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Transaction based indices for the UK commercial property market: exploration and evaluation using IPD data

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Abstract

The nature of private commercial real estate markets presents difficulties for monitoring market performance. Assets are heterogeneous and spatially dispersed, trading is infrequent and there is no central market place in which prices and cash flows of properties can be easily observed. Appraisal based indices represent one response to these issues. However, these have been criticised on a number of grounds; that they may understate volatility, lag turning points and be affected by client influence issues in relation to the underlying inputs. Thus, this paper presents an econometrically derived transaction based index of the UK commercial property market using IPD data and compares it with published IPD valuation indices for this market. The method is similar to that presented by Fisher *et al.* (2007) and used by the MIT Centre for Real Estate on NCREIF portfolio records, although it employs value rather than equal weighting. The results show stronger growth from the transaction based index in the run up to the peak in the UK market in 2007 as well as larger falls thereafter. They also show that the transaction index is more volatile than the valuation series, but, surprisingly, differences in the timing of turning points are not found. Hence, the paper concludes by debating why this might be so, as well as the applications and limitations that this transaction based series has as a practical market performance measure.

Keywords

Transaction-based indices, Property performance measurement

1. Introduction

Index construction in commercial real estate markets is not straightforward for a number of reasons. The heterogeneity of the assets concerned is one factor, as is the infrequent and irregular trading of these assets, meaning that prices are not observable for all properties in each period. Even in the case of those properties that do trade, the private nature of real estate transactions together with the lack of a central market in which transactions take place presents difficulties for obtaining the information necessary to produce robust measures of market performance. For these reasons, valuation based rather than transaction based series predominate in terms of the measurement of investment returns from commercial property assets.

Valuation based indices are possible owing to the obligations placed in many countries on certain groups of property investors to regularly revalue the assets they hold. Such revaluations are typically conducted under definitions whereby the valuation produced should represent the price for which the property in question would sell. Hence, these valuations can be used in the construction of performance indices as proxies for prices in the absence of regular, repeated trading. However, an extensive academic literature has developed that highlights problems with valuation based series. Some of these problems relate to the micro-level processes of valuation itself, whilst others concern the aggregation of valuation information into a market level series.

Micro-level issues revolve around the availability to appraisers of timely transaction evidence on prices and the subsequent selection and weighting of evidence during the valuation process. These issues are discussed by Clayton *et al.* (2001), who review rational and behavioural explanations for why appraisers incorporate both current and past price information into the estimation of property values. In the context of limited and noisy price signals from recent trades, partial reliance on past evidence may be justifiable for producing an individual valuation. When combining valuations into an index, though, whilst random errors in individual assessments should cancel out, any systematic tendency across valuations to rely partly on past evidence cannot be removed.

This would suggest that valuation based indices are likely to provide a smoothed and lagged representation of underlying price movements in the real estate market. This is then problematic for analyses based on such series, as if volatility is understated and turning points are not captured, this affects risk-return comparisons and the measurement of relationships with other variables, such as return series for other assets. Furthermore, smoothing may be exacerbated if the index construction process allows the use of valuations produced at different points in time to represent values as at a specific date.¹ Studies have also explored the potential for client influence on individual valuations (e.g. Baum *et al.*, 2000; Crosby *et al.*, 2009), which – if present – would raise further concerns about the inputs being used.

Given these points, the creation of an alternative, transaction based series may seem desirable. However, overcoming the obstacles outlined at the start of the paper is difficult. In order to control for variations in the quality and timing of property transactions, several econometric procedures have been proposed. Yet gathering sufficient data for such methods at an adequate level of detail can be a problem and, without a sufficient quantity of data, transaction based indices may contain

¹ For instance, see Geltner & Goetzmann (2000) for discussion of this problem in relation to the NCREIF index in the US.

excessive amounts of estimation 'noise'. Meanwhile, another concern is whether those properties that trade are representative of the market in terms of their characteristics and price trends, either generally or during specific phases of the real estate cycle.

Thus, transaction based indices are not without problems and, for some applications, valuation based series may be considered more reliable, such as in the area of investor benchmarking where regular, disaggregated reporting and comparison are required. Nonetheless, a transaction based series can potentially yield useful insights into the nature of commercial real estate markets and be an important aid to research, with the complementary functions of the two bases being advocated in Geltner & Ling (2001). With this in mind, this paper presents transaction based indices generated from data on commercial property sales recorded in the IPD UK quarterly database. These are then compared with valuation based series from the same source to see if new information about risk and market turning points is uncovered.

The structure of the remainder of the paper is as follows. In the next section, the method chosen for constructing a transaction based index is explained and justified. Also, a standard technique for testing and correcting any sample biases that arise (the Heckman two-step procedure) is outlined. The third section then discusses the data available and sets out how the method was implemented from data preparation through to model estimation and subsequent use of model coefficients to produce index values for the period Q1 2002 to Q2 2009. The fourth section presents results, whilst the final section concludes by debating the applications and limitations the transaction based series would have as a market performance measure.

2. Method

The simplest forms of transaction based indices are those that compute an average of prices across all properties traded in each period. However, commercial real estate assets are heterogeneous and individual prices will reflect variations in quality between properties, whilst averages will reflect the attributes of the sample of properties that happened to trade in that interval. With low levels of trading, variations in average price over time may not only reflect market movements, but also fluctuations in the quality of the assets being sold. For this reason, hedonic regression has been advocated as a technique that explicitly models the effects of characteristics on product prices and so allows these effects to be controlled for in index construction. A hedonic regression typically takes the following form:

$$\ln P = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_n X_n + \varepsilon \quad (1)$$

Where P = the sale price of a product
 X_n represent n characteristics of that product
 β_n are coefficients that capture the price impact of each characteristic
 ε = a random error term

Equation (1) may be applied on a period by period basis or estimated on pooled transaction data with time dummies included as additional regressors. In either case, though, objections have been raised as to the difficulties of identifying all relevant price influences and the correct functional form

(see Shiller, 1993: 129-131), as well as the practical problem of gaining adequate data on attributes from available data sources. If important factors are missing from the model above, this can lead to omitted variable bias whereby estimated coefficients for the included attributes are distorted by the absence of such factors. This, in turn, would bias estimates of index values from such a model.

