US commercial real estate indices: transaction-based and constant-liquidity indices

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Abstract

This paper discusses commercial price indices, focusing on transaction-based indices. It discusses the problems created by using transactions as the basis for a price index and solutions to the problems. It also introduces a recently derived index that provides measures of the value of commercial property in an environment where "liquidity" is held constant. Various transaction-based indices and the constant-liquidity index are compared with an appraisal-based index.

Introduction

Indices of the price performance of commercial real estate are important to multiple groups ranging from private market investors to pension funds. As described in a paper by Jeffrey Fisher at this conference ("US commercial real estate indices: The NCREIF property index"), the traditional method of valuing commercial properties has been to use appraisals. However, as Fisher notes, there are multiple problems with appraisal-based indices. These problems include the use of "stale" appraisals (ie dated appraisals) and inaccurate appraisals due to lack of current market information about the value of commercial properties. The latter problem causes appraisal-based indices to lag behind market changes in the value of commercial property. Further, Fisher notes that appraisal-based indices are smoothed compared with actual changes in market values. Thus, measures of the volatility of the value of commercial property are underestimated using appraisal-based indices. This mismeasurement could be important when attempting to optimally balance a portfolio of assets that contains commercial property. Fisher notes that "unsmoothing" techniques have been developed to attempt to counter this problem.

Standard transaction-based indices

An alternative to constructing an index of commercial property values based on appraisals is to use the prices recorded in transactions. Indices based on residential transactions are well known and have been created and used for over three decades. The methods for constructing these indices are well developed and thus a natural application is to commercial property.

There are various methods of using transactions to construct a price index. The most frequently used are the "hedonic-price" method, the "repeat-sales" method and the "hybrid" method. Each method uses econometric regression methods to explain price levels or price changes and then uses the results to create an index of changes in price for a "typical" property. Thus, this method "holds constant" the quality of the property, a requirement for creating a price index for a heterogeneous good.

The hedonic method has been in existence for over 70 years (Rosen (1974)) and was first used to evaluate price changes in automobiles. The fundamental relationship that is estimated is the link between the price of an asset and its characteristics. Examples include estimating the link between the transaction price of a property (commercial or residential) and characteristics such as its land area, structural area, quality of the structure, and locational attributes. Lists of characteristics included in estimations can often be extensive, depending on the amount of data describing the property.

If a dataset includes observations of transaction prices from multiple periods (months, quarters or years), then the hedonic-price method can be applied separately to each period. The result is a set of valuations of each of the characteristics of properties in each time period. These time-varying

valuations can then be applied to a particular set of property characteristics (often the sample's average values), yielding an estimate of property value for each time period. Next, these values for the selected constant-quality property can be transformed into a price index, which reveals the changes in the price of property over time. An often used alternative method is to pool all of the data and estimate a single set of valuations of the property characteristics, but include a set of variables that indicate the period in which the property sold (so called "dummy variables"). If the price is transformed into a natural logarithmic scale, the coefficients of these time period variables trace out a price index for properties.

The above technique is frequently applied to residential property because the needed data are available from both public and private sources and there are many transactions; however, it is more difficult to apply to commercial property. There are a relatively small number of large commercial properties and, of course, not all transact in a particular year. Further, one must collect an extensive set of descriptors of the property. Thus, while there are hundreds of hedonic-price studies of residential properties, there are only a handful of hedonic-price studies of commercial properties.

An alternative to the hedonic-price estimation method is the repeat-sales method. This technique, available for about 40 years, has been used to create house price indices, particularly in the last 10 years. A price index compiled using Freddie Mac and Fannie Mae data (the Conventional Mortgage Home Price Index) is available quarterly for the United States, its regions, states and major metropolitan areas. It is currently based on 17 million property valuations obtained when residential mortgages are purchased. The advantage of this method is that the dataset does not have to describe property characteristics when creating the index; rather, one need only observe the transaction prices for the same property from two periods. Based on the assumption that the property does not change quality, a price index can be created using the econometric technique developed by Bailey et al (1963). The repeat-sales technique is, in practice, impossible to apply to existing commercial property datasets. There are an insufficient number of repeat sales to create a reliable index due to the relatively small number of recorded property transactions.

