index values for The London Commercial Property Price Indices - Annual and IPD London Commercial Property Annual Capital Growth Index over the 1998 to 2011 period. The left vertical axis is the index level. 2001 is the base index period for the ordinary least squares, weighted least squares, three stage weighted least squares and Goetzmann indices.

6. London and New York

The London commercial property sector is one of the most significant real estate markets *globally* in terms of capital market wealth, cross-border capital movement and global financial stability. London's main competitor for talent, financial market power and business service placement is New York. Previous literature has looked at general comparisons of transaction levels, capital growth and employment growth in the cities (Sassen, 2001), which suggests that the same dynamic trends in financial market growth and financial services labor participation are impacting both. Coe and Jones (2010) summarize that the highest number of banking/financial services companies and investments and securities companies are located in London and New York. Moreover, globally the highest number of equities trading and commodities contracts are executed in London and New York. Lizieri, Baum, and Scott (2000) find that there is a strong link between financial service sector firms, owner-occupation and foreign ownership in the City of London office sector. Based on the previous findings, it would have been logical to assume that the commercial property markets of London and New York are strongly related.

Table 4: London and New York Transaction Turnover and Cross-Border Capital Flows
(Turnover is in £millions)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	Total
Panel A: Transaction Volume (Turnover £ & # Properties)													
London Metro													
Turnover	3,477	3,034	4,037	5,771	10,813	11,980	15,371	6,678	8,401	9,760	13,996	5,070	98,395
Properties	72	75	86	142	196	192	191	117	117	127	145	56	1,516
NYC Metro													
Turnover	1,033	3,015	1,232	2,886	2,019	4,366	5,107	2,365	854	3,709	7,346	1,554	35,492
Properties	9	22	22	34	60	66	142	34	15	44	52	24	524
Panel B: Cross-Border Capital Flows (Turnover £ & # Properties)													
US to London													
Turnover	1,118	404	674	1,338	2,070	4,464	4,140	1,206	2,807	3,350	2,865	1,479	25,919
Properties	19	16	14	43	51	51	56	25	38	39	44	23	419
UK to New York													
Turnover	22	68	2	44	82	68	264	112	277	26	41	220	1,232
Properties	2	2	1	2	3	5	40	3	3	1	1	6	69

Notes: Table (4) presents, using data from the RCA cross-boarder capital dataset, the transaction volume and cross border capital flows in money terms(£) and in number of properties for the London and New York markets over the 2001 to June 2012* period.

Along these lines, Holly, Pesaran, and Yamagata (2011) found that exogenous shocks to New York housing prices had a lagged impact on London house prices, and thereby the remainder of the UK housing market, over the 1976 to 2008 period. The basis for this result is that prices for London and New York over this period were not contemporaneously correlated, but correlated with a lag. Be that as it may, the result does not say anything directly about the relationship between the two commercial property markets of London and New York. In fact, that relationship has not been investigated with the aid of transaction-

based indices. Using our quarterly London Commercial Property Price Index and Moody's/RCA New York Office Quarterly Repeat Sales Index, we are the first to examine the relationship between the return series for both markets.

Holly, Pesaran, and Yamagata (2011) estimate their model based on a impulse response function. In other words, using a spatial vector autoregressive estimator. Our series is not sufficiently long enough to estimate a meaningful impulse response function in the commercial markets, but there are other comparisons to be made in light of the new availability of a quarterly index for both markets.

Before we turn to the comparison of the two series' return characteristics we first look at transaction volumes and capital flows for London and New York. Table (4) Panel A outlines the transaction and turnover volume of London and New York from 2001 to 2012 (Q2) as reflected by deals greater than $ 2.5 mln in the RCA transaction database. Over that full time period, aggregate transaction volume in London was almost three times that of New York. In fact, in these 11.5 years, there has not been a single year in which New York had higher commercial transaction volume than London.

However, volumes have been far from stable in both markets. Focusing primarily on the period around the financial crisis, London has had high transaction turnover volume since 2001. The maximum yearly turnover occurred in 2007 at £15.3 bln and just under £11.9 bln in 2006 with more than a fifty percent decline in 2008. Transaction volume peaked earlier in 2005, declined marginally until 2007 and then decreased by 39 percent in 2008. New York's turnover underwent a similar path during the 2000s. In 2006 and 2007, transaction turnover reached its highest levels on record at £4.3 and £5.1 bln, respectively. Similarly, physical transaction volume peaked in 2007 and dropped by 76 percent in 2008. In summary, transaction activity is distinctly different in each year for both markets and have distinctly different turnover patterns.

In the capital flows information in Panel B, we see a very big difference between those going West and those going East: flows from the UK into New York's commercial property market have been very small: only £1.2 bln over the 11.5 years covered here. This suggests that capital from the UK has had at most a very marginal effect on New York's market. Although New York is the highest target for US capital, it is not the whole of foreign direct investment. RCA's cross border capital tracker indicates that since 2007 approximately £4.0 bln has been invested in all of the US markets. The aggregate capital flow from the US into the London market, on the other hand, has been much bigger, both in absolute terms and in relation to the total transaction volume in London's commercial property market. Just over 25 percent of all transactions are US-originated, so this could have a big influence on London's market.

