Real Estate Price Indices & Price Dynamics:
An Overview from an Investments Perspective

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Abstract:
This article reviews the state of the art in real estate price indexing and, related to that, the current state of knowledge about real estate price dynamics, with a primary focus on investment property, income generating commercial properties. Such assets form a large component of the national wealth and of the capital markets, and represent a major investment asset class. They are characterized by heterogeneity of various types, among assets, markets, and data sources, making the study of real estate pricing uniquely challenging. Yet urban economists and econometricians have pioneered major new price indexing methodologies in recent decades which, combined with new types of data sources, are now shedding new light on the nature of commercial property price dynamics, revealing both important commonalities as well as unique differences compared with equities and fixed-income securities pricing.

Keywords: Commercial Property; Real Estate; Price Indexing; Price Dynamics; Asset Markets.

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1. INTRODUCTION & BACKGROUND

This article will focus on asset price indices and price dynamics in real estate. Though we will not ignore owner-occupied housing, the main focus will be investment real estate, that is to say, income-producing properties of the type and scale that are widely traded among professional and institutional investors. We will use the term “commercial property” or “commercial real estate” (CRE), with the understanding that this includes multi-family residential rental income properties held in the private sector. We will make some international observations, but the main focus will be on the United States.

Commercial real estate equity has become a major asset class in professionally managed investment portfolios such as those of pension funds, sovereign wealth funds (SWFs), life insurance companies, and other financial institutions. The market value of the stock of all real estate in the U.S. is often said to equal about one-third of all investible wealth assets, and to exceed the value of all publicly-traded equities (stocks). (Miles & Tolleson, 1997.) As of 2012 the U.S. Bureau of Economic Analysis National Balance Sheet (BEA 2014) lists a total current cost net value of over $32 trillion for structures alone. If we assume, consistent with Davis and Palumbo (2008), that land value is on average at least equal to the value of the structures on the land, this implies total real estate value of over $60 trillion, four times the annual GDP. To put this in perspective, the 2013 Federal Reserve Bank Flow of Funds Matrix (FRB 2014) lists total financial assets of $195 trillion, including $34 trillion of corporate equities, suggesting that real estate would be about a third of total assets and almost twice the value of all corporate equities.
Approximately half of the total real estate asset value is owner-occupied housing, but that still leaves over $30 trillion in commercial property of various types. Most commercial real estate is owned by private or government enterprises for their own use (owner-occupied commercial property, sometimes referred to as “corporate real estate”). A recent private enumeration of CRE asset value by Florence et al. (2010) based on the CoStar Group Inc database which seeks to capture all commercial properties in the U.S. found total CRE value (including multi-family rental) of approximately $11 trillion as of 2009, the low point of CRE value in the Great Financial Crisis (GFC). It is reasonable to assume that about half by value of the CoStar enumeration was largely non-traded corporate and owner-occupied real estate (mostly smaller properties). Considering that the FRB reports approximately $3.3 trillion CRE mortgage debt outstanding in 2013, these findings are also consistent with an approximate magnitude of at least $6 trillion for traded investment CRE assets in the U.S. (assuming average outstanding loan-to-value of about 50%). This compares to 2014 NYSE market capitalization of $16.6 trillion, $9.7 trillion of U.S. corporate bonds outstanding, $3.7 trillion of municipal bonds (SIFMA 2014). The point is, CRE is a major investment asset class by market value of the stock of assets.

In spite of this, relatively little academic research attention has focused on CRE. When, beginning in the 1950s and 60s, financial economics emerged as a rigorous discipline from its origins in general economics, its focus was largely on stocks and bonds and their derivatives as the subjects for investment theory and capital market theory, and this still remains largely true today. When, in the 1970s and 80s, real estate economics emerged as a rigorous field from its origins in micro-economics and in urban and spatial economics, its focus was largely on housing and the commercial space usage (rental) market rather than on the commercial property asset market, and this still remains largely true today. It was not until the late 1980s and the 1990s that
modern financial economic theory began to be rigorously applied to the study of commercial property asset markets. Some pioneering studies included those by Ibbotson & Siegel (1984), Hartzell et al. (1986), Firstenberg et al. (1988), Geltner (1989), Liu et al. (1990), Ross & Zisler (1991), Giliberto (1992), Gyourko & Keim (1992), Giliberto & Mengden (1996), and Ling & Naranjo (1997). The pioneering textbook for this integration of financial economics and real estate economics was Geltner and Miller (2001, presently Geltner at al. 2014), though earlier strands of academic literature notably included publications coming out of the appraisal profession (see Lusht 1988, 1997). Even today the quantity, quality, depth and breadth of CRE asset market academic literature remains relatively lean. But it is in this modern fusion of financial economics and urban economics that we find the important academic work on CRE price indices and price dynamics, with the academic literature importantly supplemented by industry research and development. This integrated field of literature forms the source from which this review article is primarily drawn.

