

A Simplified Transactions Based Index (TBI) for NCREIF Production

by

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Summary:

This paper reviews the original TBI as it has been produced at MIT from 2006 through 2010, and explores a simplified average-price-based alternative version for possible NCREIF production and publication, including detailed operating instructions for such production.

The paper first briefly describes in relatively non-technical terms the nature and role of the “transactions based index” (TBI) that the MIT Center for Real Estate, with NCREIF cooperation, has been producing and publishing quarterly for five years based on sales of properties from the NCREIF Property Index (NPI) database. A transactions based index such as the TBI is seen to be useful as a *complement* (not substitute) for the appraisal-based NPI. It is noted that during the past five years the TBI has in fact gained a substantial user constituency in academia, industry, and government.

In this paper a simplified methodology is proposed for producing a TBI without using regression analysis. The simplified method is based on the average ratio each quarter of the sale price divided by the recent prior appraisal for the properties sold from the NPI database. This index construction method can be implemented in Excel without specialized statistical software or knowledge. This version of the TBI is more amenable to NCREIF production, and may also appear more transparent to a non-academic practitioner community. It is therefore likely to be more commensurate with ease of communication to industry researchers. In the present paper this simplified TBI is labeled “NTBI”, for “NCREIF” version, to distinguish it from what is here labeled the “MTBI” for the pre-existing “MIT” version.

This paper compares the recent historical results of the NTBI with the MTBI. It is found that the NTBI works well and very closely replicates the MTBI at the aggregate all-property level. For producing sector level transactions based indices (separate indices of apartment, industrial, office, and retail market segments, or conceivably other such breakouts or sub-indices, such as geographic regions) it is recommended here that the transaction/appraisal differences be based on the all-property sample of sold properties, pooled across all of the sectors. This differs from the way the sector-level MTBI indices were produced. But in fact the MTBI sector indices have suffered from small transaction samples, and the recommended NTBI sector index procedure here is based on the reasonable assumption that transaction/appraisal differences do not tend to vary systematically across sectors.

The only major loss in a replacement of the MTBI by the proposed NTBI would be the Demand and Supply indices that have been being produced at MIT, and that are based necessarily on regression models. These indices are particularly useful for market diagnostic purposes, to quantify liquidity in the institutional property market, and to provide a measure of “constant liquidity price movements” (in the case of the Demand Index). However, these metrics have been primarily used by academics and in basic research and to date have found only limited use in industry.

Considering the above, the author’s recommendation is that NCREIF should undertake regular quarterly production and publication of what is here labeled the “NTBI” as an official NCREIF product (though for publication this could simply continue the “TBI” label). In addition, it is the author’s suggestion that NCREIF allow occasional updates of the of the Demand and Supply indices as they have been being produced at MIT, not as official NCREIF products, but to serve special requests. It would be understood that any such production of TBI Demand and Supply index updates must be produced by parties who have the capability to run the necessary regression-based models on their own (with the necessary data supplied by NCREIF under confidentiality agreements), and explicitly without NCREIF endorsement or confirmation.

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A Simplified Transactions Based Index (TBI) for NCREIF Production

by David Geltner

1. Background

“In summary, we argue that the NCREIF Index is ready to evolve into two more specialized successor families of index products: one tailored for fundamental asset class research support, and the other tailored for investment performance evaluation benchmarking and performance attribution.”

-- From: D.Geltner & D.Ling, Benchmarks & Index Needs in the U.S. Private Real Estate Investment Industry: Trying to Close the Gap (A RERI Study for the Pension Real Estate Association), October 17, 2000.

The National Association of Real Estate Investment Fiduciaries (NCREIF) is a non-profit industry association founded in 1982 to serve the institutional real estate investment community as a non-partisan collector, processor, validator and disseminator of real estate performance information. NCREIF’s seminal information product is the NCREIF Property Index (NPI) which publishes quarterly investment performance results for properties held on behalf of tax-exempt institutions by NCREIF’s data-contributing members, which represent the majority of all major U.S. pension fund core real estate investment holdings. The NPI has become a major reference and benchmark of U.S. real estate investment performance and is widely cited and used in both academic and industry research.

An issue which has long been raised regarding some types of research is the fact that the NPI is based on appraisals, or estimated valuations of its constituent properties as reported by the data-contributing members. The quote at the top of this page is from a 2000 white paper commissioned by PREA which suggested that, as valuable and relevant as the NPI is for many important types of analysis and research, the industry could benefit from the development of complementary index products based more directly and purely on realized transaction prices of properties sold in the marketplace.

With this in mind, the MIT Center for Real Estate proposed to NCREIF in 2004, and NCREIF supported, the development of a “transactions based index” (TBI), based on the actual transaction prices of the properties sold from the NPI database. Over the course of 2004 and 2005 the TBI was developed at MIT by a team led by David Geltner and Henry Pollakowski at MIT and Jeff Fisher at Indiana University. The TBI methodology and initial index results were presented at several academic and industry research gatherings during 2005 and 2006, and published in great detail in a 2007 article in one of the top academic real estate journals (hereinafter referred to as “FGP2007”).¹ At its annual fall meeting in 2005 NCREIF approved the regular on-going quarterly production and publication of the TBI by, and at, the MIT Center for Real Estate, with the proviso that the TBI was not to be labeled or identified as an official NCREIF product. MIT launched the regular quarterly publication of the TBI in February 2006 with the 4th-quarter 2005 index results (and index history going back to 1984), and MIT has published the TBI every quarter since then (now through 4Q2010).²

¹ J.Fisher, D.Geltner, & H.Pollakowski, “A Quarterly Transactions-based Index of Institutional Real Estate Investment Performance and Movements in Supply and Demand”, *Journal of Real Estate Finance & Economics* (2007) 34:5-33.

² The TBI has been published electronically, on the MIT/CRE website at: <http://web.mit.edu/cre>. Note that, like NCREIF, MIT has always clearly stated that the TBI is not an “MIT product”, and is not to be officially named or labeled as such. The MIT

In the five years since the start of the TBI's regular publication, the index has gradually gained an important user constituency. The TBI is frequently cited in academic articles (as of late 2010 the FGP2007 article had 39 citations in Google Scholar³) as well as in industry reports and white papers⁴. The Federal Reserve Board research staff employs the TBI in their quarterly update to the FOMC, and both Bloomberg and the Federal Reserve Bank of St.Louis have requested redistribution rights for the TBI.⁵ Ibbotson Associates regularly provides the TBI by request to selected clients.

Purpose of the present report:

With the above in mind, NCREIF is presently contemplating taking in-house the production and publication of the TBI, as a NCREIF product. Correspondingly, MIT is looking forward to transferring much or all of the TBI production and publication responsibilities to NCREIF. The purpose of the present paper is to present some ideas and considerations to help facilitate this transition. In particular, a simplified version of the TBI will be presented and proposed.

2. What is the TBI & Why is it Useful?

As it has been produced at MIT, the TBI is a set of related indices all using the same underlying transaction price based methodology, as described in the FGP2007 article (available on the MIT/CRE website). The TBI is produced at the "All-property" level, which aggregates all NCREIF sold properties as if in a single population. The TBI has also been produced separately at the national sector level for each of the four core commercial property usage type sectors: apartment, industrial, office and retail, in each case based on independent separate (purely within-sector) populations. For each of these five aggregations, the TBI product suite has included four indices: Price change (or capital return), Total return (which includes income), Demand-side reservation price changes (referred to as the "Demand Index" or "constant liquidity index"), and Supply-side reservation price changes (referred to as the "Supply Index"). Thus, there are in all 20 indices (4 different indices each for the five different aggregations including the four sectors and the all-property aggregate). Like the NPI, the TBI is a quarterly index, updated at the end of each calendar quarter. The TBI has been considered preliminary during the current calendar year until the final end-of-year update after which the index has been "frozen" (not subject to any further changes).⁶

Center for Real Estate has always provided the TBI *gratis* and *pro bono* as a service to the academic and industry research communities.

³ As another indication, this article ranks 9th out of 141 articles published in the *JREFE* from 2006 through 2008 in the number of its subsequent citations (by other articles) within the Social Science Citation Index, the premier index of academic journals in the economics and finance field. This is a good measure of the relative influence of an article in the academic community.

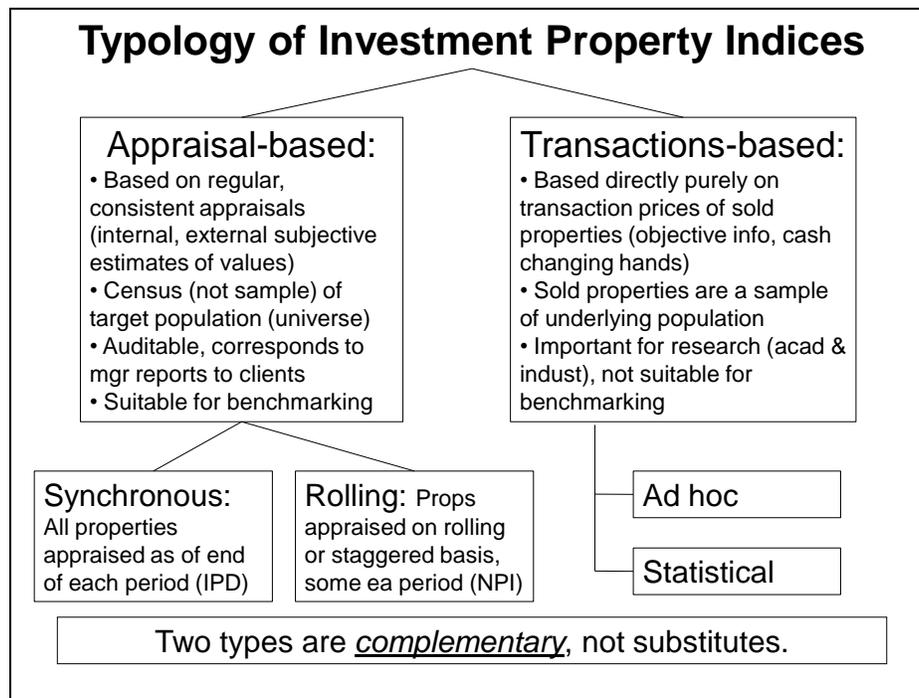
⁴ A typical example is: G.MacKinnon, "REITs and Real Estate: Is There Room for Both in a Portfolio", PREA Research Report, October 2010.