We now turn to the comparison of our Quarterly London Commercial Property Price Index and Moody's /RCA New York Office Quarterly Repeat Sales Index. Table (5) highlights the return characteristics of the London and New York series over the 2001 to 2011 period. Using the Goetzmann specification for London, returns for London and New York are on average 6.7 and 6.0 percent, respectively. The continuously com-

Table 5: London and New York Index Descriptives

	London	New York
Return Characteristics:		
Mean Return	5.98	6.68
Std. Deviation	29.73	23.04
Nominal Property Value Levels:		
Year of ultimate Peak	2006 Q1	2007 Q4
Year of penultimate Peak	2007 Q2	2008 Q1
Year of last Peak	2009 Q1	2008 Q3
Year of ultimate Trough	2008 Q1	2009 Q4
Year of penultimate Trough	2008 Q1	2008 Q2
Year of last Trough	2009 Q2	2009 Q4
Correlations:		
New York	-1.46	–
Correlation $NY_{2001-2005}$	5.25	–
Correlation $NY_{2006-2011}$	-8.06	–
Correlation NY_{t-1}	-25.98	–
Correlation NY_{t-2}	-12.93	–
Autocorrelation	14.25	54.03

Notes: Table (5) provides the descriptive statistics for The London Commercial Property Index - Quarterly and the Moody's/RCA New York office repeat sales index over the 2001 to 2011 period. Included are return statistics, index turning points and correlations and covariances.

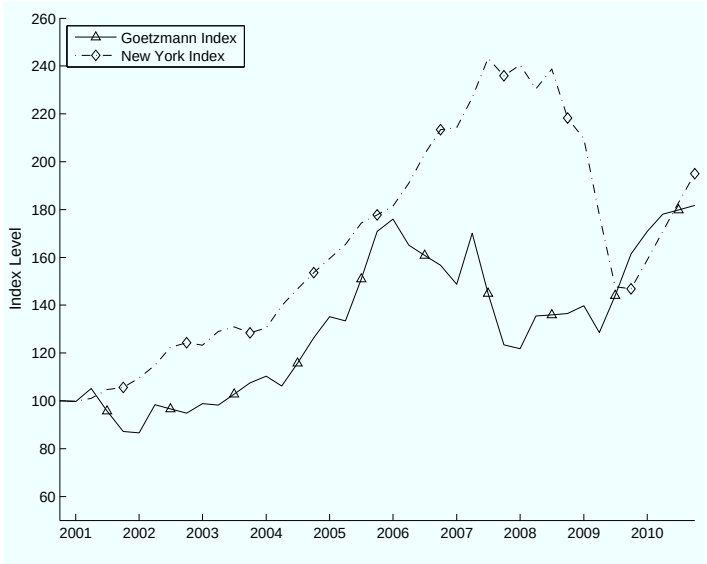
pounded returns from 2001 to the 2006 for the London series are 57.4 percent, with a subsequent decline of about 11.1 percent. New York's cumulative returns were 88.9 percent from 2001 to 2008, after which the market subsequently saw a cumulative loss in returns of 22.1 percent. In addition, the London quarterly return series exhibits more volatility than the New York series. The standard deviation for the quarterly series is approximately 30 percent, while the New York series' standard deviation lies at 23 percent.

Nominal property value levels indicate that the ultimate peak over the 2001 to 2011 period occurred in 2006 Q1 for London, and in 2007 Q4 for the New York series. Subsequently, both return series depict a brief rebound in 2008 with an ultimate trough in 2008 and 2009, respectively. Property value levels suggest that on the surface, the two indices appear correlated. However, we are more interested in the underlying return characteristics. Contemporaneous correlation between the two series is statistically insignificant. However, the series, appear to co-move and then diverge. Thus, looking deeper into sub-period correlations, the contemporaneous correlation between London and New York series over the 2001 to 2005 period have positive correlation, but insignificant, and again, after 2005 the correlation is negative, but insignificant. This is an important and surprising result, as prior literature on international diversification in property markets would suggest that these markets are more correlated. We expected to find significantly correlated return series based on the anecdotal evidence in the literature. Furthermore, the lagged correlation between the returns in London and New York is about -25 percent in $t-1$ and -12 percent in $t-2$. Lastly, the New

York index exhibits higher autocorrelation than the London Index.

Figure (6) depicts both transaction-based indices for London and New York. Returns ultimately peaked in 2006 for London and in late 2007 for New York, and then fell sharply. Although it is also obvious that both markets have experienced a strong rebound, starting in 2009 and 2010, respectively. This recovery is still underway in both markets, despite the fact that financial markets are once again in deep turmoil, and the fact that the health of the financial industry occupying the commercial properties we study here is far from perfect. Interestingly, London seems not to be more affected by the - European-centered - travails of the financial markets than New York, despite its geographic proximity to the center of the problems.