With the above background in mind, this article will proceed in four sections and a conclusion. Section 2 will present some important considerations about investment property asset markets. Section 3 will present basic conceptual and definitional issues about price indexing of CRE and some implications regarding price dynamics. Section 4 will briefly review the major methods and considerations for producing real estate price indices. Section 5 will discuss some interesting results of CRE price indexing including a brief comparison to housing and international results. Section 6 concludes.
2. SOME CONSIDERATIONS ABOUT REAL ESTATE ASSET MARKETS

To begin, it will be instructive to consider why CRE assets have remained largely outside the spotlight of mainstream financial economics. An important reason is the nature of the markets in which the assets are traded. Broadly, it might be said that there are three major types of markets in the world. First, there are the markets for mobile or perishable goods and for services and information, which are the major and most widespread markets studied in micro-economics. Such markets have been around since ancient times, and are arguably a natural and omnipresent institution of human culture, from the agora of ancient Greece and bazaars of the Middle East to the Walmarts and internet of today. All of these goods markets share fundamental commonalities across history and across cultures, enabling very general and widely applicable conclusions to be drawn from studying them, about supply and demand, equilibrium pricing, competition, and so forth. Second, there are public securities markets or exchanges, for stocks, bonds, commodity contracts, and derivatives. Such institutions are a relatively new and specialized invention in human history, dating largely only from the seventeenth or eighteenth centuries. Public securities exchanges form the main focus of the capital markets and investments theory branch of modern financial economics. Like goods markets, securities markets share fundamental commonalities across history and countries, facilitating their scientific study. Securities markets have a place in CRE price indexing and the study of CRE price dynamics, as we will note in this article, but they are not our central or fundamental focus. It is the third major type of market, the private real estate market (or “property market,” meaning, the market for the ownership of real property assets, land parcels including the permanent structures on them) that must be our main focus, and whose unique characteristics explain why CRE has been relatively ignored by mainstream financial economics.
Real property asset markets are very widespread, and in many countries go back many centuries. But they are not nearly as ancient as real property ownership itself and the transfer of such ownership. Human beings are territorial creatures. Until the industrial revolution almost all income and wealth, and therefore power, derived from land. The control, effectively the ownership, of land was certainly exchanged since ancient times, but it was not usually done so by the market mechanism. Blood was the exchange mechanism, whether by warfare, marriage, or inheritance. As civilization progressed, more and more of the exchange of real property began to occur voluntarily in return for payment, and markets arose. But in many countries they arose out of elements of the local culture different from the local goods markets. Nor did real estate generally find its exchange through public securities markets (even where these existed). As a result, unique institutions, customs and procedures arose for real property markets that can differ notably across countries. This heterogeneity makes scientific study more challenging.

In some places, the “markets” for exchanging real estate may involve pricing that still defers more to traditional formulas than to what economists would regard as the free intercourse of supply and demand that results in free market equilibrium pricing such as prevails in goods markets and public securities exchanges. Freely functioning (sometimes referred to as “arm’s length”) real estate markets that reasonably well reflect the economist’s concept of equilibrium pricing have the most history and ubiquity in the Anglo-Saxon countries and some lands of northern and western Europe, though modern real estate markets are becoming more widespread around the world. But even in places like the United States, which has among the most active and unfettered real estate markets in the world, there may be pricing influences from professional appraisal practice which go back far in time and reflect more traditional procedures. Indeed, a characteristic of real property markets is that there is often an entrenched specialized pricing
profession, referred to as “appraisal” or “assessment” or “valuation,” which has varying degrees of influence in the actual conduct and operation of the market. Though this influence can sometimes be a bit exogenous to internal market equilibrium forces, appraisals can often nevertheless be tapped as a unique source of information about CRE prices and values over time.

The point is that the nature and functioning of real estate asset markets not only differs from that of public securities markets but also is more heterogeneous across countries. Furthermore, the nature of real estate markets has meant that it is much more difficult to observe and obtain large quantities of pricing and trading data, compared to what is possible for the other major types of markets. This is because assets are traded in deals that are private, generally between one buyer and one seller. While some jurisdictions require the public recording of the price and of some characteristics of the traded asset, this requirement is not ubiquitous, and, has not generally resulted in a centralized, easily compiled database (though progress is being made in this regard). These features have no doubt made CRE a less appealing subject for study by academic financial economists.

Another feature of the property market is that it trades unique, whole assets each one of which is traded (and therefore priced) only infrequently and irregularly through time. This poses an intellectual challenge to the construction of price indices necessary for the study of the asset class’ pricing dynamics. While this challenge may be regarded by some financial economists as a barrier, it was, in effect, welcomed by urban economists as a fascinating problem to solve. And solve it they have, to a considerable degree, as we will review in this article. The infrequent trading of unique long-lived assets also gives rise to the need to value (that is, to evaluate, or estimate the value of) CRE assets more frequently than they are traded priced in the market by actual consummated ownership exchange transactions. This need is a major raison d’être for the
appraisal profession, which as previously noted can also be a source of information useful for our purposes.

To make this consideration of real estate markets more concrete for our purpose of understanding price dynamics, suppose you own a CRE asset, “123 Sesame Street,” and you want to sell it. Unlike when you want to sell a stock or bond you might own, you can’t sell your property immediately. You will hire a broker, who will put together an information package about the property and disseminate it in various ways, probably requesting written sealed bids by a certain date (likely several weeks or months in the future). You may or may not have posted a suggested minimum bid, or alternatively, an offer price, as this depends on the selling strategy you and your broker have decided on based on the nature of the property, the condition of the market, and how urgently you desire to sell the property. You have probably recently engaged a professional appraiser who has given you advice on what she thinks is the “most likely” or “expected” price at which the property will sell. (This is referred to as a “market value” appraisal.)