⁵ Rights which, through 2010, no one had authority to give.

⁶ This "freezing" of the TBI is done for convenience of users, including to give index *levels* a permanency as reference benchmarks for historical price levels. It is also done for consistency with the official NPI, which is also frozen. As a practical matter, the TBI has generally not experienced significant "backward adjustments", or changes to its previously estimated history as new sales data is appended to the historical database each quarter. (The TBI is not a "repeat-sales" index, which is a type of price index construction methodology in which backward adjustments can be more of an issue.)

To better appreciate what the TBI is and how it is useful in the context of the institutional real estate investment industry that NCREIF serves, let us step back and survey broadly the types of indices that can be constructed for tracking and quantifying the pricing and investment performance of commercial properties in the U.S. As suggested in Exhibit 1, at a very broad-brush level one can distinguish two major types of investment property asset price and/or return indices: appraisal-based and transactions-based.⁷

Exhibit 1



Transactions-based & Appraisal-based Indices:

Appraisal-based indices like the NPI are the original and “classical” type of performance index in the institutional real estate investment industry. They are uniquely useful by virtue of providing a complete and auditable “census” of all of the properties in a given specifically identified population of interest (e.g., NCREIF approximates the “universe” of all core properties held by or on behalf of major tax-exempt institutions in the U.S., all the data-contributing members of NCREIF). Because of this, and because the appraisals on which such indices are based correspond closely to how net asset value and

⁷ This ignores other types that are less relevant in the present context, such as REIT-based indices, and survey-based “notional” indices based on brokers’ opinions. The description of “Appraisal-based” indices in Exhibit 1 has in mind in particular the rigorous, auditable investment performance benchmarking oriented indices compiled from exhaustive sets of property investment database-contributing members’ valuation reports, such as that of NCREIF and the Investment Property Databank (IPD). Other types of what might be termed “expert estimation-based” indices are also possible, such as Green Street’s recent “GSA-CPPI”, but may differ in important ways from the traditional appraisal-based indices considered here.

investment performance is officially reported by funds and investment managers to their investors and clients, appraisal-based indices are most appropriate as benchmarks for gauging and understanding investment management performance, and for tracking at a broad level the fundamental property valuations underlying the official “book value” or “carried value” of the institutional investor clients of such investment managers.

However, appraisal-based indices tend to exhibit what researchers refer to as “smoothing” or “lag bias”. By necessity and norms of practice, the property-level appraisal process that underlies appraisal-based indices tends to be more conservative about recognizing value changes, and more “backward-looking” for price discovery and documentation, than are the principal parties engaging in actual transactions. Also, in some cases the appraisals (or valuation reports) used in the index are effectively not updated for all properties as of the end of each period (i.e., the appraisals in the index are staggered or rolling in time). The overall result is that appraisal-based indices tend to exhibit dampened market cycle amplitude and/or lagged turning points in the cycle, as well as lower return volatility, compared to transactions-based indices. This smoothing and lagging bias can be problematical for certain types of investment industry research, including market tracking, trading strategies, portfolio analyses, and comparisons across major investment asset classes (such as real estate, equities, and fixed income).⁸

There are also some important populations of commercial investment properties that are not regularly appraised (e.g., the broad population of *all* U.S. institutional commercial property, beyond just that held by NCREIF members, including properties held by REITs and properties collateralizing CMBS). For such properties, appraisal-based indices are not possible, but transactions-based indices can and are produced.⁹ Therefore, for apples-to-apples comparisons between NCREIF property performance and such broader populations, a transactions-based index for NCREIF properties is useful in principle.

Transactions-based indices, if well constructed, can address many of the above-noted issues concerning appraisal-based indices, and provide a different perspective more directly reflecting movements in the pricing within the asset marketplace. Transactions based indices thereby can provide a very useful and interesting *complement* to (but not substitute for) appraisal-based indices, in the context of NCREIF’s mission. Transactions-based indices by definition are based directly and purely on actually consummated property asset sale transactions. Apart from possible reporting or recording errors, they are thus based on completely objective price information, rather than the more subjective and judgment-based valuation estimates that underlie appraisal-based indices. Methodologically, transactions-based indices are in principle completely replicable. Transactions based indices have the theoretical virtue of being based on the actual timing and amount of *cash changing hands* in the free market, thereby obeying

⁸ For example, appraisal-based smoothing and lagging have the effect in classical mean-variance optimized portfolio allocation research of making the role of the private real estate asset class appear greater than it actually is in comparison with the other asset classes that do not suffer from appraisal smoothing effects, such as stocks and bonds. This undercuts the usefulness of appraisal-based real estate indices in mixed-asset investment analysis research and can undercut the credibility of real estate as a core institutional asset class. Technically, the problem is that the smoothing and lagging bias tends to reduce real estate’s apparent volatility and covariance with the other asset classes.

⁹ The initial example is the Moody’s/REAL Commercial Property Price Index (CPPI), a repeat-sales index based on the Real Capital Analytics Inc database of property sales over \$2,500,000, based on methodology developed at the MIT Center for Real Estate, produced and published monthly since December 2006. A similar more recent such index is the CoStar Commercial Repeat-Sales Index (CCRSI), produced and published monthly by CoStar Group since August 2010.

the classical dictum: “*follow the cash.*”¹⁰ Transactions prices, in contrast to appraisal-based valuations, directly reflect the current equilibrium, such as it may be, between buyers and sellers in the asset market at any given time. All of the above gives transactions-based indices a certain type of credibility and meaningfulness both among academic economists and among many practitioners and policy makers. Such credible price tracking information can be useful for the real estate investment industry, helping to raise the credibility and depth of understanding of the industry among a broader constituency. Transactions based indices are also a useful practical tool in conjunction with appraisal based indices, as the transactions based indices tend to temporally lead the appraisal indices in the major price movements or turning points. Transactions based indices therefore tend to be more predictive, and they reduce the smoothing and lagging bias problem noted previously.

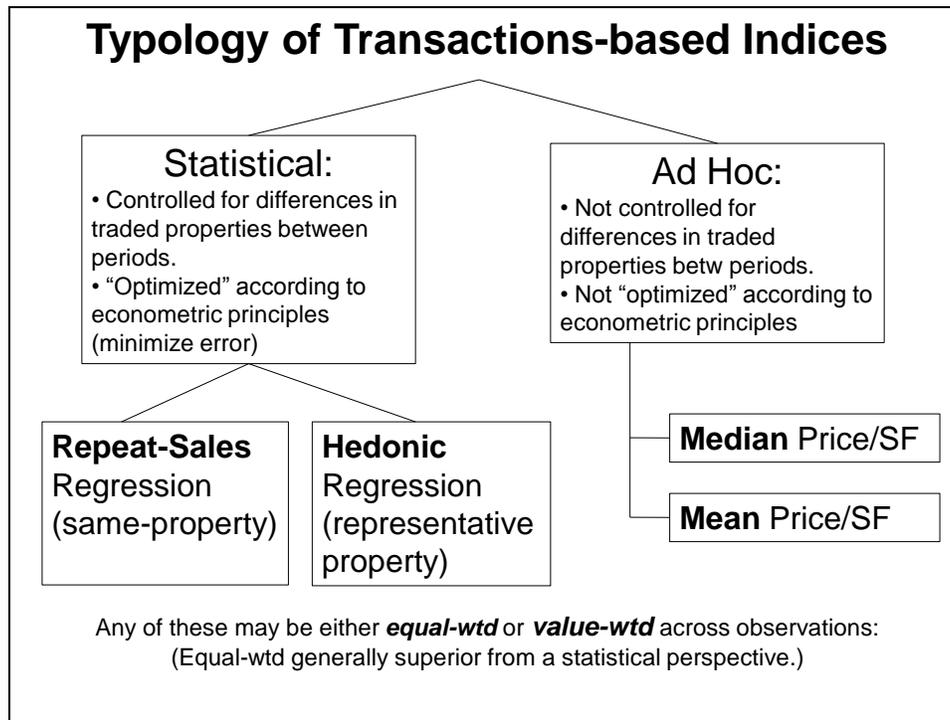
Types of Transactions-based Indices: Ad hoc vs Statistical...