In response to very limited data on land sales, Clapp (1990) proposed an alternative approach to hedonic regression for estimating real estate price indices. He noted that, whilst information on characteristics might be lacking, valuations of different land parcels were available in the area he was studying. Such valuations were carried out periodically for the purposes of tax assessment. Clapp then argued that these assessed values could be used in place of the attribute variables in equation (1). This is because, just as differences in attributes reflect variations in quality between assets, differences in assessed values made at a specific point in time will also reflect such variations, as the tax assessor will take the physical and location characteristics of each property into account when forming a judgement about value.

Therefore, if a set of valuations (denoted A) is available to substitute in place of characteristics in equation (1), the regression to be estimated would become:

$$\ln P = \beta_0 + \beta_1 \ln A + \varepsilon \quad (2)$$

In contrast with the attributes in equation (1), the valuations in equation (2) are observed as at a specific base period and so transactions should be screened for changes in characteristics between the base period and time of sale in each case. Meanwhile, it is common to add time dummies to this model so that transactions over several periods can be included in the estimation. However, it is also possible to estimate (2) on a period-by-period basis if there are repeated sets of reference valuations that can be utilised, as was the case in this study.

One advantage of this approach is that it does not have the extensive data requirements of the hedonic model and so is more easily applied provided that valuation data exists and is available for the market to be studied. Furthermore, the assessed values may capture dimensions of quality that would be difficult to observe or measure within a hedonic framework (Fisher *et al.*, 2003: 291). Yet an important issue concerns the ability of valuations to effectively represent the price differences caused by variations in quality between properties. It is highly unlikely that the differences between assets will be quantified perfectly and this has led to the relationship between assessed values and true market values being represented in the following way:

$$\ln A = \gamma_0 + \gamma_1 \ln V + \mu \quad (3)$$

Where A = the assessed value
 V = the true market value
 γ_0, γ_1 capture potential systematic errors in assessment
 μ is a random disturbance term that captures random error in assessment

This relationship has consequences for the use of assessed values in a property price model. The presence of errors means that the substitution of valuations for hedonic variables is not as simple as suggested by equation (2). The observed valuation is only a proxy for the true, but unobserved, value of the characteristics in each case. Thus, both it and the element of error in representing differences

between properties are incorporated within the regression. Thus, assuming no systematic errors for the moment,² the actual model being estimated is:

$$\ln P = \beta_0 + \beta_1(\ln A - \mu) + \varepsilon \quad (4)$$

With rearrangement, this yields:

$$\ln P = \beta_0 + \beta_1 \ln A + (\varepsilon - \beta_1 \mu) \quad (5)$$

As shown by equation (5), the implication of equation (3) is that the independent variable in the price model will be correlated with its error term, which violates the assumptions under which OLS can produce unbiased estimators. This scenario is known in econometrics as the errors-in-variables problem (see Kennedy, 2008: 157-170). It is specifically the random component of assessment error that generates this problem, although systematic errors can influence the regression coefficients as well.³

The most common approach for finding unbiased estimators in these circumstances is to use the instrumental variables technique. This involves finding another variable that is highly correlated with the problem variable, but which has no relationship with the error component of that variable. Both the original variable and the instrument are then used in estimation of the coefficients of the model. This approach was followed by Clapp (1990), but subsequent studies adopting the assessed value approach have not tended to do this (e.g. Jud & Winkler, 1999), relying either explicitly or implicitly on analysis in Clapp & Giaccotto (1992), which suggests that the problem becomes negligible in large samples.

The assessed value approach was adopted here owing to the presence in the dataset being used of valuations made at common time points for assets held in investor portfolios. At the same time, whilst the IPD databases are optimised for the recording and analysis of cash flow data, they lack detailed information on building quality and characteristics, which makes use of the hedonic method difficult, though certain key attributes (such as property type, address and floorspace) are recorded. The estimates in this paper also rely on the findings of Clapp & Giaccotto (1992) with respect to the measurement error issue. However, given that the sale samples outlined in the next section are not that large, a check on results using instrumental variables regression is planned for the next stage of the research.

Another issue common to all transaction based methods of index construction is that of sample selection. This concerns the interrelationship between characteristics and the behaviour of market participants in bidding for and accepting bids on properties, which then affects both the sample of buildings that sell and the prices that are observed. As Gatzlaff & Haurin (1998) explain, sales only occur when the offer price for a property exceeds the reservation price of the seller. Furthermore, the reservation prices of buyers and sellers (which are unobserved) may be influenced by particular

² In other words, assuming that γ_0 in equation (3) is equal to 0 and γ_1 is equal to 1.

³ For instance, a common lag across all valuations, induced by micro-level processes, would be captured in the β coefficients, but may not prevent quality differences between properties from being represented effectively. In this case, the coefficients would still be useful for 'pricing' non-traded assets whose valuations are similarly affected.

characteristics and external conditions, which, in turn, alter the likelihood of different assets trading and the prices that will be realised, with those assets that do sell providing a potentially distorted picture of movements in the market in general.