Your sale of 123 Sesame Street is in competition with other similar properties nearby and not so nearby, competing for the investment dollars of various possible types of buyers, which might include private taxable investors, investment managers working for tax-exempt pension funds or various types of private equity funds, REITs, life insurance companies buying for their own account, foreign investors, and so on. Some of these buyers might be counting on borrowing money in the commercial mortgage market, and/or bringing in equity joint venture partners, in order to come up with the cash they will need to make the purchase. The easier it is for your potential buyers to raise their sources of capital, the more potential buyers you will have and, ceteris paribus, the lower will be the opportunity cost of capital (OCC) and the higher will be the
price you are likely to be able to negotiate. The reason why 123 Sesame Street is in competition not just with close-by properties but also with some that could be quite distant, is because many of these potential buyers can place their capital anywhere they think they find the best investment.

When you receive the sealed bids, you will probably select a few of the most appealing ones, based both on the bid price and also on other terms and conditions of the bid, and also on the reputation you can ascertain about the bidder’s ability and propensity to expeditiously close the transaction without playing too many “games.” You will invite that small number of first-round bidders to a second round of “best and final bids.” From among those you will select the trading partner with whom you will attempt to negotiate the details of the sale, which, if all goes well, will close within a few weeks or months after detailed due diligence has been performed by the buyer.

Now suppose that just before, or during, this process, news arrives that is clearly relevant to the value of 123 Sesame Street. It might be news about the local rental market, such as an announcement of a large new tenant, perhaps a corporate branch headquarters, looking for space in the market. Or it might be national or international news about interest rates, or the macro-economy. Suppose in fact it is bad news. How will this news affect the sale price of 123 Sesame Street? Will it affect the price at all as such, or perhaps instead the likelihood of the sale happening, or happening within a given time frame? We cannot know, no one can, the answers to these questions with great precision or certainty.

In contrast, if 123 Sesame Street were a vast asset carved up into millions of identical common shares of equity ownership actively traded on a public stock exchange, we would immediately (or almost immediately) be able to observe a current equilibrium asset price
reaction to the news. We would see exactly how much the liquid value of 123 Sesame Street equity shares fell on the day of the news and subsequent days. This price drop would reflect a market consensus among numerous buyers and sellers all trading exactly the same asset (common shares in 123 Sesame Street) at immediately publicly-quoted prices. The speed of the information aggregation and price discovery would be much faster than what must occur with your actual 123 Sesame Street in the private property market. (See Gyourko & Keim (1992), Barkham & Geltner (1995), Clayton & MacKinnon (2001), Geltner et al. (2003), Yavas & Yildirim (2011), Ang et al. (2013), Bond & Chang (2013), among others.)

Now consider Figure 1, which depicts the functioning of the CRE asset market, in effect the market for 123 Sesame Street and other similar properties competing in the investment marketplace. The chart on the left shows the frequency distributions of reservation prices, sellers (property owners) on the right (dashed line), and buyers on the left (solid line). The reservation price frequency distributions in the left-hand chart correspond to demand (solid line) and supply (dashed line) functions in the property asset market depicted in the right-hand panel (cumulative integrals under the reservation price frequency distributions). The potential participants on both sides of the market are heterogeneous, as are the traded assets, and these heterogeneous agents must search for and find trading partners for the heterogeneous assets in what is effectively a double-sided private search market (Wheaton, 1990). There is thus a range or distribution of reservation prices on both sides, which means that the supply and demand functions in the asset market are sloped; there is no infinite elasticity as has been often assumed in the classical capital market theories of financial economics. Thus, the flow of financial capital into and out of the
property market influences the pricing in that market. (Fisher et al., 2003.) As transactions can only be consummated between buyers whose reservation price is at least as great as that of a corresponding seller, actual sales will only be drawn from the overlapping roughly triangular intersection region below both frequency distributions. The larger this region, the easier it will be for willing partners to find each other and the greater will be the transaction volume in the market. But in any case, the heterogeneity causes individual asset transaction prices to be dispersed around a market equilibrium central tendency value. Thus, individual transaction price observations are “noisy” (Case & Shiller, 1987, 1989).

In real estate markets demand (potential buyers’ reservation prices) tends to move sooner or faster or farther than supply (property owners’ reservation prices, which seem to be more “sticky”). Thus, when demand is increasing (decreasing) and equilibrium prices rising (falling), the overlap between the two frequency distributions increases (decreases). This pattern, with dispersed reservation prices and demand moving more or sooner than supply, results in, and reflects, a salient feature of such markets, which is that trading volume is highly variable and pro-cyclical: volume and price move together. Usually volume moves slightly ahead of price, or is able to be tracked slightly ahead of price movements. (Fisher at al., 2007.) In real estate markets, trading volume is viewed as reflective of “liquidity” in the market, the ease or speed with which properties can be sold, reflecting the strength of demand relative to supply. An implication is that consummated price levels alone do not provide sufficient information to fully represent the state of the market. Volume also is important. A price index reflecting only the movements in the observable transaction price levels will be to some extent “apples versus oranges” between up-markets and down-markets. More property assets can be sold quicker and
more easily at the observed prices in the up-market than at the observed prices in the down-market. (Goetzmann & Peng, 2006.)