With this in mind, let us continue our overview of index typology, now focusing within the world of transactions-based indices. Here one can distinguish two major approaches to transactions-based index construction, as indicated in Exhibit 2 (on the next page). *Ad hoc* price indices are based on simple average price metrics, without use of econometric optimization techniques or explicit control for differences among the properties transacting in one period compared to the next. *Ad hoc* transaction price based indices have been around for a long time in the housing industry, such as the National Association of Realtors Median Home Price Index. Similar such indices in commercial real estate tend to be more recent and not as high profile or not regularly published, but are available from sources such as Real Capital Analytics and CoStar (among others). But *ad hoc* price indices have more serious problems for commercial real estate than for housing, because of the much greater degree of heterogeneity across individual properties in the commercial market. This leads to a major apples-vs-oranges problem in comparing the average prices of properties sold one period with the average prices of properties sold the next period. If, for example, the average price per square-foot increases from one period to the next, to what extent is that due to an actual increase in same-property (or “same-store”) asset prices, or rather to some sort of “flight to quality” in which a larger proportion of “premium” assets were sold during the second period? Such *ad hoc* indices also do not take advantage of the capabilities of modern statistics and computational power to minimize error or noise in the price indices.¹¹

¹⁰ Good transactions-based indices, like the TBI, strive to filter out from the index database deals that are not “arms length”, whose prices do not reflect free market exchange.

¹¹ A major attempt to produce what would here be classified as an *ad hoc* transaction price based index of commercial property occurred in 2007 with the launch by Standard & Poor’s of their S&P/GRA Commercial Real Estate Index available for trading on the CME (ticker: SPCREX). This was a type of average price per square foot index that attempted to control for differences in property types trading from one period to the next, but in an *ad hoc* manner without use of formal regression models. The index folded at the end of 2008 after it failed to register a significant decline in prices during the market collapse of that year, and with no trading of the index taking place. A more recent index which is a bit hard to classify is the Green Street Commercial Property Price Index (GSA-CPPI, launched in 2009), which is based on Green Street’s value estimates of REIT-held properties (used to construct Green Street’s REIT NAV estimates). As the author understands this index, though Green Street states that transactions are considered in the GSA-CPPI’s computation, the GSA-CPPI attempts to represent a leading indicator of property price trends by including information gleaned from brokers and information about deals in the negotiation phase in addition to closed transactions. The exact index construction methodology is not clear, and it is not clear to what extent formal econometric models are employed. The GSA-CPPI is interesting, but seems to be clearly (and perhaps purposely) a subjective measure, at least in part, and in that sense more akin to an appraisal-based index than a pure transactions-based index, though a very different type of “appraisal” process than what underlies the NPI.

Exhibit 2



For these reasons, most academics, and more recently some of the more sophisticated industry researchers, advocate statistically rigorous, econometrically-based transactions price indices. Such indices make use of statistical regression to estimate the changes in market prices from one period to the next, with more explicit and effective controls for differences in the type and quality of properties transacting in different periods. On the other hand, *ad hoc* indices can sometimes have an advantage over statistical indices in that many industry practitioners lack familiarity or comfort with regression models of property prices. The *ad hoc* indices may appear more transparent or easy to understand without specialized expertise, in some cases.¹²

The TBI as it has been produced at MIT represents an econometrically rigorous statistical index, based on all, and only, the properties sold each quarter from the NCREIF population of properties (that is, the properties included within the NPI). As will be presented later in Section 4, this paper will propose a simplified version of the TBI that might be classified as an *ad hoc* index by the criteria described in this section. However, it will be shown that the proposed simplified methodology replicates extremely closely the econometrically based TBI that has been being produced at MIT. Indeed, the simplified TBI methodology proposed in this paper attempts to have “the best of both worlds”, by taking advantage of NCREIF’s unique data advantages to produce an index that essentially reflects the rigor and purity of a

¹² This is not necessarily always true, particular if one delves into the details of index production, and in any case may be a problem more of communication about index methodology than an inherent or irreducible problem of the index methodology itself. It is also the type of problem that tends to go away over time, as the industry gradually learns about the transactions based indices, which are a relatively new type of information product in commercial real estate.

statistical transactions based index while retaining the transparency and intuitive appeal of a simple *ad hoc* type index, as we shall see in the next section.

3. How does the TBI work?

In this section we will review the way the TBI has been being produced at MIT so as to facilitate the understanding of, and transition to, the simplified TBI production method being proposed in this paper.

As produced at MIT, the TBI is based on a statistical regression model of the transaction prices of the NCREIF sold properties. This is known in the academic literature as a “hedonic” price model. It will be useful to understand something about this methodology even if NCREIF will use a different methodology going forward, as the TBI to date has been based on this price model and the proposed simplified TBI in fact tracks the regression-based index extremely closely.

A hedonic price index controls for the differences between properties transacting in consecutive periods of time by the use of “hedonic variables” in a regression model of property transaction prices. The hedonic variables describe the essential price-determining characteristics of each property. In classical academic hedonic price models the explanatory variables typically include parameters such as the size, age, and location (e.g., neighborhood, or distance from CBD, or from airport, etc) of the property. The regression’s estimated coefficients on the hedonic variables control for *cross-sectional* differences which could affect prices among the properties in the transaction sample. If the hedonic variables are all temporal constants (i.e., they don’t vary across time within a given property, e.g., property size), then the price model will also include time dummy variables (i.e., set equal to one for the period when the property transacts, zero otherwise). The coefficients on these time-dummy variables will then reflect the *longitudinal* (i.e., *across time*) differences in prices, and it is these longitudinal differences that matter for constructing the price index.

If some of the hedonic variables also vary across time (e.g., property age, or more to the point: property’s current appraised value), then the price index must be constructed by defining a “representative property” whose hedonic characteristics are used in the right-hand side of the equation. The price index is then defined by the changes in the model’s predicted price for the representative property each period. To reflect “same-property” (or “same-store”) asset price changes in the index such as investors actually face, it is necessary to somehow reflect in the hedonic variables the aging of the properties from one period to the next, so that the representative property reflected in the index ages one-for-one with the passage of calendar time (this of course is the case in property appraisals as they are updated for the same building over time).

A data challenge in constructing a hedonic transactions-based index is that it requires good and consistent hedonic data on all the properties in the transaction sample, for all of the important hedonic variables. This is often problematical for commercial property in the U.S. Another (related) problem is the issue of defining an appropriate “specification” of the model, that is, which hedonic variables to use, and how to use them (e.g., what functional form, for example, shall one consider building age as a linear variable in years, or a quadratic variable in years and years-squared, or what?...) These challenges often make it difficult to construct useful hedonic price indices of commercial property, particularly from a practical perspective for industry usage as opposed to purely academic study.

The TBI's Advantage as a Hedonic Price Index:

Fortunately, the NCREIF Index database provides a unique way to get around this data limitation, because the properties in the NPI are all subject to frequently updated appraisals that are generally of high quality and largely consistently made. The recent appraised value (or, more exactly, the NCREIF data-contributing member's officially reported valuation as employed in the NPI) of each property just prior to its sale can be employed as an excellent "catch-all" composite hedonic variable, for use on the right-hand-side of the hedonic price model.¹³

The recent appraisals capture almost all of the cross-sectional dispersion in the price-determining property characteristics across the properties that are sold in the NCREIF database. The recent appraisals also capture most of the longitudinal variation in property values, as the appraisals are frequently updated and do largely reflect the changes over time in the market value of the properties (as indicated in the appraisal-based official NPI capital return index). The time-dummy variables in the TBI price regression therefore don't have to do as much "work" as typical time-dummy variables in a more traditional academic hedonic price model. They don't need to capture all of the longitudinal changes in value, but rather only the relative *difference* between transaction prices and appraisals each period. They thus reflect, and enable "correction" of, the effect of the previously noted smoothing and lagging bias in the appraisals.

The TBI is then constructed essentially as indicated in Exhibit 3 (next page), as the percentage price changes implied by the changes in the model's predicted transaction price of the TBI's representative property each period. The representative property is constructed so that its appraised value each period (which is an explanatory variable on the right-hand-side of the price regression equation) reflects the appreciation returns in the appraisal-based NPI capital return index. The TBI's predicted price for the representative property thus reflects both the evolution of the appraised values in the NPI as well as the model's estimated time-dummy coefficients which reflect the relative differences each period between the transaction prices of the NCREIF properties sold that period versus their recent appraised values.¹⁴

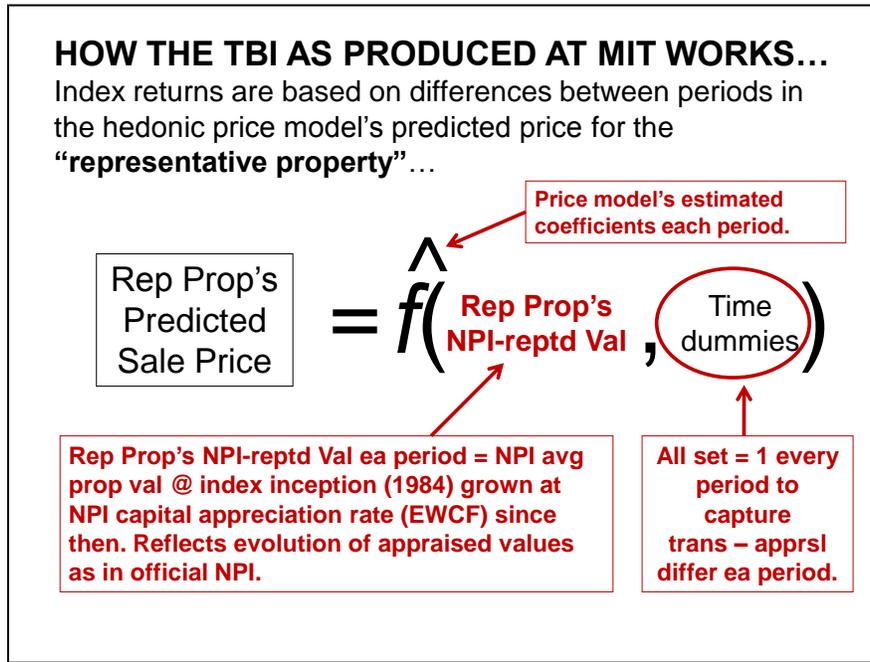
In essence, one can think of the TBI capital return each period as consisting of two additive components: (1) The change in the Representative Property's appraised value since the previous period (as reflected in the NPI capital return index); plus (2) The change in the relative *difference* between the transaction prices and the appraised values (reported two quarters earlier) between the previous period and the current period (the difference in the hedonic price model's time-dummy coefficients between the last period and the current period). For example, suppose the appraisal-based NPI capital return in Quarter "t" is 2%, and suppose in Quarter "t" transaction prices (of deals closed in Quarter "t") average 5%

¹³ To be more precise, the TBI uses the NPI reported valuation two quarters prior to the sale, so as to insure independence between the appraisal and the subsequent transaction price. In many cases the data contributor knows of a forthcoming agreed transaction price, and simply reports that as the property valuation for the NPI in the current quarter of the sale transaction and often even in the prior quarter. This is a practice that is entirely proper for the NPI, but would inject a tautological element into the regression model of the price if we did not go back to an earlier valuation report. We find that two quarters prior to sale is sufficient.