Gatzlaff & Haurin (1998) therefore propose the use of a procedure developed by Heckman (1979) that both tests and corrects for the existence of any bias caused by selection effects.⁴ This is with the insight that, although the differences in reservation prices are unobserved in each case, the outcome in terms of whether or not a property sold can be observed. Thus, this outcome may be modelled as a function of observable factors using probit modelling techniques, which estimate the effects of the different factors on the likelihood of an event (sale) occurring, as well as the overall likelihood of sale for the observation in question. Defining the dependent variable in such a model as:

$$S = \begin{cases} 1, & \text{if } RP^b \geq RP^s \\ 0, & \text{otherwise} \end{cases} \quad (6)$$

With RP denoting the reservation price of either a buyer (*b*) or a seller (*s*), the following can be estimated:

$$\Pr [S = 1] = \Phi[\omega_1 \ln A + \sum \gamma_n X_n] + \eta \quad (7)$$

Where A = the assessed value of the property
 X_n represent n further factors hypothesised to be influential on sale decisions
 ω, γ estimate the impact on sale probability of individual variables
 Φ is the cumulative density function for the standard normal distribution, and
 η is an estimation error term

A key output from this probit model is a parameter termed the inverse Mills ratio. This estimates the amount of error in price that would arise were a property to trade given its likelihood of entering the sale sample in the first place. This parameter can be entered as an additional regressor in equation (2) to counteract the element of bias in the errors of that model that arises from sample selection effects. Hence, the new price model to be estimated is:

$$\ln P = \beta_0 + \beta_1 \ln A + \sigma_{\epsilon\eta} \lambda + \nu \quad (8)$$

Where λ = the inverse Mills ratio as calculated for each observation
 $\sigma_{\epsilon\eta}$ is a coefficient that estimates the covariance in errors between equations (2) and (7)
 ν = the new unbiased error term

The significance of σ is then conventionally treated as a test of whether sample selection bias is, in fact, present in the data being researched.

The two-step procedure outlined above was adopted by Fisher *et al.* (2003) in their research on sales recorded in the NCREIF database for the US real estate market, though with some differences in the actual models estimated. For instance, rather than use valuations, their proxy for missing hedonic information was the log of the property purchase price and both this and the dependent

⁴ See also Fisher *et al.* (2003) for a detailed exposition.

variable were divided by the size of the asset in square feet. They also used time, property type and geographical location dummies in one or both of the models concerned. Their results suggest that the selection correction procedure has an important impact on transaction index output, as illustrated by their comparison with an uncorrected price series.

In contrast, later research by Fisher, Geltner & Pollakowski (2007) found that, whilst the first stage model worked well as a model of property sale probability, the impact of selection bias on the estimated price series was not significant. In this study, valuation per square foot was adopted as the composite hedonic variable, whilst type, location and time dummies were once again used to augment the estimations. An interesting aspect of their specification is that, unlike in early papers on the assessed value method, the valuations do not refer to a fixed date, but lie at a fixed distance in time from the transaction (2 quarters before). Meanwhile, both this and the prior study by Fisher *et al.* (2003) extract further information from the probit model to present both selection and liquidity corrected price series.

The approach taken in Fisher, Geltner & Pollakowski (2007) underlies the transaction based series for the US real estate investment market now published regularly by the MIT Centre for Real Estate in collaboration with NCREIF.⁵ It is also similar to the approach taken here. However, in this research, rather than pooling transaction data, equations (7) and (8) are estimated on a period by period basis. This enables variations in the dimensions of sample selectivity and its significance to be assessed in each quarter and it also prevents minor historical restatements associated with using pooled models should the series be updated. On the other hand, this framework does entail some loss in statistical efficiency, as well as being relatively cumbersome to implement, though given the size of the dataset involved, it was not straightforward to use a pooled estimation either.

Finally, some other important differences are that this study uses actual rather than per square foot versions of valuations and prices (of which logs are then taken) and it estimates value weighted rather than equal weighted series, enabling comparison with the published valuation based indices for the UK, which are also value weighted. The research also concentrates solely on variable liquidity versions of transaction based series.

3. Data and implementation

The data used in this study are drawn from the IPD UK quarterly database. IPD are now well known for their provision of performance benchmarking services and valuation based indices in many major real estate markets. In the UK, the quarterly database and its associated index are a relative recent development, with the index and majority of data dating back only as far as the end of 2000.⁶ By the end of March 2010, though, 8,367 properties worth around £95bn were being valued at a quarterly frequency (IPD, 2010a), meaning that this database forms a very large subset (approximately 80%) of the older annual database and index, the latter documenting UK property investment returns back to 1970.

⁵ See <http://web.mit.edu/cre/research/credl/tbi.html> (link correct as at June 2010).

⁶ There is, however, a long established monthly database and index for the UK that comprises mostly unitised funds and which stretches back to December 1986.

As noted in the previous section, this database is rich in terms of cash flow data, but it has less information on asset characteristics. Nonetheless, some information on characteristics was utilised to form either filters for defining the assets to be analysed or variables for the models themselves. Meanwhile, the incorporation of a procedure to test and correct for sample selection bias meant that data on all assets, whether held or sold, had to be extracted and analysed. The total number of properties available in each quarter, before and after filtering, is disclosed in Table 1 together with a count of the number of sales used in the price model for each period. The modelling focuses on sales rather than purchases and is conducted over Q1 2002 to Q2 2009.