3. PRICING AND PRICE INDEXING IN THE PROPERTY ASSET MARKET

With these fundamentals about market functioning in mind, and also considering the nature of asset price discovery as described in our 123 Sesame Street example, consider Figure 2, which depicts four different conceptual constructs of real estate price indices. The four indices in the Figure are actual empirical CRE asset price indices in regular production for commercial investment property in the United States, covering the period 2001-2014. Three of the four indices in the Figure are based on the private property market, in particular, on the portfolio of investment properties tracked by the National Council of Real Estate Investment Fiduciaries (NCREIF), the first organization in the world to publish a regularly updated and widely used index of commercial property values. The official NCREIF Property Index (NPI), which dates to 1984 (with index inception 1977), is based on appraised values self-reported by NCREIF’s member firms, which represent most of the major tax-exempt real estate investing institutions in the country, dominated by pension funds. Presently the NPI includes over 7,000 properties worth over $350 billion. The fourth index in Figure 2, the FTSE-NAREIT PureProperty® Index, is based on the stock market. The over 100 real estate investment trusts (REITs) in the PureProperty Index presently hold over 30,000 properties worth over $800 billion. Both the REITs and the NCREIF members hold broadly similar types of commercial properties, generally relatively large, prime investment properties generating stabilized income, dominated by office buildings, retail stores, multi-family apartment properties, and industrial warehouse type
properties, the so-called “core” sectors of the investment property market, located in major metropolitan areas throughout the U.S.

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Insert Figure 2 about here.
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The four indices in Figure 2 depict different ways and conceptions for measuring and defining investment property price change in the U.S. But before delving into the differences, it is important to note that all four of the indices present a broadly similar picture of the almost 15 years of history beginning in 2000. They all show a huge boom (arguably ultimately a “bubble”) beginning by 2004, peaking around 2007-08, followed by a tremendous crash bottoming around 2009-10, and then a strong recovery bouncing right out of the trough and continuing through early 2014. The major differences across the indices are in the exact timing of the major turning points in the prices, and to some extent in the magnitude of the cycle and/or in the apparent volatility and inertia in the price movements. Let us consider each of the four indices in turn.

The first index in Figure 2 in terms of the timing of the major cyclical turning points is the stock market based PureProperty Index. From our earlier discussion of the sale of our 123 Sesame Street example property and its contrast to a public securitized asset, it is not surprising that the stock market based valuation of commercial property moves ahead of the private market based valuations in time. The PureProperty® capital return index depicted in the Figure is derived from daily price movements of REIT common equity share prices on the stock market, with the index being de-levered to reflect the stock market’s implied valuation of the underlying property assets held by the REITs. It is thus a daily-frequency, liquid price indicator for the CRE assets held by REITs. By using the stock and bond markets (the latter to offset leverage in the traded REIT equity shares), investors can actually trade in the stock market at prices reflected by
the PureProperty Index. As REITs are “pure play” type firms specialized in holding commercial property assets, stockholders can be under no illusions that they are essentially investing in commercial property, so it must be presumed that REIT share prices essentially reflect the stock market’s valuation of those assets.

It may appear visually that the PureProperty Index is more volatile than the other indices in the Figure, and real estate investment practitioners often claim that the stock market adds volatility to real estate assets. But this is arguably an illusion of the different frequencies at which the indices are reported. As noted in the table of statistics for the indices (included in the Figure), the quarterly volatility for the PureProperty Index is no greater than two of the three private market based indices in Figure 2. However, the REIT-based index does register some short-run price movements that are not echoed by the private market based indices. During the run-up in prices in the great bull market before the GFC the PureProperty Index registered at least four sharp, but temporary, downturns, in spring 2004, early and mid-2005, and spring 2006, each of which corresponded to an increase in FRB interest rate policy. The PureProperty Index also registered a sharp (but again temporary) pull-back in the nascent price recovery in mid-2011, at the time of the debt ceiling brinksmanship and S&P downgrade of U.S. Treasury debt.

The stock market is designed to enable prices to move to whatever level they need to in order to maintain liquidity, and therefore the price movements depicted by the PureProperty Index in Figure 2 reflect highly liquid values throughout the cycle. The other three indices in Figure 2 reflect the private property market, in different perspectives, and therefore we must consider the variable liquidity point raised earlier in our discussion of Figure 1.

The index that moves next, after the PureProperty Index, is the NCREIF NTBI Demand Index, which represents “constant liquidity” price movements. This index tracks estimates of the
relative movements in the central tendency of potential buyers’ reservation prices on the demand side of the investment market. It is an econometrically derived index, produced by the MIT Center for Real Estate, based on both the sold and unsold properties in the NPI database, using a procedure described in Fisher et al. (2003, 2007). (A similar approach is presented in Goetzmann and Peng, 2006.) By modeling at the disaggregate level both the transaction prices at which individual properties actually trade and the probability of their trading based on the same observable characteristics of the properties, it is possible to infer the movements in the reservation prices on both sides of the market (supply and demand). If sellers were willing to exactly follow the movement in potential buyers’ reservation prices at all times in the cycle, then it would be as easy to sell as many properties in the down-market as in the up-market, and the property market would be characterized by constant liquidity. Thus, the demand-side reservation price index depicted in Figure 2 represents how market prices would have had to have moved in the private property market in order to keep constant liquidity in the market. This index therefore attempts to collapse into a single price-dimensioned metric a more complete representation of the condition of the asset market as reflected on both the dimensions of the consummated prices and the trading volumes (liquidity). In some sense the constant-liquidity private market price index is more directly comparable to the always-liquid stock market based PureProperty Index. With this in mind it is interesting to note that the constant-liquidity private market index moves slightly later than the stock market based index (perhaps a one to two quarter lag during the depicted history).