The repeat-sales technique has been criticised because of its assumptions that properties do not change over time. All properties age and depreciate, and some are renovated. To account for these changes, Case and Quigley (1991) developed a hybrid technique that modifies the repeat-sales method to include selected property characteristics (similar to the hedonic technique) in the estimation model. Again, due to the lack of data, this technique can be applied to commercial property only with great difficulty.

The conclusion drawn from the above is that the most feasible method to create transaction-based commercial price indices is the hedonic-price method. The required data include transaction prices, characteristics of the property, and the date of sale.

Problems with the hedonic-price method of creating a transactions-based commercial property price index: the issue of sample selectivity

An important problem encountered when using the hedonic-price method to create an index of variations in prices over time is bias created by not using a random sample of properties for the estimation. This problem is known as sample selection bias. The basic problem is that not all properties transact during a particular period. If the properties that transact are not representative of the entire stock of properties, then the standard econometric techniques may yield biased estimates of the coefficients in the hedonic model and this may lead to a biased price index. Research by Gatzlaff and Haurin (1997, 1998) showed, using a sample of residential properties, that sample selection could induce biases in residential price indices. The analogy to commercial property is direct. If the commercial properties that transact systematically differ over time in ways not controlled for by the set of explanatory variables (ie property characteristics), then a commercial price index created from transacted properties may be biased. This problem is likely to be particularly acute for commercial property because only a small percentage of the stock of properties transact during any particular time period. The nature of the bias depends on the specifics of how transacted properties change over the real estate or business cycle.

Both formal search theories and intuition suggest that transacted properties may not be representative of the stock of properties. For example, in a normal market, the real values (ie deflated values) of

some properties will rise while others may decline. If the owners of properties with falling values tend to choose not to sell their properties, while owners of properties with rising values tend to choose to sell (or vice versa), then the sample of transacted properties is clearly not random and is biased towards a particular price outcome. It is also plausible that the choices of whether to sell properties with rising and falling values change over the real estate cycle and thus the nature of the sample selection bias will change over time. This changing bias results in an estimated transaction-based price index that differs from a price index that tracks the market value of the *stock* of properties.

Only through empirical testing can it be determined whether bias exists in a particular sample. There is a well known multi-step statistical technique that corrects for possible sample selection bias (Heckman (1979)). The first step develops a model of which properties sell in a particular time period, followed by the creation of a variable that corrects for the bias. The final step is to estimate the hedonic-price equation with this correction variable included (this variable is known as the inverse Mills ratio). This technique was followed by Gatzlaff and Haurin (1997, 1998), who used a sample of residential properties, and Judd and Winkler (1999) and Munneke and Slade (2000, 2001), who used samples of commercial properties. The data requirements are, in addition to the data needed for a hedonic estimate, knowing the factors that influence the likelihood of a property selling.[1]

Problems with the hedonic-price method of creating a transactions-based commercial property price index: the issue of time-varying liquidity

A price index should measure changes in the value of a representative property, where this property's characteristics remain constant over time. This requirement is similar to standard consumer price indices, where the requirement is that the market basket of goods remains constant over time. When creating the index based on the hedonic method, the method enforces the requirement that the observed property characteristics are unchanged. However, there is another important aspect of the transaction that should be held constant, but is difficult to do so in practice. This aspect is the "liquidity" of the market.

Market liquidity refers to the ease, or speed, with which properties transact, or are expected to transact. One measure of the liquidity of a market is the reciprocal of the transaction frequency. More commonly, market liquidity is measured as the expected time required for a particular property to transact. Thus, market liquidity depends on the relative number of buyers and sellers in the market at a particular time - reflecting the conditions of the market and other factors affecting purchase/sale decisions. It is important to note that the relative change in the number of sellers and buyers is fundamental to changes in market liquidity.

Market liquidity and transaction prices are related. Property owners can sell any given asset quicker and easier (holding price constant) when there are more buyers in the market (ie the market is more "liquid"). Alternatively, a property owner can sell a given asset in the same amount of time at a higher price when there are more buyers in the market. This relationship also holds when one aggregates the transactions in a market. Thus, transaction frequency (and liquidity) is positively correlated with the asset market "cycle". Controlling for market size, transaction frequency is typically greater when the property prices are relatively high and/or rising, and lower when prices are relatively low and/or falling. Relative to the general economic conditions, changes in the frequency of transactions are typically found to be procyclical and persistent. During "up" markets, capital flows into the real estate sector, there is a greater volume of trading, and it is easier to sell assets. Just the opposite typically occurs in "down" markets.