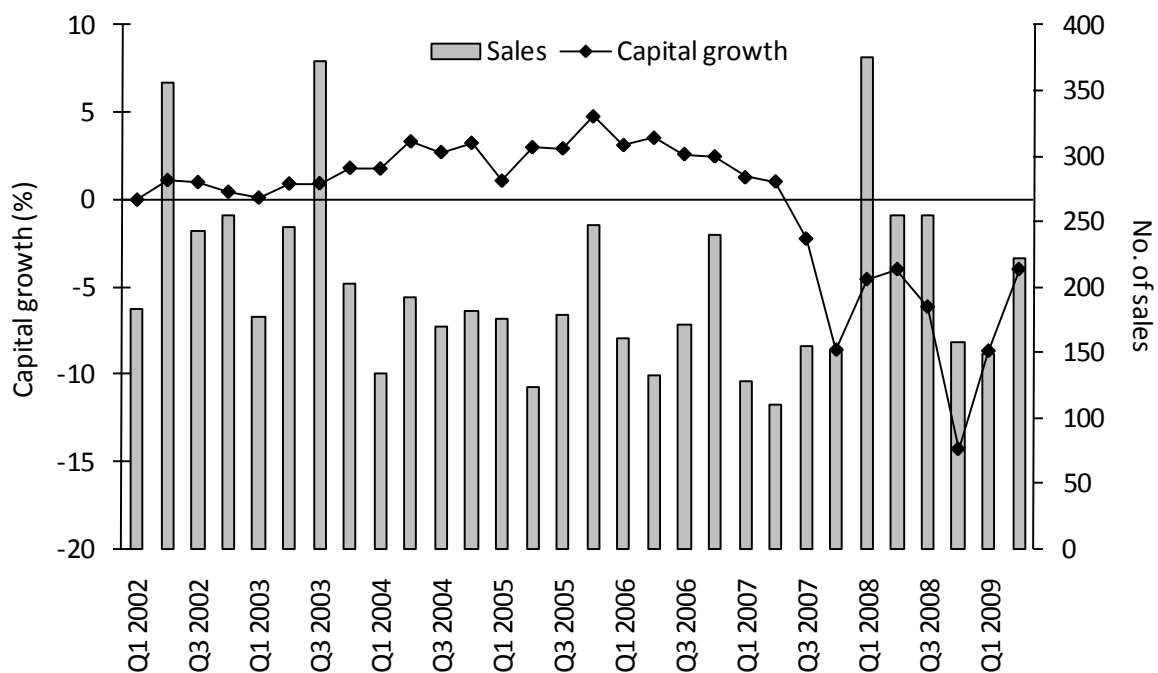
Table 1: Number of assets and number of sales in the dataset

	Properties in dataset	Number of properties after filtering					
		Total	%age	Sales	Retail	Office	Industrial
Q1 2002	9,077	7,124	78%	183	122	43	18
Q2 2002	9,208	7,121	77%	356	222	79	55
Q3 2002	9,082	6,839	75%	243	146	62	35
Q4 2002	9,047	6,705	74%	254	149	72	33
Q1 2003	8,900	6,506	73%	177	99	41	37
Q2 2003	8,811	6,616	75%	246	112	51	83
Q3 2003	8,795	6,696	76%	372	187	97	88
Q4 2003	8,599	6,496	76%	202	88	71	43
Q1 2004	8,482	6,502	77%	133	64	51	18
Q2 2004	8,600	6,473	75%	192	75	65	52
Q3 2004	8,822	6,405	73%	169	78	53	38
Q4 2004	9,073	6,451	71%	182	68	69	45
Q1 2005	9,189	6,258	68%	175	74	65	36
Q2 2005	9,209	6,327	69%	123	55	35	33
Q3 2005	9,434	6,540	69%	179	83	49	47
Q4 2005	9,711	6,657	69%	247	110	68	69
Q1 2006	9,701	6,915	71%	160	69	56	35
Q2 2006	9,739	7,007	72%	132	56	47	29
Q3 2006	9,945	7,072	71%	171	86	58	27
Q4 2006	10,076	7,213	72%	239	114	68	57
Q1 2007	10,224	7,029	69%	128	51	38	39
Q2 2007	10,197	7,142	70%	109	52	23	34
Q3 2007	10,135	7,154	71%	154	58	56	40
Q4 2007	10,057	7,026	70%	151	73	44	34
Q1 2008	9,882	7,538	76%	375	196	107	72
Q2 2008	9,483	7,488	79%	255	118	75	62
Q3 2008	9,279	7,226	78%	254	114	60	80
Q4 2008	8,920	7,270	82%	158	81	32	45
Q1 2009	8,560	7,037	82%	148	64	46	38
Q2 2009	8,415	6,905	82%	222	98	60	64

The filters applied to the dataset were as follows. First, the analysis concentrates on the three main types of commercial property held in UK investor portfolios; retail, office and industrial. These three sectors account for 95% of the assets monitored in the quarterly database. Second, to exclude 'flips' (properties sold within a very short time of being bought), only properties held for at least one year were included in the exercise. Third, properties were excluded if they had data missing from a field that was required by the models, excepting sale price, which is evidently unobserved for those properties that have not yet been sold. Finally, anomalous cases were excluded by dropping assets whose value or sale price was less than £10,000, more than £1.5bn, or sales where the mark up on previous valuation lay outside the range -50% to +100%.

Some more information about the pattern of sales is given in Figure 1. This graphs the number of sales in each quarter alongside quarterly capital growth as recorded by the IPD all property valuation based index. The graph shows there was more selling at the beginning and end of the time frame in question and, surprisingly, this tends to correspond with weak rather than strong market conditions. Thus, some of the quarters with most trades are during the muted real estate market of 2002 and the falling market of 2008. There were typically more sales of retail properties than of the other two property types, but this reflects the relative size of each sector in the dataset as a whole.

Figure 1: Sales per quarter and market performance



Both sold and held properties were used in the first stage model of sale probability. The general form of this model was set out earlier in equation (7), whilst the actual model estimated is shown at the foot of Table 2, which also provides definitions of each of the variables being used. The second stage price model is shown as well and, in common with previous studies, this simply contains the

valuation variable (as a hedonic proxy) and additional dummies for distinguishing separate segment price trends, as well as a selection correction term.