The constant-liquidity index in Figure 2 moves slightly ahead, and in a more exaggerated manner, than the next index in the Figure, which is the “Transactions Based Index” published by NCREIF (the NTBI Price Index). The NTBI tracks the movements in the actually consummated
transactions prices of properties sold from the NPI database, prices that reflect both the supply and demand sides of the market. The fact that the transaction price index moves slightly behind and not as far as the demand-side index reflects the tendency of property owners to display “sticky pricing,” particularly in the down direction. Both sides of the market react conservatively in the face of uncertainty such as occurs around major downturns, meaning that buyers reduce their reservation prices while sellers may actually increase theirs, causing or reflecting a drop in “liquidity” (trading volume). The prices in the deals that do get done do not reflect as great a drop as has occurred in most potential buyers’ reservation prices. Thus, the transaction price index fell only 34% in the GFC and its aftermath, while the constant-liquidity index fell 42% and the stock market based index fell 38%.

The last of the four indices in Figure 2 is actually the first in the timing of its historical development and is still the most widely used in industry practice among the four indices in Figure 2. As noted, the NPI is based on the self-reported appraisals of the properties held by the NCREIF members. The version of the index shown here is equally-weighted, that is, counts the appraisal-based percentage change in value for each property equally in computing the average same-property value change within each quarter. The version of the NPI capital return shown here also includes the effect of capital improvement expenditures during the period. (That is, the period’s “capex” is not subtracted from the end-of-period valuation, as is done in the official NPI appreciation index.) It is thus directly comparable to the other three indices in the Figure described previously. The NPI is lagged behind the TBI in the major turning points, and is smoother with a dampened cycle amplitude (the boom was +77% versus +85% and the crash was -28% versus -34%). Alone among the four indices in Figure 2, the NPI has strong positive first-order autocorrelation, over 80%, reflecting strong quarterly inertia. These differences between
the NPI and TBI are characteristic of appraisal-based versus direct transaction price based indices of commercial investment property prices. They reflect two phenomena. First, the appraisal of individual property values reflects procedures of professional appraisal practice that tend to result in some temporal lagging bias, and properly so, as appraisers need to document their valuation estimates based on historical transaction price evidence, and as they need to filter out the noise that exists in individual transaction prices. (Quan & Quigley, 1989, 1991.) Secondly, although pension funds and their property investment managers are required by law and by NCREIF rules to reappraise each property at some frequency, this is rarely done for every property every quarter. Yet the quarterly NPI includes all properties every quarter, including those that are not effectively reappraised in the current quarter and thus are reported into the index at a prior (“stale”) appraisal value. In spite of these problems, and the implications they have for the apparent price dynamics revealed by the NPI, we see that in the big picture the price history depicted by the stale appraisal-based NPI is not terribly different from that depicted by the consummated transaction price based NTBI. Of course, the types of differences revealed in Figure 2 can be important for some purposes.

To summarize this discussion of investment property pricing and price indexing, it is clear that there are important differences between real estate and the securities markets that financial economists are most used to studying. The differences are fundamental, and can be important in many types of analyses and studies. Indeed, we see that some of the issues are conceptual and definitional in nature, not merely reflective of less data for real estate markets. But we also see that a variety of different types of price indices can be defined and measured, at least in some contexts.
4. METHODOLOGY OF PROPERTY PRICE INDEXING

While stock market or appraisal based indices of property prices can be useful and offer interesting perspectives, the most direct and fundamental source of information about property asset prices are the consummated transaction prices for individual assets that occur in the private property market. How do urban economists and econometricians use this type of information directly to compute transaction based price indices?

The basic concept of a price index is that it compares the change over time in the price of the same good. In computing such an index for real estate assets there are two major technical challenges. The first is that the “good” that is traded (real property assets) is heterogeneous, as each property is unique, and the individual assets are traded only infrequently and irregularly through time. Indices cannot be computed directly from property market transactions data with simple matched samples or with stock market price indexing procedures. The second challenge is that there is often relatively sparse transaction data, especially for commercial property. This results in small (and often variable) sample sizes in the relatively short intervals of time to be tracked by a periodic price change index. This second problem is closely related to the segmentation that exists in the space usage (rental) market, such that properties in different locations can have different price dynamics, reflecting different supply and demand characteristics in the space market. Volatility, cyclicality, and the role of structure depreciation (hence, long-term price trend rates) can all differ across locations due to factors such as land availability and local economic and political environments. This means that relatively “granular,” segment-specific indices are required for some purposes. Compounding the sparse data problem is the transaction price “noise,” or dispersion, noted in Section 2. Evidence suggests that individual property price movements can be quite idiosyncratic (Geltner et al. 1994,
Hansz & Diaz 2001, Shimizu & Nishimura 2006 & 2007). Noise in the price index, which directly reflects random statistical estimation error caused fundamentally by sparse data and individual transaction price dispersion, is one of the two major problems that transaction price index estimation methodology seeks to minimize. The other major problem is the potential for bias, as transaction samples may not be fully representative of the type and location of property one is interested in studying, or data may have omitted variables that bias the index. (See Case et al. 1992, Gatzlaff & Haurin 1997 & 1998, and Guo at al. 2014 for index comparison methodologies.)