The relationship between transaction frequency and property appreciation is shown in Graph 1 below (reproduced from Fisher et al (2003)). The annual appreciation rate of the capital component of the National Council of Real Estate Investment Fiduciaries index (NPI) is denoted by the solid line for the period 1984 to 2001. The grey bars chart the percentage of properties in the NCREIF portfolio that transacted each year. A strong positive correlation between periodic movements in the annual

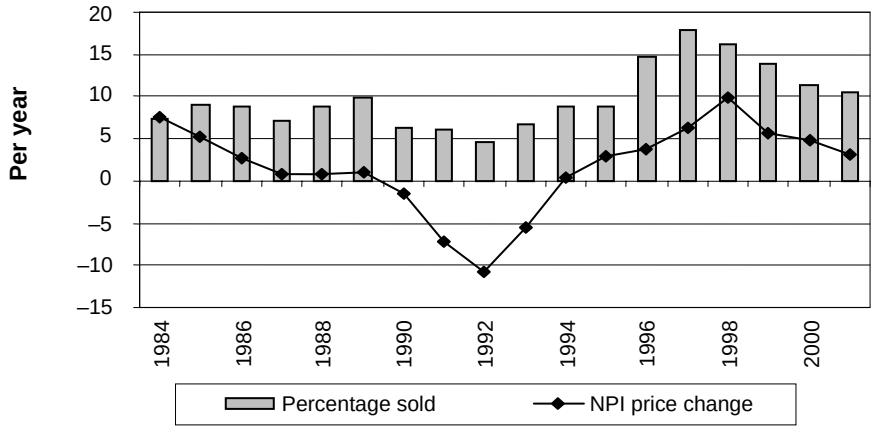
[1] One of the first fairly complete empirical models of a commercial property's probability of sale is in Fisher et al (2004).

transaction frequency and the rate of appreciation is noted. During the economic downturn of the early 1990s, both the percentage of transactions and the annual rates of appreciation experienced persistent declines from 1990 to 1992. Transaction frequency and appreciation rates then rose consistently until peaking in 1997 and 1998, respectively.

Graph 1

Transaction volume and capital appreciation in the NCREIF index

1984-2001, in per cent



The conclusion drawn is that transaction prices reflect not only property characteristics, but also market liquidity. While the issue of heterogeneous property characteristics can be addressed with the hedonic-price technique, it has to be modified to address the issue of intertemporal variations in market liquidity. Otherwise, variations in the price index reflect not only true changes in commercial property values, but also changes in market liquidity.

The solution to purging transacted prices of time-varying liquidity is fairly complex. Fisher et al (2003) developed a search model where a property owner has a reservation price below which he or she will not sell the property and potential buyers have an offer price that they will not exceed. Some matches of sellers and buyers are successful and transaction prices are negotiated. The frequency of these successful matches in the market during a particular period of time yields information about the liquidity of the market, and this information can be used to adjust the hedonic estimates of prices to hold liquidity constant. The method involves a three-step procedure where the first two steps are similar to the correction for sample selection bias. The final step fully identifies all of the parameters of the model, thus allowing for a correction to be made for time-varying liquidity.

The intuition of the above discussion is that the liquidity of the market affects transaction prices and prices in the market affect transaction frequency. Thus, there is simultaneous determination of prices and the probability of a property selling. Empirically, we observe both transaction prices and which properties sell, providing enough information for the analyst to separate these effects. This separation allows the possibility of creating a new price index, one in which liquidity effects are held constant.

An application to the NCREIF Commercial Real Estate Database

The results of a study by Fisher, Gatzlaff, Geltner and Haurin (FGGH (2003)) of the NCREIF Commercial Real Estate Database are discussed below. They created multiple indices of commercial property prices including an appraisal-based index, an index based on transaction prices, an index based on transacted prices but which includes a correction for selection bias, an index that holds liquidity constant, and a stock exchange based index (NAREIT).