Table 2: Variables used in the first stage and second stage regression models

Variable name	Description of variable
<i>ANNTR</i>	Total return achieved over last four quarters
<i>EYLD</i>	Equivalent yield in most recent quarter (yield assumes reversion to current rental values)
<i>FUND1</i>	Dummy equal to 1 if owned by a life insurance fund, 0 otherwise (omitted category)
<i>FUND2</i>	Dummy equal to 1 if owned by a pension fund, 0 otherwise
<i>FUND3</i>	Dummy equal to 1 if owned by a property company, 0 otherwise
<i>FUND4</i>	Dummy equal to 1 if owned by a unitised fund, 0 otherwise
<i>FUND5</i>	Dummy equal to 1 if owned by another type of investor
<i>HOLDING</i>	Holding period: measured precisely, but expressed in years
<i>INVMILLS</i>	Inverse mills ratios produced by stage 1 probit model
<i>LN CV</i>	Log of the asset valuation made two quarters before sale
<i>LN PRICE</i>	Log of the gross sale price (before fees)
<i>SALE</i>	Dummy variable equal to 1 if asset sold in period, 0 otherwise
<i>SEG1</i>	Dummy equal to 1 if property is a standard retail premises, 0 otherwise (omitted category)
<i>SEG2</i>	Dummy equal to 1 if property is a shopping centre, 0 otherwise
<i>SEG3</i>	Dummy equal to 1 if property is a retail warehouse, 0 otherwise
<i>SEG4</i>	Dummy equal to 1 if property is a London office, 0 otherwise
<i>SEG5</i>	Dummy equal to 1 if property is an office outside London, 0 otherwise
<i>SEG6</i>	Dummy equal to 1 if property is an industrial property, 0 otherwise

Models estimated

1) $SALE = \omega_0 + \omega_1 LN CV + \gamma_1 SEG2 + \gamma_2 SEG3 + \gamma_3 SEG4 + \gamma_4 SEG5 + \gamma_5 SEG6 + \gamma_6 FUND2 + \gamma_7 FUND3 + \gamma_8 FUND4 + \gamma_9 FUND5 + \gamma_{10} ANNTR + \gamma_{11} EYLD + \gamma_{12} HOLDING$

2) $LN PRICE = \beta_0 + \beta_1 LN CV + \beta_2 SEG2 + \beta_3 SEG3 + \beta_4 SEG4 + \beta_5 SEG5 + \beta_6 SEG6 + \sigma INVMILLS$

The segment dummies were defined in such a way as to strike a balance between disaggregation of the most important parts of the market and representation, such that sales in each category were observed in every period. Even then, there were no Shopping Centre sales during the final quarter of the period, which meant that the non-traded assets had to be treated as Standard Retail properties during the mass appraisal stage for that quarter (which is further explained below). Meanwhile, fund dummies identify various types of owner represented in the IPD UK databases, who may be more or less active in selling assets at different points in time. This, in turn, could influence the composition of the sale samples.

Other available variables thought to be potentially important in affecting sale decisions, and so used in the first stage model, were recent performance (measured by *ANNTR*), the yield of the asset in question (*EYLD*) and the length of time that each property has been in the portfolio (*HOLDING*). The dataset does not contain information on whether properties are leveraged, whilst the valuation is used to account for factors such as size and age in both stages of the modelling process.⁷

As in Fisher *et al.* (2007), the valuation used for the *LN CV* variable is not the valuation recorded in the quarter prior to sale, but is instead the one from the quarter before. This is to ensure that this variable is independent of the sale price variable. For instance, if an appraiser is aware that a sale is being negotiated, the amount under discussion may influence the valuation that is then produced for that asset. Some empirical evidence on movements in valuations prior to point of sale has been presented by Crosby *et al.* (2003) that would seem to support this contention. Subsequently, their findings have led to the use of a similar screening process within UK industry studies of valuation accuracy (e.g. RICS, 2009).

However, the use of a valuation two quarters prior to sale rather than from the preceding quarter does have an important influence on the results that are generated. Tests using the set of valuations from the previous quarter led to transaction based indices that tracked the valuation based series much more closely than those shown and summarised in the following section. Although this could reflect a greater degree of accuracy in relation to market conditions or changes in the asset before sale, it is also consistent with appraisers gaining knowledge of negotiated price. Thus, an apparently small degree of difference between prices and valuations made under these circumstances would be used to predict prices (in the manner outlined next) for non-traded assets whose valuations are not similarly informed.

For this reason, the two quarter assumption was retained and the *LN CV* variable with this set of values was used in both the first stage probit and second stage price regressions. Once these models were run, the coefficients from the price model were stored and applied in a mass appraisal process. In a given quarter, the coefficients from the regression using last quarter's sales were used to predict a start (ln) price for all assets that did not trade in that quarter. The coefficients from the regression on the current quarter's sales were then used to predict an end (ln) price for that same set of assets. The two sets of predicted log prices were then exponentiated and summed, either across all assets or for a subset (i.e. sector) of particular interest, and the rate of change between these two totals computed.

This percentage change represents a value weighted capital return estimate that is derived from transaction evidence on conditions in the real estate market. These rates of change were then chain-linked into a longer series, within which the sample is held constant over individual computation intervals, but across which new assets are allowed to enter as the composition of the UK commercial real estate market evolves. The results from the regressions and the computed indices are presented next.

⁷ The first stage regression is not intended to be a detailed model of the property sale decision in its own right. Fisher *et al.* (2004) consider this decision in a separate paper from their own index research.

4. Results

The first results produced in each quarter are the coefficients and associated output from the probit model. These results can be summarised as follows.⁸ The variable found to be most often significant at the 5% level was the *LN CV* variable (in 23 out of 30 quarters). This almost always exhibited a negative coefficient, which would seem to suggest that larger, more valuable properties had a lower probability of sale in the UK commercial real estate market over this period. The other continuous variables in this model, *ANNTR*, *EYLD* and *HOLDING*, were not often significant and showed no strong patterns, although there was perhaps some tendency for higher recent returns to reduce the probability of sale in quarters towards the end of the time frame being studied.