¹⁴ The previously-noted two-quarter lag is also accounted for in the index construction. That is, the representative property's "appraised value" reflects the NCREIF appreciation index two quarters earlier, as the model's time-dummy variable coefficients reflect the differences between the current transactions (closings) prices and those properties' appraised values two quarters prior.

above the “t-2” appraisals of those same sold properties. Suppose further that in Quarter “t-1” transaction prices averaged 4% above the “t-3” appraisals (for the “t-1” sold properties). Then the TBI capital return for Quarter “t” would be (in essence): $2\% + (5\% - 4\%) = 2\% + 1\% = 3\%$.¹⁵

Exhibit 3



4. Addressing NCREIF’s Requirements for TBI Production: A Simplified TBI...

The focus of the present paper is to assist NCREIF in making the TBI an official NCREIF information product, including NCREIF taking over responsibility for production and publication of the TBI. With this in view, an important consideration is the methodological nature of the TBI. As it has been produced at MIT, the TBI is based on an econometric model, the hedonic regression price model described above. Yet NCREIF does not wish to take on the production and publication responsibility for an index that has the level of statistical modeling involved in the pre-existing TBI, including in particular the hedonic price regression model that is at the core of the TBI as it has been produced at MIT.

This leads to the present proposal for a slightly different “TBI” based on a simplified methodology, in effect, a type of *average price* index not relying on regression analysis. In essence the simplified methodology being proposed is to compute the average each quarter of the ratio of the relative price difference between the transaction price and the recent prior appraised (NPI-reported) valuation of the sold properties each quarter, and then to apply this average ratio to the NPI capital return index level, to

¹⁵ This is a slight simplification, as the model actually contains some other explanatory variables and other features of the statistical regression system, and as a mathematical device the MIT TBI’s regression model works in logs. But the above numerical example captures the essence of how the TBI works, and also suggests intuitively why and how a simplified version of the TBI could work, as will be described in the next section.

“convert” it to a transaction price based version. Such a procedure might be labeled as “*ad hoc*” according to the earlier discussion of transaction based index methodologies in Section 2. While it was suggested there that in general there can be problems with such methodology for commercial property price indices, we shall see in this section that a NCREIF-based average price index in the spirit of the TBI can be quite effective, essentially just as effective as the econometric based TBI that has been being published at MIT.

Why an Average-Price-Based TBI could work well for NCREIF:

The reason why a simple average-price based index can work well in the NCREIF context is fundamentally the same reason that we noted earlier as to why the TBI’s hedonic price regression model is able to avoid the major data challenge that faces most commercial property hedonic price indices. This reason is NCREIF’s unique database of high quality, frequently-updated, consistent appraisals of all the properties in the NCREIF population. These appraisals serve as the major right-hand-side explanatory variable in the TBI regression model of transaction prices, by capturing most of the cross-sectional and longitudinal dispersion in NCREIF property sales prices. In the TBI price regression, the appraised value variable is the dominant explanatory variable, with a coefficient very near unity and a standard error barely a percent or two (“*t-statistic*” in the 50 to 100 range or more), meaning that the vast bulk of the price dispersion among NCREIF property sales is explained reliably and directly by the appraised value.

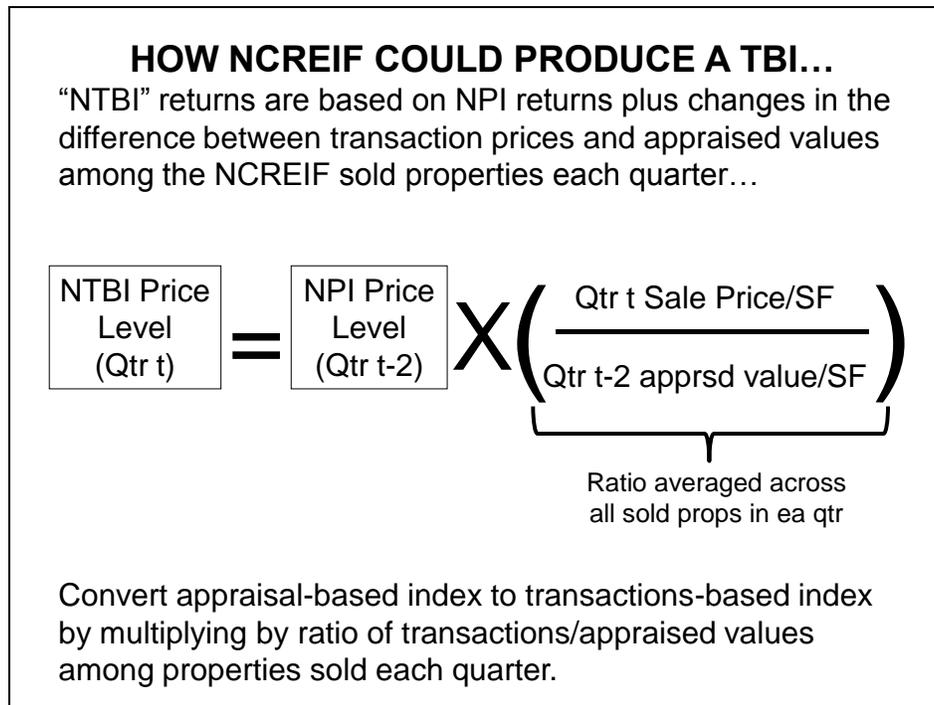
Essentially, the only thing one has to do to create a good transaction price model of NCREIF property sales is to estimate the relative *difference* (or ratio) between the sale price and the recent appraised value among the properties selling within each period, and then multiply the average of these ratios each period times the appraisal-based NPI appreciation index level to convert it to a transactions price based index level each period (as suggested by the numerical example at the end of Section 3). In the existing TBI as it has been produced at MIT the job of estimating the average difference between transaction prices and appraised values each period is done in the hedonic price regression model by the time-dummy variables. Those estimated differences are then applied to the index’s “representative property” whose appraised value evolves exactly as the appraisal-based NPI capital index, to, in effect, “convert” the NPI to the TBI.

But it is important to note that the basic statistical process that is used in the MIT TBI is what is known as “Least Squares” regression (LS for short), which means that the computer calibrates the model by picking coefficient values (on the explanatory variables, including the time-dummies) such that the sum of the squared values of the “residuals” (the differences between the model’s predicted value of each sold property and the actual selling price of each sold property) is minimized. In this process, *by construction*, the sum of the (signed, not-squared) residuals becomes zero (as a mathematical by-product of the minimization of the squared residuals). This means that the model’s average predicted sale price exactly equals the actual average sale price among the NCREIF sold properties. This begs the question: instead of using the regression model’s prediction of the average transaction price, why not just directly use the actual average transaction price, as the basis for a “TBI”?

Thus, we may expect that we will get a very similar result to the TBI if we simply take the average sale price among the sold properties each quarter and compare that to the recent prior average appraised value of those properties, and apply that difference to the appraisal-based NPI appreciation index. In

effect, we continue to define the “Representative Property” the same way the regression-based TBI does, as a property whose appraisal-based appreciation equals that of the NPI capital value index, and we then use the actual average transaction prices from one period to the next to define the changes between periods in the difference between transactions and appraisals that are necessary to convert the appraisal-based price return index to a transactions-based price return index.¹⁶ This is summarized in Exhibit 4, labeling the simplified NCREIF-produced TBI as the “NTBI”.¹⁷

Exhibit 4



¹⁶ This type of approach to examining the difference between transaction prices and the NCREIF Index valuations has a long history, going back through the 1990s with a series of reports on the differences between NPI reported valuations and sales prices. (See for example: J.Fisher, M.Miles, & R.B.Webb, “How Reliable Are Commercial Appraisals, Another Look”, *Real Estate Finance* 16:3, 9-15, Fall 1999.) What is new is the idea of using these differences quarter by quarter to produce a regularly updated and published index of transactions based prices, and the discovery that such an index bears an extremely close resemblance to an econometrically rigorous hedonic regression based index in the form of the TBI as it has been produced at MIT. The result is a sort of “fusion” of industry and academic conceptions of a transaction price based index.