Their database includes property-specific information on over 8,500 investment grade properties. These data have been used to construct an appraisal-based price index (NPI) since the fourth quarter of 1977. For 2001, quarter four, the NCREIF portfolio of properties includes 3,311 properties, with an aggregate appraised value of just over $100 billion. Properties included in this database are generally well distributed across the four major regions of the nation (East, Midwest, West and South represent 22%, 16%, 33% and 29% of the number of properties in the database, respectively). The database includes four property types: office (29%), industrial (29%), apartment (24%) and retail (18%). During the period 1982:2 to 2001:4, 3,138 properties sold and there are 27,254 observations of properties that did not sell during a particular year.

Results of the NCREIF application

FGGH's (2003) results are reproduced in Table 1 and Graph 2 below. The table presents a statistical summary comparing five capital return indices and the graph depicts the cumulative log value levels of these indices. All five commercial real estate value indices reviewed here present a similar general pattern, characterised by a very notable cycle, peaking in the mid- to late 1980s and again in the late 1990s (or possibly 2001). All five indices present a very similar long-run trend or average growth rate over the entire cycle. At a more detailed level, the five indices display interesting differences.

The appraisal-based NPI presents a smoothed and lagged appearance compared to the other indices. This is not surprising, given the nature of the appraisal process, and the way the NPI is constructed (including some "stale appraisals" each quarter).

Table 1

Annual return for five alternative commercial price indices

Annual return statistics (continuously compounded returns), 1984-2001

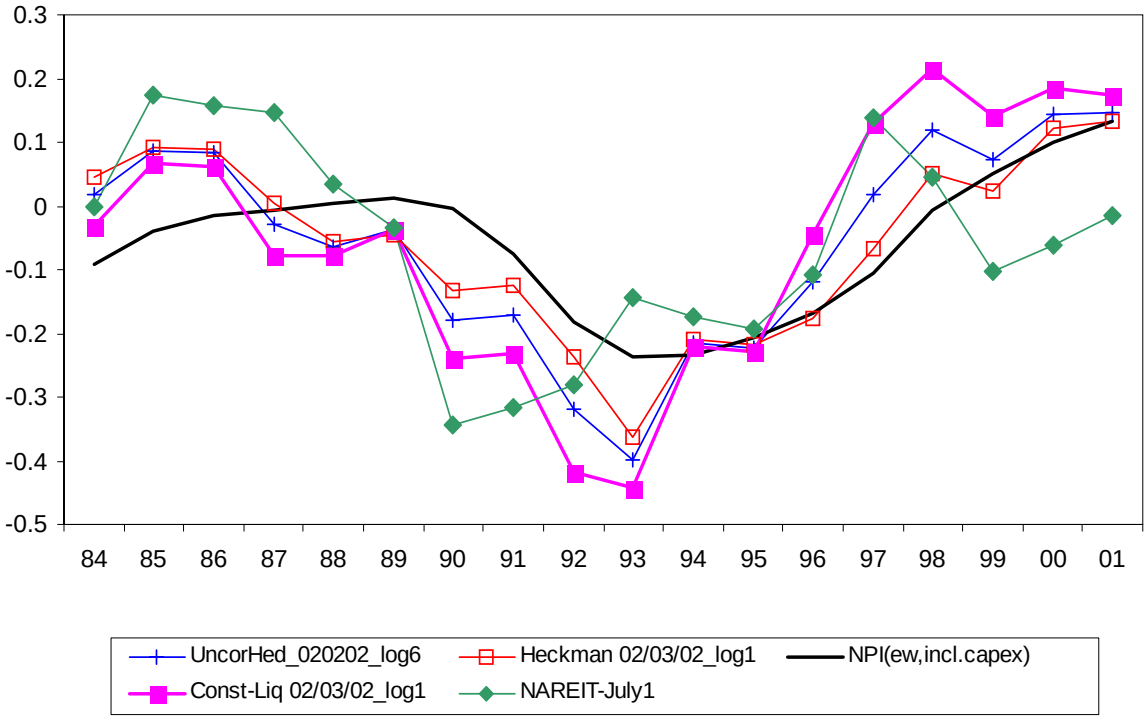
Index	NPI	Transaction-based	Selection-corrected	Constant-liquidity	NAREIT
Mean	1.32%	0.76%	0.52%	1.22%	–0.08%
Std dev (volatility)	5.22%	9.61%	8.33%	12.07%	12.99%
Autocorrelation (1st order)	0.801	0.081	0.066	0.088	0.102
Correlation coefficients					
NPI	1	0.584	0.631	0.495	0.024
Transaction-based		1	0.951	0.966	0.403
Selection-corrected			1	0.838	0.260
Constant-liquidity				1	0.502
NAREIT					1