Meanwhile, with regard to the sets of dummy variables, the fund dummies denoting types of owner were significant more often than the segment dummies and they also provide a clearer story. Thus, through the first half of the time frame, there were often significant and negative coefficients on either most or all the included fund dummies, suggesting that properties were more likely to be sold if they were in the portfolios of owners in the omitted category, life insurance funds. This then changes during the downturn in the UK market from mid-2007 onwards, whereby both significant and positive coefficients are consistently found on the dummy for unitised funds, as these became sellers in order to meet unit redemptions.

The second set of results relates to the price models, for which coefficients and significance levels are displayed in Table 3. The coefficient on *LN CV* captures the relationship between prices and end quarter valuations from two quarters beforehand. Owing to the time difference, it does not provide a measure of valuation accuracy. Instead, the coefficient incorporates the effect of both the distance in time between these figures and any general inertia that might be present in the valuations. When computing quarterly price changes, it is then shifts in this relationship between sets of transactions that drive the changes observed. The segment dummies test whether different parts of the market exhibit distinct price relationships. Initially, this has been done in the form of intercept shifts, though slope variations could be tested as well.

The final column of Table 3 records the coefficients on the *INVMILLS* variable in each quarter. The significance of this variable is one test of whether sample selection bias was an influential factor in that quarter, thus justifying the incorporation of a procedure to correct for this bias. As can be seen from the table, selection bias does not appear to consistently be an issue over the period. However, there are two distinct phases where a persistent effect appears to be in evidence, which are from Q2 2004 to Q2 2005 inclusive and from Q2 2007 to the end of the time frame researched, a total of nine consecutive quarters. The fact that this latter period corresponds with the marked downturn in the UK real estate market is particularly noteworthy.

⁸ Summary regression output from the probit models can be supplied by the authors on request.

Table 3: Price model coefficients

	β_0	LN CV	SEG2	SEG3	SEG4	SEG5	SEG6	INVM
Q1 2002	0.18 *	0.98 ***	0.09 **	0.05 **	0.04	0.03	0.01	0.08
Q2 2002	0.15 *	1.00 ***	-0.03	0.02	-0.01 ***	-0.01	-0.01	-0.04
Q3 2002	0.16 *	0.97 ***	0.12 **	0.01	0.08	-0.01	-0.04 *	0.14 ***
Q4 2002	0.23	1.04 ***	-0.12	0.12 **	0.04	0.02	0.16 *	-0.40 *
Q1 2003	0.05	1.03 ***	-0.03	0.01	0.01	0.01	0.05 **	-0.17 ***
Q2 2003	0.24 ***	1.00 ***	-0.15 ***	0.04	0.00 *	-0.02	-0.04 **	-0.08
Q3 2003	0.16 **	0.99 ***	-0.05	0.00	-0.03 **	-0.04 ***	-0.03 **	0.01
Q4 2003	0.60 ***	0.97 ***	0.10 *	0.05 *	0.06	0.00	0.05 **	-0.05
Q1 2004	0.37 **	0.99 ***	0.07	0.03	-0.01 *	-0.05 **	0.00	-0.03
Q2 2004	0.25 *	0.97 ***	0.08	0.06 **	0.05	0.05 **	0.01	0.12 ***
Q3 2004	0.26 **	0.98 ***	0.02	-0.03	0.02 **	-0.04 *	-0.02	0.07 ***
Q4 2004	0.13	0.98 ***	0.01	0.03	0.06	0.00	-0.05 ***	0.09 **
Q1 2005	0.34 ***	0.97 ***	0.04	0.03	0.03	0.04	-0.03	0.06 **
Q2 2005	0.50 **	1.00 ***	0.02	0.02	0.01	-0.05	-0.04	-0.19 **
Q3 2005	0.13	0.99 ***	0.03	0.03	-0.03 ***	0.01	0.01	0.08
Q4 2005	0.20 *	0.99 ***	0.05	0.11 ***	0.20 ***	0.01	0.01	0.03
Q1 2006	0.16	0.97 ***	0.11 *	0.05	0.09	0.06 *	-0.01	0.18 **
Q2 2006	-0.09	1.02 ***	0.12	-0.05	0.02	-0.03	-0.04	-0.04
Q3 2006	0.09	1.00 ***	0.05	0.00	0.04 ***	0.02	-0.02	0.03
Q4 2006	0.37 ***	0.98 ***	0.07	0.05 **	0.09	0.00	0.03	-0.01
Q1 2007	0.21	0.99 ***	0.01	0.01	0.02	0.00	-0.02	-0.03
Q2 2007	-0.58 *	0.99 ***	0.18 **	-0.04	0.08 *	0.02	-0.04	0.30 ***
Q3 2007	0.73	1.03 ***	0.09	0.32 *	0.16	0.00	0.11 *	-0.53 **
Q4 2007	0.50 **	0.99 ***	0.18	0.08	0.02 ***	0.11 **	0.05	-0.21 **
Q1 2008	-0.34 ***	0.99 ***	-0.01	-0.11 ***	-0.10	-0.05 **	-0.08 ***	0.22 ***
Q2 2008	0.04	0.98 ***	0.04	-0.03	0.04	-0.01	-0.01	0.14 ***
Q3 2008	-0.45 **	0.98 ***	0.07	-0.04	0.03 ***	-0.07	0.04	0.27 ***
Q4 2008	-1.07 ***	1.03 ***	-0.32 ***	-0.23 ***	-0.15	-0.07	-0.04	0.22 ***
Q1 2009	-0.35	0.97 ***	0.60 ***	-0.18 ***	-0.02	-0.02	-0.08 **	0.28 ***
Q2 2009	-0.18 *	0.97 ***	n/a	-0.01 **	0.02	-0.04	-0.06 **	0.24 ***

*, **, *** equal significance from zero at the 10%, 5% and 1% levels, respectively

The results of applying the mass appraisal procedure using these coefficient values are exhibited in Figures 2 and 3, which show the price index and price changes calculated across all properties in the dataset, whilst Table 4 gives summary statistics for series calculated at both the all property and sector level. In each case, comparisons have been drawn with the equivalent valuation based series that are published in the IPD Quarterly Digest for the UK real estate market (IPD, 2010b).⁹ Looking first at the two charts, it is clear that there are broad similarities in the two types of series at the all property level. However, the transaction based price series both rises and falls further, and it is also more volatile, as might be expected.