¹⁷ The pre-existing TBI as produced at MIT actually works in log values per square foot (both for sales prices and appraised values), which are then converted into straight levels by exponentiation. For ease of communication we often speak simply in terms of “value” or “price” when we might technically mean log-price or log-value. In any case, in a non-regression average price based index construction methodology, working with geometric ratios (i.e., multiplying the price/appraisal ratio times the appraisal-based index value to convert to transaction price based value) makes little substantive difference compared to working with log-differences (i.e., adding the difference LN(price) – LN(appraisal) to LN(appraisal-based index value) to convert to a log transaction price index which is then exponentiated to a straight level index value). In practice, for simplicity and transparency sake in an industry context, the ratio method will be used in the simplified TBI index recommended for NCREIF.

Terminology Note: “MTBI” & “NTBI”...

At this point it will be useful to establish some new terminology. Henceforth in this paper, unless it is otherwise clear from the context, we will use the term “MTBI” to refer to the traditional regression-based TBI developed and produced at MIT, and the term “NTBI” to refer to the non-regression-based version based on average price relatives introduced here. If referring to issues that are in common with both versions, we may simply use the term “TBI”.

5. Comparison of the MTBI & NTBI:

Exhibit 5 (on the next page) shows how well the expectation that the NTBI could produce index results very similar to the MTBI is born out at the All-property level. The red line marked by diamonds traces the NTBI over the past 10 years set to a value of 100 at the end of 2000. The blue line is the corresponding MTBI.¹⁸ The black line is the corresponding NPI capital value index. From the evidence in Exhibit 5 it would seem that there is very little difference, indeed no economically significant difference, between the simple average price based NTBI and the more academic statistically based MTBI, at the All-property level. Exhibit 6 then compares the NTBI to the MTBI at the sector level, and here we see greater differences, which merit some discussion.

To begin, it is important to note that the primary focus of the development and publication of the TBI at MIT has been at the all-property level. The TBI at MIT was a pioneering project, the first regularly-published transactions-based price index of commercial property in the world, and as such it would inevitably be a “learn as we go” project to some extent. This has been particularly true regarding the sector indices.

The decision was made at the launch of the TBI in 2005 to produce the sector indices based only on the sold property samples *within* each sector. In other words, each sector TBI as produced at MIT was independent, based only on the properties sold within the subject sector. This seemed to make sense in 2005, when property transactions were plentiful. Even then, however, the scarcity of transaction observations within each sector made it necessary to employ a special technique in the price regression model at the sector level, known as a “ridge regression” noise filter. As transactions became exceptionally scarce during the great downturn of 2008-09, the sector indices based only on their within-sector sold-property samples seemed more problematical. This appears most notably in the case of the Retail Index, which is the sector with the smallest number of property sales in NCREIF. In the quarterly commentaries and FAQs-responses accompanying the MIT publication of the TBI updates, it was often noted that users should be particularly cautious in using the sector level TBI indices, which it was noted sometimes appeared inconsistent with the all-property results.

¹⁸ For an apples-apples comparison, both of the transactions-based indices are based on the same database, NCREIF’s “research” database as updated through 4Q2010. The version of the MTBI presented here is therefore “unfrozen”, reflecting any backward (historical) revisions based on this latest database. It therefore differs slightly from the “official” MTBI which as noted previously has been frozen at the end of each calendar year and until recently has not been based on the “research” database. (NCREIF’s “research” database differs from that on which the official NPI is based by including all revisions and additions into the history, whereas the official NPI has a frozen history.) In taking over production of the TBI, NCREIF may elect to officially retain the frozen history of the index as it has been published at MIT through 4Q2010, in which case the official NTBI history would differ slightly from what is depicted in Exhibit 5, in the same manner as noted above.

Exhibit 5

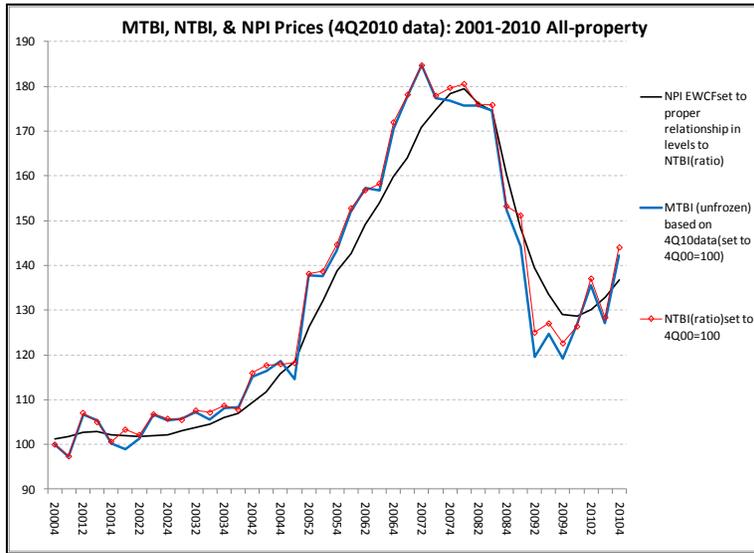
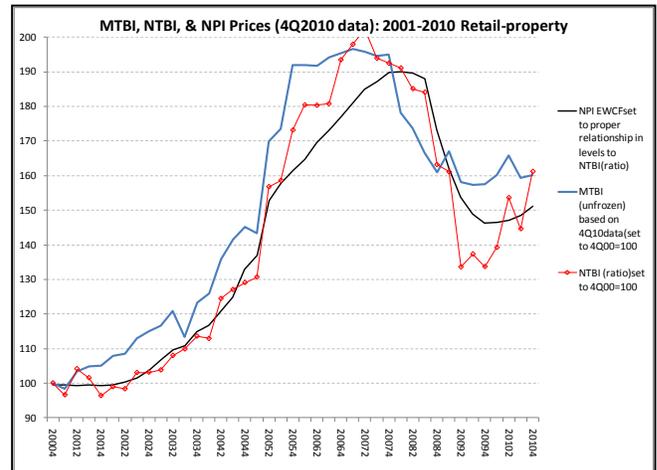
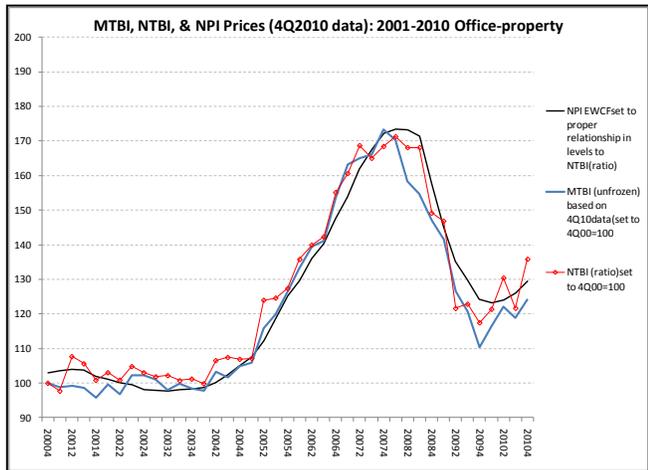
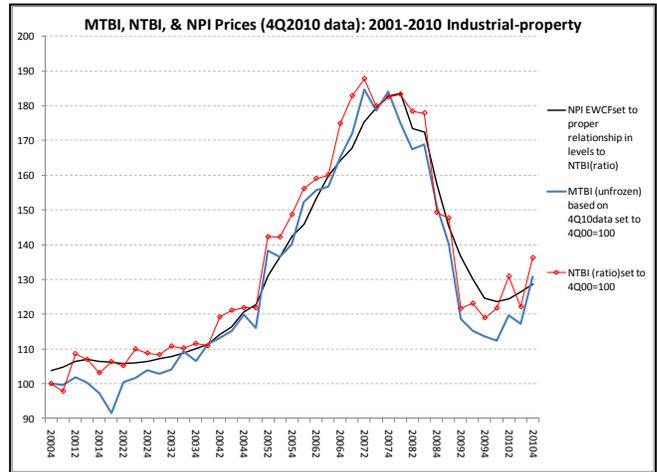
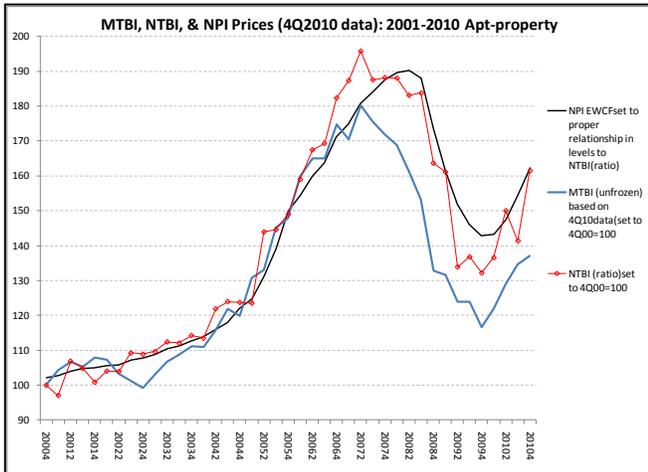


Exhibit 6: Sector Indices Comparison of MTBI, NTBI, & NPI



The transition of TBI production from MIT to NCREIF is an opportune time to revisit the methodology underlying the sector level TBI indices, and in particular to reconsider the use of the independent within-sector-only transaction samples. If we were to apply the above-described average-price-based “NTBI” procedure independently within each sector, as the MTBI has been doing with the regression-based index, we would obtain sector indices that would appear excessively noisy, even more so than the MTBI sector indices shown in Exhibit 6.¹⁹

Instead, we propose to base the average-price-based NTBI at the sector level on the all-property sold property sample for the purpose of computing the average transaction price/appraisal ratio. In effect, we propose basing the NTBI for sector indices or other such sub-indices on the assumption that the relative difference between appraisals and transaction prices tends not to vary systematically across the property sectors (or regions or any such breakout for which a sub-index would be produced). Under this assumption, the pooled all-property transaction price sample is as valid for estimating the price/appraisal ratio for any sector as it is for all sectors combined, and it therefore makes sense to use the largest-possible sample to estimate the price/appraisal ratio for *each* sector, namely, the all-property aggregate sample.