Graph 2

Various indices of commercial price movements, 1984-2001

Transaction-based value indices of NCREIF vs appraisal-based NPI and securities-based NAREIT indices

Estimated log value levels (Set AvgLevel = Same 84-01)

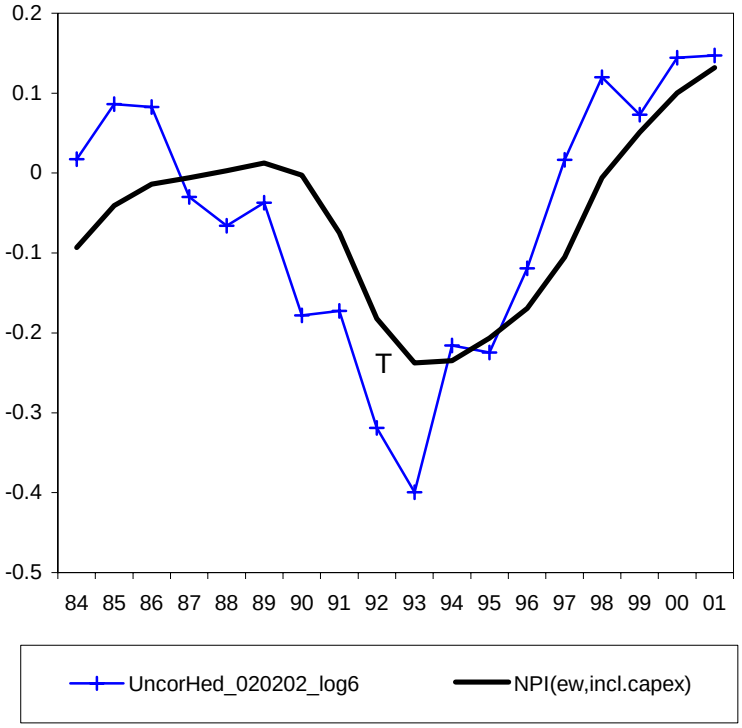


Notes:
The "uncorHed" index is the standard transaction-based index.
The "NPI" index is the NCREIF appraisal-based index.
The "Heckman" index is the sample selection corrected price index.
The "Const-Liq" index is the constant-liquidity index.
NAREIT is a stock market based index of REITs.

The three transaction-based indices (uncorrected transaction-based, selection bias corrected, and constant-liquidity) behave in a generally similar way, tracing out a pattern roughly in between those of the REIT-based index (stock) and the appraisal-based index. The uncorrected transaction-based index displays greater volatility and greater cycle amplitude than the appraisal-based index (see Graph 3), and it appears to temporally lead the NPI. Specifically, the peak in the mid-1980s is earlier (and similar to the NAREIT peak) and the rise out of the early 1990s trough steeper. Unlike the appraisal-based NPI, but like the NAREIT index, all transaction indices depict a down market during 1999, a period when commercial real estate securities suffered setbacks due to the 1998 financial crisis and recession scare, choking off a major source of capital flow into commercial real estate markets.

Graph 3

Transaction-based (uncorrected) vs the NCREIF (appraisal-based) price index



The selection-corrected transaction-based index lags slightly behind the uncorrected index (see Graph 4). Recall that the transaction-based index is the observed index, while the selection-corrected index is representative of the change in prices of the stock of commercial properties. This finding suggests that NCREIF members tended to sell their "losers" during the downturn of the early 1990s and sell their "winners" during the upswing of the late 1990s. Lower-quality properties would tend to suffer the worst performance during a severe real estate slump. Conservative institutional investors such as the pension funds whose capital is managed by NCREIF members may prefer to sell underperforming real estate during such a period, even though such a disposition policy makes their investment performance look worse during the down market. They may then try to recoup the performance hit by selling star properties in the upswing.