⁹ This does mean that there are some differences in the underlying samples as well as in terms of the basis being compared (transaction vs. valuation). However, comparisons with valuation based indices derived from the filtered sample provide qualitatively similar findings to those that are discussed here.

Figure 2: Comparison of transaction and valuation based capital growth indices

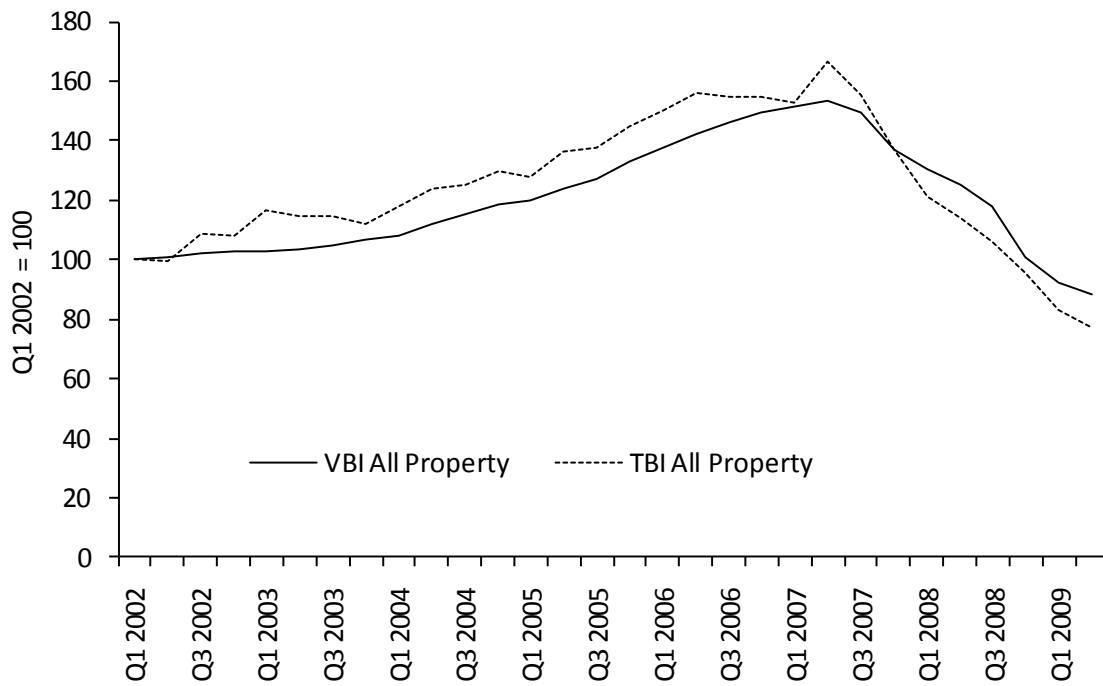
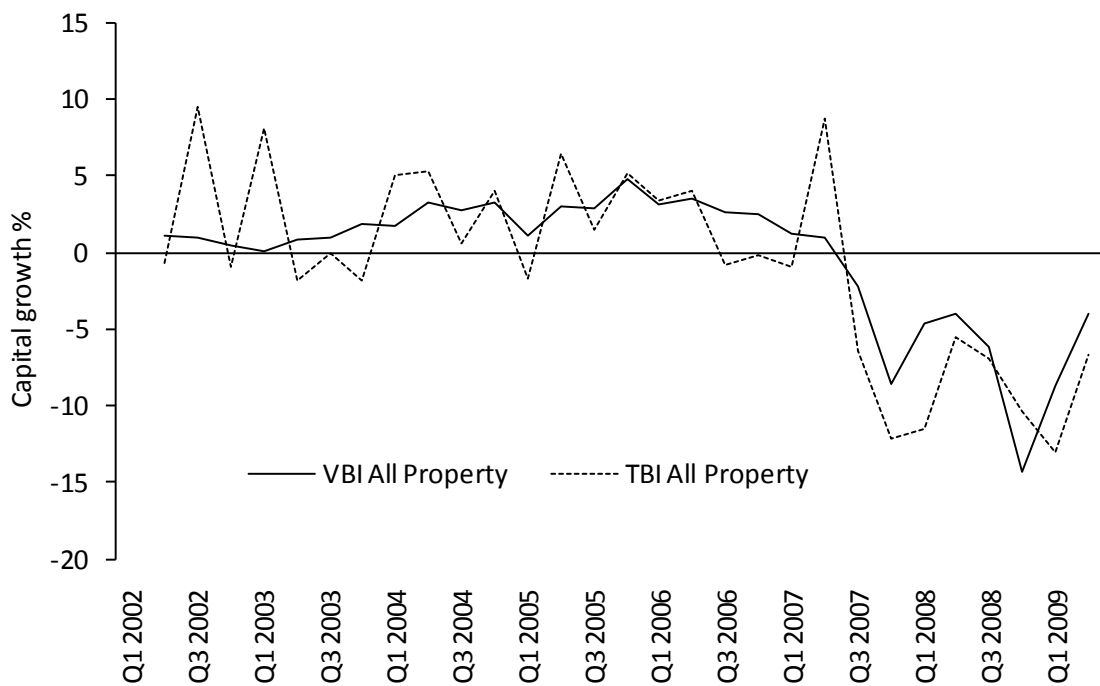