Thus, in the proposed NTBI represented by the red diamonds indices in Exhibit 6, we have applied the same price/appraisal ratios to each of the sectors, ratios that are based on the larger all-property sold property sample. The result is a set of NTBI sector indices that behave quite well, arguably better than the MTBI sector indices, in terms of lack of excessive noise and in terms of movements in relation to their corresponding appraisal-based NPI sector indices. The differences between the NTBI (red diamonds) and MTBI (blue) indices at the sector level in Exhibit 6 is due largely to two factors: (1) the use of the all-property transaction sample in the NTBI versus the sector-specific samples in the MTBI; and (2) the use of the special ridge regression noise filter in the MTBI sector indices.²⁰

¹⁹ The ridge regression noise filter is not possible in the simplified NTBI, and it has been that noise filter that has been largely responsible for keeping the MTBI sector indices from excessively noisy or wild-looking results. We should also note that the ridge regression noise filter was originally applied to the All-property index as well. At the all-property aggregate level the noise filter has no appreciable impact after the early years of the index, and has been dropped from the All-property index as it is currently produced at MIT. However, the early history of the All-property index would be considerably more noisy without that filter. This is one reason why NCREIF may want to retain the frozen MIT history for the All-property index. This is also why the sector indices only begin in 1994 instead of 1984 like the All-property index.

²⁰ There are two other sources of the difference between the MTBI and NTBI at the sector level. One is that the regression-based MTBI is estimated on a pooled sample across the entire history of NCREIF transactions, and includes some additional explanatory variables which improve the price model’s fit at the individual transaction level but which are longitudinal constants and therefore have minimal impact on the index. Another source of difference is that the MTBI includes a special procedure to correct for “sample selection bias”, possible systematic differences between the properties that are sold and those that remain unsold in the database. This procedure, known as the “Heckman 2-stage” procedure has generally had only a very minor effect on the MTBI results. Analysis suggests that both of these differences account for only a small part of the empirical difference between the MTBI and NTBI apparent in Exhibit 6 in the Industrial, Office, and Retail indices. In the Apartment sector these other considerations appear to play a larger role, though the NTBI apartment index still appears superior to its MTBI counterpart (at least in relation to the NPI). Finally, note that the (relatively minor) differences across sectors in the relationship between the NTBI and its corresponding NPI are due purely to differences in the NPI sector indices appreciation between their 2-quarter-lagged values (to which the common all-property based price/appraisal ratio is applied) and their current values (with any such differences appearing on a rolling basis each quarter).

Implications of the use of the all-property transaction sample at the sector level

While the assumption that transaction price/appraisal differences do not tend to vary systematically across sectors is a reasonable working assumption, which appears to yield a useful set of sector or regional sub-indices, it is of course only an approximation. It is important to keep in mind that this assumption does have the effect of causing the contemporaneous correlation across the sectors (or regions, across any breakout sub-indices) to appear larger than it otherwise would be. This is because much of the quarterly volatility in the TBI derives from quarter-to-quarter changes in the transaction price/appraisal ratio, and this ratio is being *assumed* to be the same across all the sectors or breakout sub-indices within any given quarter. This “excess covariance” bias should be clearly noted on any NCREIF publication of sector level NTBIs (or other breakout sub-indices), but it is not an issue with the All-property Index.

Implications of the NTBI regarding Demand & Supply indices

The simplified average price based “NTBI” methodology will allow NCREIF to produce both price index and total return index versions of the TBI.²¹ However, it will not enable production of the Demand and Supply indices that have been part of the MTBI suite produced at MIT. The construction of the demand and supply indices depends on the use of regression-based econometric modeling, including a “probit” binary-choice model of property sales probability for the entire NPI population (unsold as well as sold properties), in conjunction with the previously-described hedonic price regression model of the sold properties. Of course NCREIF could certainly report simplified statistics about sales volume as a fraction of NCREIF properties held each quarter, information that obviously speaks to the level of liquidity in the NCREIF branch of the investment property marketplace. Such data about transaction volume would be an excellent complement to the NTBI price index publication each quarter. However, the econometric models are necessary to “convert” such volume-based measures into “price units” that can be applied directly to price indices.

In other words, the MTBI Demand and Supply indices have enabled analysts to make statements such as:

- *“Potential buyers reduced the prices they were willing to pay by X percent last quarter”*
or:
- *“A combination of potential buyers raising their willingness-to-pay prices and potential sellers, property owners, reducing their willingness-to-accept prices, by a total of X percent as a fraction of the average current transaction price, will bring the marketplace back to its long-term average level of liquidity or trading volume.”*

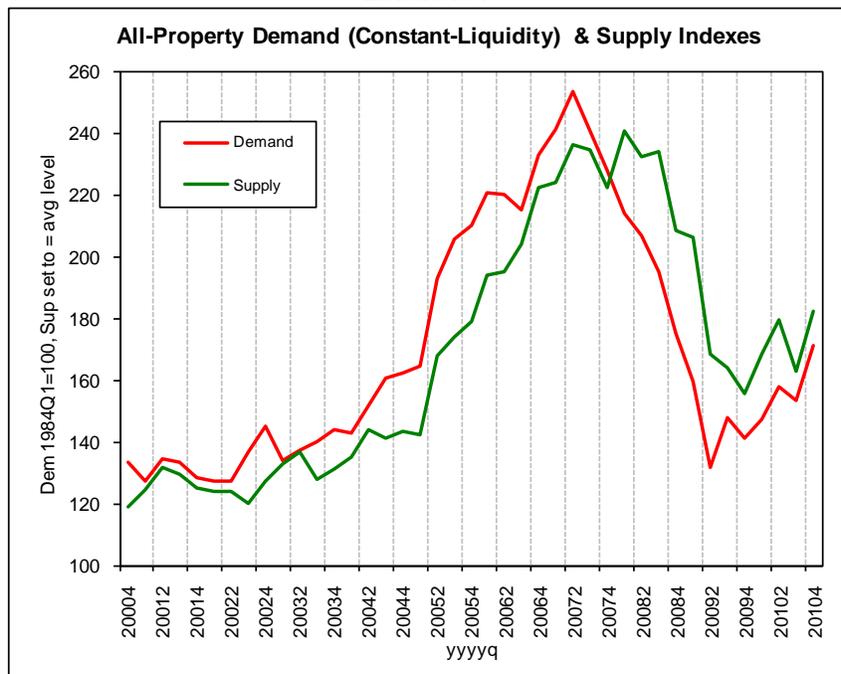
Such *integration* of price and volume information about the market does not occur by merely publishing volume information alongside transaction price information. The MTBI Demand Index in particular may be interpreted as a type of “constant liquidity index,” tracing out the quarterly percentage changes in potential buyers’ reservation prices which, if matched by sellers in actual deal prices, would keep the

²¹ See Appendix B and the Excel® example templates accompanying this white paper for details of NTBI production for both the price and total return indices.

trading volume constant across the asset market pricing cycle (i.e., price movements at which property owners could sell as many properties, as quickly and easily, in a down cycle as in an up cycle).²²

This type of information product will not be supplied by the simplified non-regression-based NTBI indices described above. While it is true that this information has not been nearly as widely used as the basic MTBI price index, there have been some users of the MTBI Demand and/or Supply indices, in both academia and industry.²³ As seen in Exhibit 7, the MTBI Demand Index was particularly effective in the early stages of the market downturn in 2007 and 2008 at indicating the extent of the drop in commercial property valuation sentiment among potential investors (witness the precipitous fall in the red, demand side, index from mid-2007 through mid-2009). At the same time, the Supply Index reveals that it was property owners' refusal to agree with that market sentiment that prevented the prices in consummated transactions from falling as far or as fast as they otherwise would have, and that underlay the drastic dry-up in liquidity in the market. The gap between demand and supply peaked at some 26 percent of the average then-prevailing transaction price in the first quarter of 2009, greater than it had been at the worst of the previous downturn in the first quarter of 1992. The chart also shows how the demand side of the market (potential investors) has been much more bullish about revising their valuations upward since the second quarter of 2009 (through 4Q2010 the demand index was up 30% from its 2Q2009 bottom, while consummated transaction prices as measured by the MTBI price index were only up 19% from their 4Q2009 bottom).²⁴

Exhibit 7



²² This perspective on the Demand Index was developed in depth in a highly cited academic paper that was the original basis for the development of the TBI at MIT: J.Fisher, D.Gatzlaff, D.Geltner, & D.Haurin, "Controlling for the Impact of Variable Liquidity in Real Estate Price Indices", *Real Estate Economics* 31:2, 269-303, 2003.

²³ The original industry user of the Demand Index, as a "constant liquidity index", was Ibbotson Associates, which still supplies this index by request to certain clients.

²⁴ In general, the MTBI demand and supply indices have shown that demand movements often tend to lead supply movements, that property owners' willingness-to-accept prices tend to move more conservatively than potential buyers' willingness to pay prices.

This type of perspective provides a unique real-time window into the functioning of the institutional property market, with more depth than simple transaction prices alone, by drilling beneath those prices into the two sides of the market that underlie the deals. This can be useful for diagnostic as well as basic research purposes. It would seem sad to totally and forever remove from the information marketplace the ability to access updates of these TBI Demand and Supply indices. For this reason, NCREIF may want to remain receptive to future requests on the part of parties who have the capability to produce such regression-based indices on their own, under suitable confidentiality restrictions and without NCREIF assuming any responsibility for, or endorsement of, the product.