Graph 4

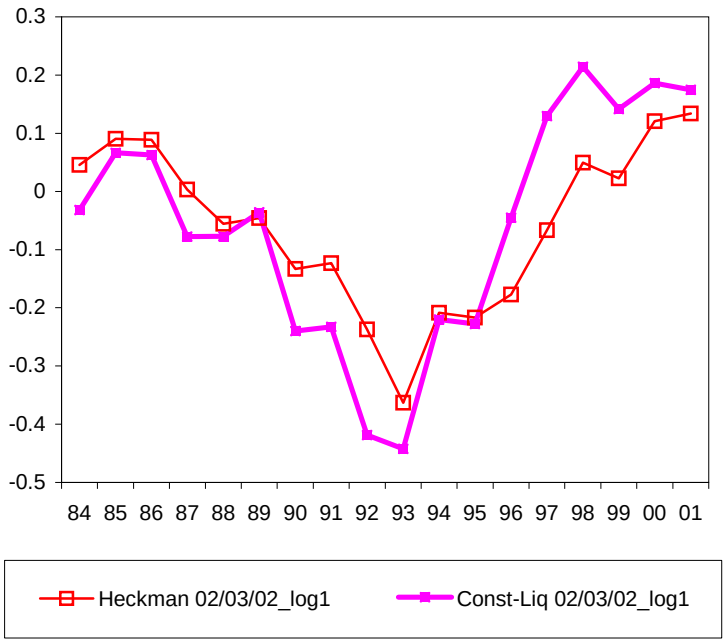
Sample selection corrected transaction-based vs the uncorrected transaction-based value index

The constant-liquidity value index displays greater cycle amplitude and greater volatility compared to the variable-liquidity transaction price indices (see Graph 5). Indeed the constant-liquidity value index has annual volatility almost equal to that of the NAREIT index (12% for the constant-liquidity index versus 13% for NAREIT, compared to less than 10% for the variable-liquidity price indices), and it has a cycle amplitude even greater than NAREIT in the 1990s upswing (see Graph 6). There is also evidence that the constant-liquidity value index leads the variable-liquidity transaction price indices in time, for example in the earlier peak in 1998 and the slightly faster fall in the late 1980s. The increased amplitude and volatility of the constant-liquidity index are consistent with buyers changing their reservation prices more so than do sellers in response to news.[2] Specifically, the temporal lead in the constant-liquidity index is consistent with "quick buyers" and "sticky prices" for sellers' reservation prices. A comparison of the constant-liquidity value index with the selection-corrected variable-liquidity price index suggests that both of these behaviours are present to some degree in the institutional commercial real estate market.

[2] Fisher et al (2003) derive a theoretical model that shows the relationship of the buyer and seller behaviour to the constant-liquidity and variable-liquidity indices.

Graph 5

Constant-liquidity index vs selection-corrected variable-liquidity index



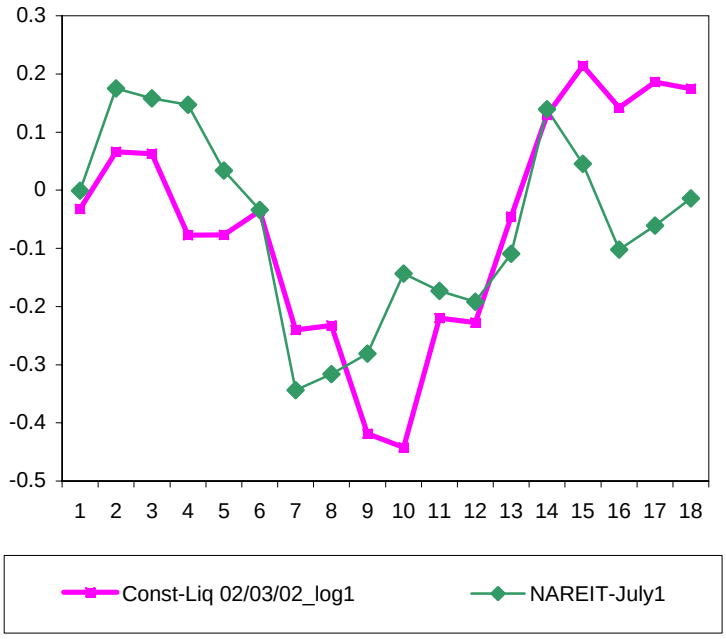
The stock exchange based NAREIT index presents a bit of an "odd man out" appearance, with some movements that are not echoed in any of the other indices. In part, this may reflect fundamental differences between REITs and direct property investments.[3] It may also reflect the effect of the different type of asset market in which REIT shares are traded. Obviously, the market microstructure and functioning of the public stock exchange are very different from those of the private real estate market, in which whole properties are traded. In addition, the investor clienteles are different between these two types of asset markets. There is some evidence of a lack of complete integration between the stock market and the private real estate market.[4] It is interesting to note that, in Graph 2, the NAREIT index shows some evidence of leading the private market indices in time, particularly in its turning points at the bottom of the cycle in 1990 and subsequent peak in 1997. This may reflect the greater informational efficiency of the public stock exchange mechanism, compared to private asset markets.