Figure 3: Changes in the transaction and valuation based capital growth indices



The greater magnitude of the rises and falls is quantified in Table 4, together with the volatility of the different series, as measured by their standard deviations. The results for the industrial sector are somewhat anomalous in that the transaction based series shows a smaller rise than its valuation based counterpart, but, in all cases, the standard deviations of changes in the transaction series are larger. The extent to which they are larger is of some interest given an earlier literature that tries to estimate the 'true' volatility of the commercial real estate market by econometric manipulation of valuation indices in the absence of other evidence.¹⁰ Here, the standard deviation of the transaction based all property series is 1.4 times higher than that of the comparable valuation based series, whilst, for the sector series, it is between 1.3 and 1.6 times higher. These multiples lie at the lower end of the range suggested by results from the de-smoothing literature.

Table 4: Comparison of summary statistics

	Peak of index	Capital gr. to peak	Capital gr. after peak	Geometric mean gr.	Arithmetic mean gr.	Standard deviation
Panel A: Valuation based indices						
All Property	Q2 2007	53.2	-42.4	-0.4	-0.3	4.5
Retail	Q2 2007	68.0	-43.6	-0.2	-0.1	4.8
Office	Q2 2007	37.8	-42.7	-0.8	-0.7	4.6
Industrial	Q2 2007	43.8	-40.4	-0.5	-0.4	4.1
Panel B: Transaction based indices						
All Property	Q2 2007	66.4	-53.5	-0.9	-0.7	6.3
Retail	Q2 2007	96.6	-60.8	-0.9	-0.6	7.5
Office	Q3 2007	59.8	-46.2	-0.5	-0.3	7.4
Industrial	Q3 2007	30.7	-43.1	-1.0	-0.9	5.3

One surprising result in Table 4 is that the average returns produced by the two types of series are not very close, with the transaction based series typically showing worse performance. However, it is important to stress that the indices do not cover a complete market cycle and it is only over a whole cycle that these figures should be expected to converge. Another surprising result that is more difficult to explain is that of the similarity in turning points, particularly given the discussion at the start of the paper on the criticisms of valuation based indices and the influence of the valuation process on their inputs. It was therefore anticipated that the transaction based indices would lead the valuation based ones, but, instead, the turning points occur either in the same or in the following quarter. Why this is so is not completely clear, but some tentative suggestions are as follows.

First, sales occur throughout each quarter, but the method currently aggregates all such evidence and treats it as applying to the quarter end. Thus, there is some temporal aggregation within the index construction process and ways to reduce this effect are currently being investigated. Second, it

¹⁰ See Geltner *et al.* (2003) for a review.

should be noted that the date recorded for each sale is the final completion date, but it is probable that prices are agreed between buyers and sellers at sometime prior to that point, although exactly when is uncertain.¹¹ As a result, price evidence appropriate to an earlier quarter could end up being analysed within a later one. Finally, it may be noted that all quarterly valuations recorded in the IPD databases are, in principle, genuine asset revaluations. Hence, the valuation indices do not suffer a 'stale appraisal' problem to the same extent as the NCREIF indices in the US. However, some degree of lag was still expected.

5. Conclusions and applications

This study has set out to produce transaction based indices using IPD data on commercial property sales in the UK. Its aim was to establish whether these could provide new information about risk and turning points in this market, particularly in relation to existing information provided by established valuation based series. The study uses the 'assessed value' method first proposed by Clapp (1990) and recently adapted and applied to data on US investment property sales by Fisher *et al.* (2007). It also adopts similar procedures to the latter authors in respect of correcting for sample selection effects, but, in contrast to that research, uses output from the modelling to produce value weighted indices that are then compared with similarly weighted valuation based indices for the UK real estate market.

From the results, it is apparent that the transaction based indices constructed here exhibit more volatility together with stronger rises and falls in price levels than the valuation based comparators over the period Q1 2002 to Q2 2009. These findings were expected in the context of prior critiques of valuation based indices as being smoothed representations of real estate market performance. However, in regard to turning points, and specifically the change in the UK real estate market from growth to decline during 2007, there was either no difference or a one quarter lag in the dates that were suggested by the transaction series from those shown by the valuation series. This finding was surprising, although aspects of the method require refinement before other explanations advanced for this can be explored in more depth.

Although this research is ongoing, some comments about the potential applications of the series are possible. In particular, it is important to stress that these transaction based series, if published regularly, are more likely to be complementary than competitors to the valuation based series that are currently published. For instance, in applications that require both precision and continuity at disaggregated levels, such as property performance benchmarking, the transaction series would not be appropriate. This is illustrated by the fact that this paper could not report series below those for the three main sectors of the UK commercial real estate market and that there were no sales in the Shopping Centre segment in the final quarter studied; yet, by value this segment represents a large fraction of the real estate investment universe.

On the other hand, the series could be of much use in real estate research owing to the evidence based estimates they provide of the volatility of the commercial real estate market at an aggregate

¹¹ Anecdotally, there is potential to amend price even at a very late stage in the transaction process, especially in the case of 'chipping', where buyers seek to use unforeseen complications to reduce the amount to be paid.

level. Even if such estimates are not used directly, they could at least inform applications such as risk modelling and asset allocation, providing an alternative perspective to the results of de-smoothing studies conducted on UK real estate data. It is also possible that the series could be used as market barometers, at least regarding the extent to which prices are rising or falling, thus potentially helping in the identification of price bubbles. However, without a clear leading relationship to the valuation series currently produced, their popularity as barometers may be limited.

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