6. Conclusions & Recommendations Regarding the NTBI & MTBI

Based on the discussion and analysis presented in this paper, it seems eminently feasible for NCREIF to take on production and publication of a “TBI” as an official NCREIF product and as a legacy of the existing “MTBI” that has been being produced and published at the MIT Center for Real Estate. This transition affords a good opportunity to make some changes in the TBI production methodology, and this paper has presented and proposed such a change, in particular, a simpler, average price based version of the TBI that does not require regression modeling. With this in mind, the following specific recommendations are made.

1. NCREIF should move to adopt regular quarterly production and publication of a transactions based index based on the simplified average price based methodology described in this white paper (labeled herein as the “NTBI”, but for NCREIF publication purposes the acronym could continue as simply the “TBI” that has gained fluency in the existing user community, i.e., without the “N”).
2. Sector level (or other such breakout) sub-indices of the NCREIF-produced TBI should be based on the all-property average transaction price/appraisal ratio, applied in common to each breakout sub-index, rather than being based on pure within-sector samples as the MTBI sector indices have been. This recommendation is based on the plausible assumption that transaction/appraisal ratios do not tend to differ systematically across sectors, and on the observation that using the larger all-property sample for the sector indices seems to result in better sector-level TBIs.
3. Publication of any such TBI breakout sub-indices based on the all-property average price/appraisal ratio should be accompanied by a “caveat” statement to the effect that cross-correlations among breakout sub-indices may appear larger than they otherwise would as a result of the all-property computation of the average price/appraisal differences.
4. It is recommended that in the interest of smooth transition NCREIF adopt the pre-existing frozen history of the TBI as published at MIT through 4Q2010 in the case of the All-property aggregate indices (both price and total return). However, due to the small-sample issues with the sector indices as published at MIT, and in view of the more substantial change in the sector indices reflecting recommendation (2) above, the NTBI sector indices should commence with new re-stated histories going back to their (same) inception dates of 1Q1994; and finally...

5. Regarding the Demand and Supply indices, NCREIF should continue to be receptive (as it has been to the MIT Center for Real Estate) to parties appropriately requesting to, on their own, run the Demand and Supply indices as these have been being produced at the MIT Center for Real Estate as part of the TBI up until now, under suitable confidentiality restrictions, and under the proviso that such Demand and Supply indices are not a “NCREIF product” and are not supported or endorsed by NCREIF. Also, NCREIF should consider publishing transaction volume data alongside the regular quarterly publication of the NTBI, including each quarter’s fraction of the NCREIF stock sold that quarter (by count and by dollar volume). Such volume information is a vital complement to pricing information to provide a current picture of the market.

Appendix A:

Value-weighted &/or NOI-based Versions of the NTBI

In defining the TBI representative property's appraised value in constructing the price index, the MTBI employs the equal-weighted/cash-flow based (EWCF) version of the NPI capital return index, rather than NCREIF's official value-weighted/NOI-based version (VWNOI) which is represented by the NPI. There are two considerations underlying why the MTBI employs the EWCF version of the NPI. One consideration is related to the "EW" (equal-weighted) issue, and the other is related to the "CF" (cash-flow-based) issue. In both cases, this is a discretionary or "policy" decision of the MTBI, and NCREIF could in principle elect to produce and publish an alternative VWNOI-based version as the NTBI without violating any fundamental statistical principles. This Appendix will review this policy question, and compare VWNOI-based and EWCF-based versions of the NTBI at the All-property level.

Equal-weighted vs Value-weighted indices:

The MTBI has been using the EW version of the NPI to define the index's representative property because we view the TBI as a statistical inference device rather than a "universe" or benchmark. In general statistical inference is more accurate when each observation is treated equally.

One way to see this is to think of the principle of diversification of a portfolio. To take an extreme example (which is correct for demonstrating the relevant point), a portfolio consisting of 100 nearly equal-sized assets will be more diversified (hence, have lower volatility) than a portfolio containing 99 tiny assets and one gigantic asset whose value dominates the portfolio.²⁵ This is why the equal-weighted version of the NPI tends to have lower volatility than the official value-weighted version.

In the TBI's original conception, before any other transactions based price indices of U.S. commercial property existed (such as the Moody's/REAL and CoStar indices today), we viewed the TBI as representing the entire institutional U.S. investment property market, a larger population than the NCREIF database. We were in effect viewing the NCREIF properties, and the sold sample from them, as representing this broader population of properties. Treating the TBI as representing a population broader than NCREIF meant treating NCREIF as a statistical "sample" of this broader population, which in turn meant that one should use an equal-weighted version of the NPI to represent the appraised value of the "representative property" used in constructing the TBI.

This perspective changes a bit if one views the underlying population of properties represented by the TBI as being not the broad U.S. institutional investment real estate market as a whole, but just the specific properties held by NCREIF members and included in the NPI. Of course, the TBI is still from this perspective a statistical inference, as most NCREIF properties are not sold each period, and thus the sold properties represent a sample of the overall NCREIF property population. Therefore the hedonic price regression model (or average price/appraisal ratio

²⁵ This assumes the assets all have equal individual variance and pair-wise covariance.

estimate in the case of the NTBI) should still be based on equal-weighted data-points as before.²⁶ But the NCREIF properties are now from this perspective no longer a sample but rather constitute the entire population of interest. From this perspective it would be valid in principle to apply the TBI's estimate of transaction price/appraisal ratios to a representative property defined (in terms of its appraised value) based on a value-weighted version of the appraisal-based NCREIF Index.

Cash-flow based vs NOI-based capital return indices:

We now turn to the question of whether to base the TBI representative property's appraised value evolution on the "CF" or "NOI" definition of the capital return (aka "appreciation return"). As is well known, investment periodic total returns (aka "simple holding period returns" – HPRs), include two components: (1) the change in the asset (or static portfolio) value from beginning to end of the period (calendar quarter in the case of the TBI); and (2) the net income or cash flow generated by the asset (portfolio) for its investors during the period. The former component is referred to as the "capital return" (or sometimes as the "appreciation return", or the "capital gain" or "growth component"). The latter component is referred to as the "income return" (or sometimes the income or cash "yield", or "current return"). The two components should be defined in a non-overlapping manner so that their sum equals the "total return" (sometimes referred to as "total yield", or simply, the "yield").

In the official NPI the capital return is defined for each property (and then aggregated up into the index) as the change in the reported valuation of the property between the beginning and end of the period *minus any capital expenditures* made on the property during the period. The official NPI capital return thus reflects *only* the effect of the market for the asset (changes in its market value) as well as the aging or "wasting" of the structure part of the asset, without reflecting how the asset's value may have been improved by capital expenditure investments made by the owner into the property. Correspondingly, the official NPI income return is defined to equal the net operating income (NOI) of the property *without subtracting capital expenditures* paid by the property owner during the period. In other words, capex is *not* subtracted from the income return even though it reduces the net cash paid out from the property to investors, and capex *is* subtracted from the capital return causing that return to represent something *less than* the change in property asset value from beginning to end of the period.

There is no doubt some rationale for this convention, and it is indeed common in many real estate indices (e.g., IPD uses a similar convention). But the NPI properties exclude development projects and major redevelopment or rehabilitation projects; so the vast majority of all the capital expenditures in question are routine in the operation of the properties, and generally self-

²⁶ A relevant limitation is the assumption, implicit in statistical inference, that the estimation sample is drawn from a single underlying population, as far as the parameters of interest are concerned. This can make the TBI non-representative for some segments of the property market if there arise market segments (possibly temporary) across which the relationship between transaction prices and appraisals differs sharply. For example, if larger properties systematically have a different transaction price/appraisal relationship than smaller properties. However, the solution to any such problem is probably not to value-weight the underlying data-points in the price/appraisal ratio estimation (given the small sold property sample size in any given period this would probably inject too much noise into the index). Rather, one would like to break the index into separate sub-indices corresponding to the different market segments, although again the small sold sample size might make this impractical.

financed from the operating revenues of the properties. As a result, the official NPI convention in defining the breakout between capital and income returns can be somewhat “apples-vs-oranges” and potentially misleading when comparing the NPI with stock and bond market based indices (including REIT indices). In the stock market, for example, price or capital gain indices do not subtract out the corporate capital expenditures made from earnings plowed back into the company, and income returns are defined based on dividends, the cash actually paid out to investors net of retained earnings held back in the company.

One of the major original motivations in developing the MTBI was to help provide the real estate investment industry with a historical returns series that would facilitate apples-to-apples comparisons between real estate and other asset classes (especially stocks and bonds). Therefore, the policy decision was made at the inception of the MTBI to define its representative property’s appraised value evolution based on the *cash-flow* based definition of the NPI capital return rather than the official NOI-based definition. Another reason for this policy has to do with the other transactions based price indices of commercial property which have been launched since the TBI. Both the Moody’s/REAL CPPI and the CoStar CCRSI are repeat-sales indices which (like the Case-Shiller and OFHEO repeat-sales housing price indices) do not subtract capex from the price-changes tracked by those indices. Thus, for apples-to-apples comparison with the other transactions based commercial property price indices, the TBI also needs to be based on the CF-based definition of the NPI capital return. This makes the TBI a true *price change* index, reflecting the changes in the average transaction price fetched by NCREIF sold properties from one period to the next (on a “same-property” basis).