[3] The types of properties held by REITs are not exactly identical to the types of properties represented in the NCREIF database. In addition, REIT management policies and considerations (including property trading, development projects, and financial strategy) add a layer of investment performance results on top of that of the underlying "bricks and mortar" represented by operating property assets in place.

[4] See Ling and Ryngaert (1997) and Ling and Naranjo (1999).

Graph 6

NAREIT (stock) index vs constant-liquidity value private market index



Summary

This paper describes alternative indices of price changes for commercial property. The "traditional" measure of commercial property price change is based on appraisals. An advantage of this method is that all properties can be appraised relatively frequently (although this is costly). However, there are significant disadvantages, including the use of old (stale) appraisals. More importantly, appraisal-based indices tend to lag price shifts over the real estate cycle, this lag being substantial at times. Further, appraisal-based indices tend to be smoothed compared to other, more accurate measures of price change. A recent study by Fisher, Gatzlaff, Geltner, and Haurin (2003) of the NCREIF database confirms the existence of these problems. The appraisal-based NCREIF price index is both smoothed and less volatile than actual changes in commercial property prices.

An alternative method of constructing a commercial price index is to use data on observed transactions. Problems of smoothing and lagged measures of price changes are addressed with this method. The creation of a transaction-based index requires the use of a technique to adjust for quality differences among transacting properties. The most feasible method of controlling for property differences is to use the hedonic-price method. This method requires that the characteristics of transacted properties be recorded, a requirement that is typically met. Using NCREIF data, the feasibility of creating a transaction-based index was demonstrated.

A transaction-based index created with the hedonic-price method is also subject to particular problems. One is that the sample of properties that transact may not be a random sample of the stock of commercial properties. In this case it is possible that the index created from transacted properties is biased. FGGH (2003) found evidence of the presence of this bias, but the impact on the estimated commercial price index was relatively slight. A second problem is that the liquidity of the market varies over the real estate cycle. Thus, some transactions occur when it is relatively easy to sell a property (a liquid market) and others sell when it is relatively difficult to sell (an illiquid market). Holding the liquidity of the market constant is relatively difficult; however, FGGH present a two-equation model that allows for liquidity to be held constant.

The constant-liquidity market shows greater volatility than the simple transaction-based index. Changes in values in the constant-liquidity index tend to lead changes in the transaction-based index. It is sensible to argue that the desired measure of the value of commercial property is one where the

ease of selling a property is held constant over time. Our findings suggest that a constant-liquidity index is much more volatile than the commonly used appraisal-based indices. Also, the appraisal-based index lagged the constant-liquidity index by a substantial amount.

FGGH (2003) also compared the transaction-based indices to the NAREIT index of publicly traded REITs. The NAREIT index appears to be slightly more volatile and to temporally lead the constant-liquidity value index. The general pattern of price discovery seems to involve the NAREIT index typically moving first, followed by the constant-liquidity value index, then by the variable-liquidity transaction-based indices, and last by the appraisal-based NCREIF index. The total time lag between NAREIT and NCREIF can be several years, as measured by the timing of the major cycle turning points.

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