Real estate transaction price indexing that attempts to control for the heterogeneity issue in a statistically rigorous and sophisticated manner has become widespread primarily only in the past generation, and largely focused on single-family housing. Investment property transaction price indices have been developed primarily only since the turn of the present century. (Early exceptions include Fisher et al. 1994, and Gatzlaff & Geltner 1998.) Two major different approaches to controlling for heterogeneity have characterized the development of transaction price indices. The first, hedonic indexing (based on hedonic price modeling), controls for heterogeneity by modeling property assets as bundles of characteristics (hedonic variables). This approach goes back to general economic price indexing of goods whose quality changes over time (Court 1939, Griliches 1961), and was early related to real estate (Kain & Quigley 1970), and developed further into equilibrium modeling and formal index number theory notably with Rosen (1974). With hedonic data one can regress prices onto characteristics and then compute an index by holding the property characteristics constant, revealing the pure price changes. The basic hedonic techniques were honed by the 1980s for housing. A single definitive specification and functional form was generally found to be illusive, though most models have tended to use
log prices as the depended variable. (See Halvorsen & Pollakowski 1981, Pollakowski 1982, Hill 2013.)

There are two major different hedonic specifications, the “chained” or “imputed,” and the “pooled” or “time-dummy.” The former, which re-estimates the price model on each period’s data, is the primal and theoretically more complete and flexible specification, the preferred model in principle (for example, it allows rigorous Laspeyres or Paasche price indexing useful in national accounts, and it satisfies “time-fixity” in that data updates do not generate backward historical revisions). But the chained hedonic is the most data intensive, and requires specifying a “representative property” to construct the index. The alternative is the pooled or time-dummy specification, which runs a single regression on the entire history with the time-dummy coefficients providing the price index. The pooled model is less data intensive but constrains the relative implicit prices to be invariant, thereby providing less structural information and a less “pure” price index (and making the index subject to backward revisions). A hybrid approach is the “rolling window” imputed model (de Haan & Diewert 2011). Most hedonic indices in the academic literature have been of the pooled dummy-variable type, and they are especially useful for commercial property due to data scarcity.

The major alternative to the hedonic approach is the repeat-sales regression. With data on properties that sell more than once, one can regress the log price changes over time within the same properties onto time dummy-variables representing the historical periods in the index, thus producing the repeat-sales index. The coefficients on the time-dummies trace out the price index based on the price changes experienced by the investors between the “buy” and the “sell” of the investment asset. This approach dates from Bailey et al. (1963), Bryan & Colwell (1982), and Case & Shiller (1987, 1989). The repeat-sales specification can be derived as a special case of
hedonic price modeling, ignoring changes in the hedonic values of the property between the buy and sell dates (e.g., depreciation is included in the price index unless explicitly addressed as in Shimizu Nishimura & Watanabe 2010). But the repeat-sales index can also stand on its own as a primal specification by viewing the object to be measured as the price-change experiences of the homeowners or investors (the dependent variable in the regression).

Following Case & Shiller’s seminal publications, there was a flowering of interest in repeat-sales indices for housing, stimulated in part by the idea of using them to form tradable house price futures contracts (Shiller 1993). Some push-back to repeat-sales indices came from those concerned about sample selection bias (Gatzlaff & Haurin 1997 & 1998, Meese & Wallace 1997, Munneke & Slade 2000 & 2001), and backward revisions in index histories as the repeat-sales estimation sample is updated (Clapham et al. 2006). In general, repeat-sales samples tend to show greater house price appreciation due to the nature of the repeat-sales sample (properties that appreciate more tend to be sold more frequently). And the nature of the estimation methodology causes repeat-sales indices to be particularly susceptible to historical revisions (updates of the repeat-sales sample inherently bring into the index the effect of first-sales that may have occurred far back in history).

To date, both in housing and commercial property, most of the regularly published indices have been repeat-sales rather than hedonic, particularly in the case of commercial property. (The only regularly published hedonic index of commercial property is the recently-launched vdpResearch Property Price Index of the Association of German Pfandbrief Banks, tracking property prices in Germany.) The popularity of repeat-sales indices in practice is probably due to the fact that they do not need hedonic data, are relatively robust to specification error and omitted variables, and they appear relatively transparent and easy to understand for
industry practitioners and the public. By the mid-1990s repeat-sales housing indices were being published on an on-going basis by Case-Shiller-Weiss Inc (now the S&P/Case-Shiller Home Price Index) and U.S. Federal housing regulators (now the FHFA House Price Index, see Abraham & Schaumann 1991, Calhoun 1991, 1996). Nevertheless, hedonic indices have also had substantial academic development, particularly in housing and urban studies, and they are also of interest in national economic statistics.