Figure 6: London and New York Repeat Sales Indices



Notes: Figure (6) displays the index values for the London Commercial Property Index - Quarterly and Moody's / RCA Quarterly Repeat Sales New York Office Index over the 1998 to 2011 period. The left vertical axis is the index level.

Overall, we find two primary differences between the two markets. First, for the 2001 to 2011 period, turning points in commercial real estate in New York do not lead London's markets. On the contrary, the 2006/2007 turn in London's property cycle occurred almost one full year ahead of New York's cycle. This is even corroborated by the IPD valuation series, where the turning point for the London market was seen in 2007 and for that of New York in 2008. Secondly, the two return series are not correlated contemporaneously, nor correlated with a one or even two quarter lag, which suggests strong diversification effects from a combination of London and New York commercial properties.

In contrast, there are two main similarities between the markets. Both New York and London markets share remarkably in the boom period until the collapse in the markets in 2006/2007. Moreover, both mar-

kets share in the same recovery in 2010 and 2011, despite the fact that the global financial markets are still in turmoil in 2012.

7. Conclusion

We examine the realized returns for investors in London commercial real estate between 1997 and 2011. We estimate a repeat sales transaction-based index at the metro level, combining two transaction datasets, noise filtering techniques and high frequency conversion to produce a quarterly frequency index. The estimation strategy incorporates the most recent techniques in repeat sales index construction techniques and applies them to the most liquid commercial-property market in the world. Results suggest that their is sufficient liquidity across all market periods for a metro level index. However, returning to the extant literature on index construction, we have provided another empirical outcome to test the trade-off between noise and lag in index construction. Overall, there was a decrease in noise and lag but, future techniques should concentrate on sufficiently ridding indices of "noise".

The resulting index differs markedly from IPD's London Commercial Property Annual Capital Growth Index. It has higher volatility and lower autocorrelation, while it leads the IPD Index in the timing of troughs and peaks by approximately 1 year. These differences are in line with the previous US based index literature (Fisher, Gatzlaff, Geltner, and Haurin, 2003) and (Geltner and Pollakowski, 2007).

The results of the index are comparable to Moody's/RCA repeat sales New York office index on the grounds of capital return and volatility. However, the results presented here suggests that London's market and that of New York's are not consistently related. Correlations are low and not significant, even when using lags. In fact, there are periods of higher positive correlation and periods of higher negative correlation, suggesting that for international portfolio diversification, London and New York are excellent counter parts in an investment portfolio.

Repeat sales indices are absent in the commercial real estate sector in Europe (IMF and FSB, 2010). This leads to a lack in timely yardsticks for the commercial property markets, while these are strongly needed by Central Bankers, policy makers, and property researchers. For London, a global real estate investment center, a repeat sales index is a contribution to the suite of *ex-post* analysis tools for investors, regulators and academics alike.

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Appendix A Data Restrictions

Following Geltner and Pollakowski (2007) and Geltner and Bokhari (2008) and adapted for our data set, we employ specific controls for data inclusion in the repeat sales or spatial-temporal index. The rules mainly restrict spurious data or speculation in the markets. In addition, employing the rules ensures that the same cross-section of data is comparable to MIT Center for Real Estate's transaction price index. The exact filtering process is difficult to report as a transaction event may belong to one or many of the exclusion criteria. However, we report the exclusion criteria along with the number of observations that were excluded on those grounds.

1. "Flips" filter. All properties in the index are held for 1 year or more. This filter prevents "flipped" properties from entering the index. The flips filter removed 186 transactions.
2. Portfolio transactions. All properties that are a part of portfolio (multiple-property) transactions, 546 in the sample, are discarded.
3. Excessively old data. All properties with first transactions prior to 1996 are dropped due to data sparsity. Data collection began for EGi's electronic database in 1973. Transactions were sparse over the 1973-1996 period, for a total deletion of 627 transactions with on average 6.5 transactions per quarter. Our data does not have time-series information from RCA prior to 2000.
4. Incomplete information. Properties without transaction price or date are dropped for the repeat sales analysis, 164 observations.
5. Consistent Usage. Properties must be comparable in terms of use and size from the first sale to the second. Thus, they cannot change property types, i.e., become residential, or if they have been renovated a flag must be included. There was no filtering necessary on the sample due to changes in property type.
6. No major change in size. The rentable area must not change between transactions. If so, then the change is discarded. There are 490 observations that undergo a change in size.
7. Extreme yearly returns or losses are also filtered from the analysis. Transactions that had a higher yearly return than 50 percent within the first 16 quarters, i.e., 4 years were removed. As well as those that had a yearly loss greater than 50 percent.