In fact, the innovation and honing of real estate transaction price indexing methodology during the past two decades has been quite impressive. Not only has index methodology been perfected, but large scale transaction databases have been developed, first in housing and more recently in commercial property. Hybrid specifications that combine elements of hedonic and repeat-sales indices have been developed and advocated. (See Case & Quigley 1991, Case et al. 1991, Quigley 1995, Knight Dombrow & Sirmans 1995, Meese & Wallace 1997, Hill Knight & Sirmans 1997, Clapp & Giacotto 1998.) At one point there was even a formal contest to see which index methodology was “better,” based on a common dataset made available to all academics. The result of the competition basically argued for a hybrid approach if sufficient data is available (Case et al. 1991). By the mid-1990s review compendia were being published in special issues of the leading real estate journals (Thibodeau 1997). Truly a plethora of tools and techniques are now available. For example, hedonic indices have been combined with appraisal or assessment data to deal with omitted variables or sparse hedonic data (Clapp & Giacotto 1992, Fisher at al. 2003, Fisher et al. 2007, Devaney & Diaz 2011, Gatzlaff & Holmes 2013). Repeat-sales techniques have been elaborated to allow value-weighted and arithmetic average indices (Shiller 1991) and total return indices (Geltner & Goetzmann 2000). Various methods for dealing with sparse data have been developed, including: Bayesian techniques (Goetzmann 1992,
Francke 2010); Pre-regression data manipulation methods forming matched samples that combine hedonic and repeat-sales approaches or effectively expand the usable sample size (McMillen 2012, Deng et al. 2011, Guo et al. 2014); Time parameterization specifications (McMillen & Dombrow 2001, Francke & Vos 2004, Francke 2008); Estimation techniques such as spatiotemporal autoregression (Pace et al. 1998, LeSage & Pace 2010, Chegut et al. 2014); and Post-regression index construction techniques such as filtering and curve-fitting (e.g., Hodrick & Prescott 1997) and frequency conversion (Bokhari & Geltner 2012). Recently a specialized hedonic specification has been proposed to allow the simultaneous estimation of structure value and land value indices from property asset price data, consistent with economic statistical national accounts criteria (de Hann & Diewert 2011, Diewert & Shimizu 2013).

5. SOME FINDINGS FROM PROPERTY PRICE INDICES

The developments in property price indexing described in the previous section have helped to shed light on some interesting questions about real estate price dynamics. Some of these have already been noted in Section 3. There we noted the tendency of private property market asset prices to move more sluggishly than corresponding liquid public securities market prices, although with volatility and cyclical amplitude of similar magnitude, and we noted that appraisal-based price indices tend to be even more lagged, as well as somewhat smoothed and damped. In this last section we will take a broader look at a few other points of interest.

An important characteristic of investment property pricing that is revealed in part by price indexing is that real estate asset market pricing seems to share the characteristic of securities markets asset pricing that much of the volatility and cyclical price movements are driven more by capital market forces than by news or changes in the underlying operating cash
flows that fundamentally undergird the value of the capital assets. Apparently, at least in the case of investment property, the relatively high friction in the private property market (search and transactions costs), which in part causes the sluggishness noted in Figure 2, does not prevent asset pricing from exhibiting this type of “excess volatility” first suggested by Shiller (1981). Viewed from the perspective of the classical present value model, longitudinal changes in the discounted present value of property assets in the U.S. are driven more by changes in the discount rate (the opportunity cost of capital, or realistic expected total returns going forward) than by changes in the expected future net cash flow stream. (Geltner & Mei 1995, Plazzi et al. 2010.)

A second important feature of investment property pricing that echoes major findings in the stock market is that there exists a type of pricing factor that is not immediately related to risk or volatility as these can be easily quantified and understood in classical financial economic capital market theory, a type of real estate analog to Fama-French pricing factors in the stock market (Fama & French 1992, 2004). In the case of commercial real estate, the non-risk factor is not exactly the same as the market capitalization and book/market ratio factors made famous by Fama and French, but it may have some commonality with some aspects of those. In real estate the most obvious and persistent non-risk pricing factor is the distinction between what is often termed “institutional” and “non-institutional” investment property. It has long been noted from surveys and empirical transaction price data that smaller (by value) properties that tend to be located in less prime locations or that have older or lower-quality structures trade at higher initial cash flow yields. The gap is often in the neighborhood of 200 basis-points or even more. Commercial property price index data now allows one to see whether this gap in cash yield is offset by either a lower price growth trend or greater volatility in the “non-institutional”
properties, and in fact this does not appear to be the case in either respect, at least since around the turn of the century when the commercial property transaction price based indices provide a historical record (Geltner et al. 2014, Chapter 25). In particular, the CoStar Commercial Repeat-Sales Index (CCRSI, launched in 2010, inception 1998) is based on all commercial property sales in the U.S. and is reported separately for “Investment” (corresponding to “institutional”) and “General” (corresponding to “non-institutional”) properties. From 1999 to 2014 the average annual price growth rate was 3.0% for institutional property and 4.2% for non-institutional, while the annual volatility was 10.3% for institutional versus 9.6% for non-institutional (CoStar Group 2014). The magnitude of the price crash in the GFC and subsequent recession was 40% (of peak value) in the institutional index versus 36% in the non-institutional index. The greater total returns provided by non-institutional properties do not seem to be justified by greater “risk” as traditionally measured. This “non-institutional factor” may reflect segmentation in the financial markets, as different sources of financing and different types of investors are typical of the two different types of properties. There may also be an uncertainty premium in the smaller properties, as information may be less transparent among them.

A third interesting point that is revealed by real estate price indices regards the similarity and difference between commercial (investment) property and single-family housing price trends, including the relationship to the real economic business cycle. Figure 3 depicts a longer term historical extension of the NCREIF NTBI index of commercial property prices described in Figure 2 (Geltner 2013) along with Shiller’s long-run historical home price index and the Consumer Price Index (Shiller 2014). Recessions are indicated by the shaded bars. Both of the
real estate price indices track nominal values of same-property prices (i.e., they include the effect of both structure depreciation and capital improvement expenditures). It is interesting to note that in the U.S., single-family home values have shown a greater long-term price growth trend than commercial real estate with home prices generally slightly outpacing inflation, while investment properties track slightly below inflation. At the broad-brush aggregate level shown here, home prices (as distinct from sales volume) were not very cyclical until the great crash of 2007-09, while commercial properties experienced two major crashes prior to the mid-2000s, one in the early/mid-1970s and another in the late 1980s/early’90s. Investment property may have had greater cyclical tendencies than single-family housing for most of the post-war history. On the other hand, housing is a much larger sector of the economy, with a consumption multiplier effect that CRE lacks, making housing much more influential than CRE in the business cycle. Commercial real estate tends to be a lagged effect of the business cycle (particularly the space market), while housing has often been a leading or causal factor, though until the GFC housing’s influence was not primarily through price change.

The fourth and final point which CRE price indexing can suggest in a rather graphic way relates to one of the initial points raised at the beginning of Section 2, about the nature of property markets as highly heterogeneous cultural phenomena. Figure 4 displays two price indices of commercial investment property assets in Germany, quarterly from the end of 2009 to through 2012. The vpd Property Price Index is a hedonic transactions price based index of commercial property produced by the German mortgage bankers association. The index labeled “PureProperty” is based on publicly traded European REITs and listed property companies holding properties in Germany, de-levered in the manner described in Section 3 regarding the FTSE-NAREIT PureProperty® Index (Elonen 2013). In the case of Germany, the two indices
reflect not so much different types of data or index construction methods (though that is also the case), but rather they highlight the different price dynamics of different types of asset markets, trading fundamentally the same types of assets, income-producing commercial investment property. The three year period covered by the chart were eventful ones in the German economy and financial markets, including the initial recovery out of the GFC, followed by the crisis in the euro in 2011, which by 2012 led to capital flight into Germany. The European stock markets on which the “PureProperty” index is based are public securities markets, a type of market in which prices reflect an equilibrium that moves very freely and quickly responding to news and shifts in supply and demand. The private property market in which German investment institutions trade the properties whose prices are reflected in the vdp Index is a much quieter and more traditional arena. The resulting difference in price dynamics is obvious in Figure 4 (along with a little statistical estimation noise in the vdp Index).

6. CONCLUSION

The preceding discussion has covered a lot of ground. Real estate assets are a large and very important component of the national wealth and the capital markets, and their price dynamics present a fascinating and important phenomenon. Heterogeneity of various types, among assets, markets, and data sources make the study of real estate pricing both challenging and uniquely interesting, not least for the econometricians and urban economists who have pioneered important new price indexing methodologies. Tremendous development in data sources and price indexing over the past few decades, and still continuing apace both in the U.S.
and abroad, relating to both housing and commercial property assets, has already provided
important findings and insights about real estate pricing and price dynamics, and no doubt it will
continue to provide more.
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Quan D, Quigley J. 1989. Inferring an investment return series for real estate from observations on sales. *Real Estate Econ.* 17:218–30


Figures:

Figure 1: Property Asset Market Functioning
Figure 2: Four Definitions & Measures of U.S. Investment Property Prices, 2000-2014:

<table>
<thead>
<tr>
<th>1999 Value = 1000*</th>
<th>PP</th>
<th>Dem</th>
<th>NTBI</th>
<th>NPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geometric Mean</td>
<td>0.79%</td>
<td>1.13%</td>
<td>1.04%</td>
<td>1.05%</td>
</tr>
<tr>
<td>Volatility</td>
<td>5.50%</td>
<td>6.83%</td>
<td>5.55%</td>
<td>2.83%</td>
</tr>
<tr>
<td>1st order Autocorrelation</td>
<td>8.52%</td>
<td>-10.98%</td>
<td>-13.14%</td>
<td>83.16%</td>
</tr>
<tr>
<td>Boom</td>
<td>69%</td>
<td>81%</td>
<td>85%</td>
<td>7%</td>
</tr>
<tr>
<td>Bust</td>
<td>-38%</td>
<td>-42%</td>
<td>-34%</td>
<td>-25%</td>
</tr>
<tr>
<td>Recovery</td>
<td>60%</td>
<td>70%</td>
<td>38%</td>
<td>37%</td>
</tr>
</tbody>
</table>

Sources: FTSE, NCREIF. Figure updated and modified from Geltner et al. 2014, Chapter 25.
Figure 3: CPI & Nominal CRE & Home Prices Since 1970²

CRE Same-Property Transaction Prices, Shiller Nominal Home Price Index, CPI
1969=100  shaded bars = GDP recessions:

² Source: Geltner 2013.
Figure 4: Stock Market Based & Transactions Based CRE Price Indices for Germany

Germany Commercial Property Capital Value Indices:
4Q1999 = 100.