Summary:

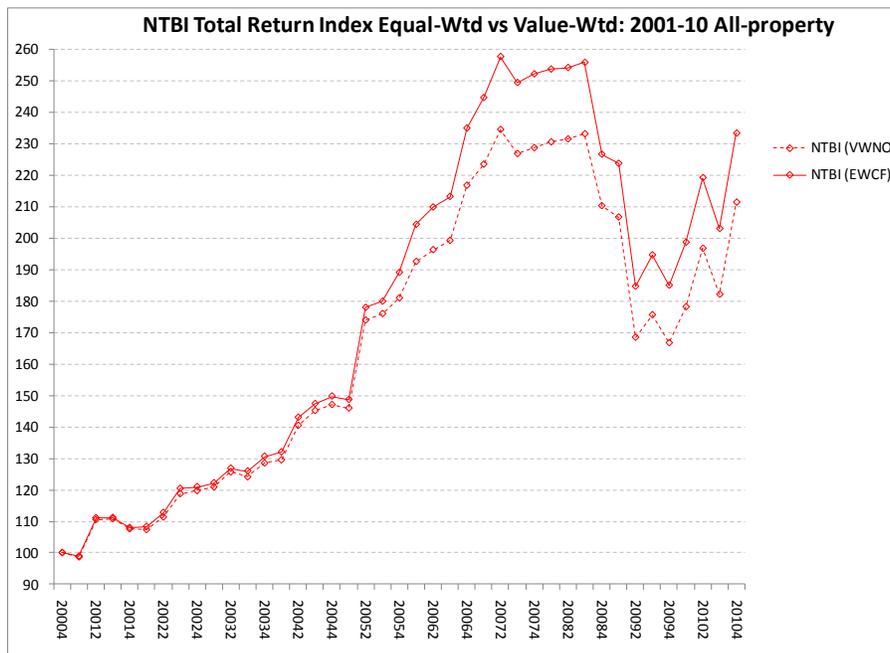
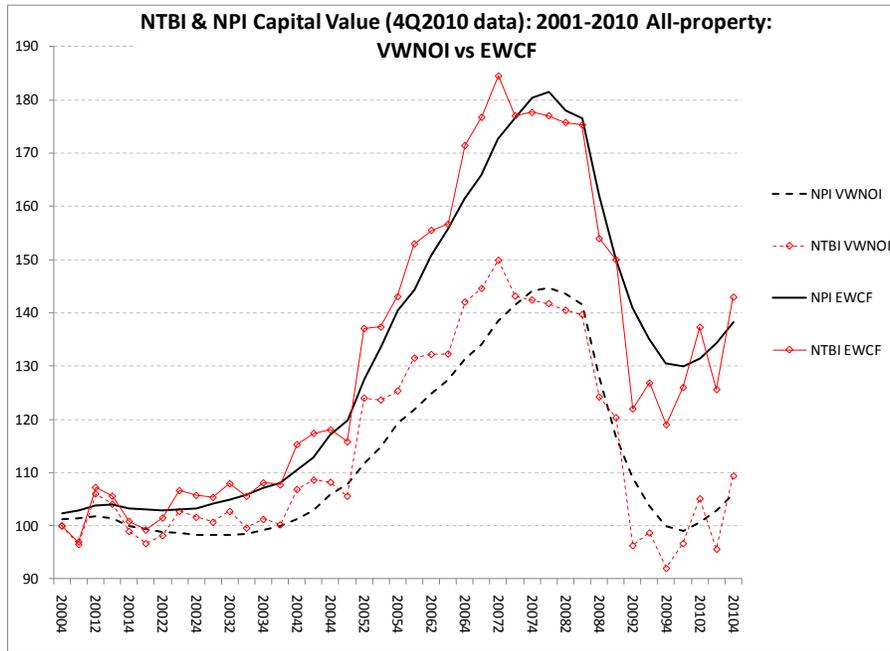
In summary, the MTBI has by policy been based on the EWCF version of the NPI capital return index. There are good reasons for this, in both the EW and CF considerations. However, particularly given that there are now other commercial property transactions price based indices, this is a policy decision that NCREIF might choose to revisit, if and to the extent that NCREIF will launch its own “NTBI” version of the TBI. From a statistical perspective, it would be possible to produce a VWNOI-based version of the NTBI, simply by applying the average price/appraisal differences to the official VWNOI-based NPI capital return index rather than to the EWCF-based version.²⁷

Exhibit 8 (on the following page) provides a comparison of these two alternative approaches. The top chart displays the NTBI capital value or price indices, together with their corresponding versions of the NPI. The VWNOI-based versions, reflecting the official NPI capital growth index in the NTBI’s representative property’s appraised value, show a markedly lower capital value growth trend, due to the effect of subtracting capex out of the capital return component. The bottom chart compares the equal-weighted vs value-weighted versions of the NTBI in the cumulative total return indices. The equal-weighted index shows a slightly higher trend,

²⁷ The Excel template provided with this white paper demonstrates exactly how to do this. Slight differences between the indices shown in Exhibit 8 and those in the Excel template reflect the fact that the indices in Exhibit 8 are based on log differences while the Excel template reflects ratio-based NTBIs.

indicating that on average in recent years smaller (lower-valued) properties held by NCREIF members tend to have performed better than larger properties.²⁸

Exhibit 8



²⁸ It should also be noted that the VW index is based on the official NPI and therefore based on NCREIF’s “NPI” dataset of historical property returns, whereas the EW index is based on NCREIF’s “Research” dataset. The latter may have more backward-adjustments than the former, and this could also partially explain the difference between the two indices. Most of the differential trend in the total return indices is attributable to a few particular historical quarters: 2005Q4, 2006Q1, & 2006Q4.

Appendix B: Steps in the Operational Production of the NTBI

See accompanying Excel example template

The primary rationale for the development of the simplified non-regression-based “NTBI” version of the TBI is to facilitate NCREIF in-house production of the index. A related rationale is to facilitate communication to and with the industry and practitioner community about the NTBI, including the meaning and construction of the NTBI. In fact, the NTBI has been designed to be able to be easily produced by NCREIF using only the existing NCREIF property database and Excel[®].

An illustrative example of all of the steps in the production of the NTBI is contained in the Excel workbook files that accompany the transmission of this report by the author to NCREIF. The Excel workbooks start from the property-level NCREIF database and walk the reader through all the steps of NTBI construction, including both capital (price) index and total return index, with examples of both the All-property index and all four of the sector indices. The example computations reflect the EWCF-based NTBI, but the All-property template also includes an example of a VWNOI-based version. The Excel examples are fully annotated and documented, and can serve as templates for actual NCREIF NTBI production. They are based on the actual real world historical case of the 4Q2010 quarterly return computation and index update.²⁹

Although the Excel example file is rather complete and self-explanatory, the essential production steps will also be explicated here.

Computation of the NTBI price index:

There are two major phases in the NTBI price index construction: property level computations, and index construction. We can divide the overall process into four major steps, which correspond to the first four tabs in the example Excel workbooks (after the “readme” introductory tab).

Step 1) Current Quarter Sold Property Compilation:

In this step the analyst compiles all of the properties that sold from the NPI database in the current quarter (which we shall refer to generally as Quarter “t”). For conformity with the MTBI, computations are based on values per square foot, and only on the core property types of: apartment, industrial, office, and retail. Thus, we drop any observations that do not have a valid square-foot entry or that are not among the four core property types.³⁰ We also need to base the

²⁹ In the case of the All-property NTBI, if NCREIF decides to retain the frozen MIT TBI history through 4Q2010, then the example in the template would be illustrative only, as the actual 4Q2010 result would be taken from the MTBI. This possibility is documented and treated in the template, which clarifies how the NTBI updating process would proceed from 1Q2011 onward.

³⁰ This treatment of the square-foot variable could be re-examined by NCREIF. The division by square foot was originally adopted because it was contemplated to report the price model’s predictions in dollars per square foot rather than simply in an index of longitudinal percentage changes, and it was felt that price/SF would be more

appraisal value on the NPI reported valuation two quarters prior to the sale, so we must drop any properties sold in Quarter t that don't have valid square-foot and appraised (reported) valuations in Quarter t-2.³¹ For the remaining valid, usable current-quarter sold property observations (which is usually the vast majority of all the property sales out of the NPI in the current quarter), you need to compile the sale price and the square-footage of each sold property.

Step 2) Lagged Two Quarters Data Compilation for Current Sold Properties:

In this step the analyst compiles the appraised (reported) valuation and the square-footage as of Quarter t-2 for all of the properties sold in Quarter t. Generally this information would be derived from the most recently updated historical dataset, the Quarter-t historical dataset, even though we are pulling information about the properties as of two quarters earlier.

At this point it is important to verify that the valuation and square-footage information for Quarter t-2 for all of the Quarter-t sold properties is consistent with the sale price and square footage information for those properties as of Quarter t. For example, if a property had a partial sale in Quarter t-2, and then the remainder of the property was sold in Quarter t, it might be necessary to drop that observation from the index estimation dataset. The reason is that the property as of Quarter t-2 before the partial sale may have been heterogeneous in terms of its value per square foot. For example, the property might have included a retail component and an office component, each with very different valuations per square foot. Supposing the retail component was sold subsequent to Quarter t-2 but before the current quarter, the lagged valuation per square foot would not be comparable to the current sale price per square foot.

Step 3) Computation of the Price/Appraisal Ratio for Quarter t:

The essence of the NTBI is to adjust the appraisal-based NPI by the average ratio each quarter of the sold properties' transaction prices divided by their recent (2-quarters prior) appraised (NPI-reported) valuations (in each case adjusted by square-footage in the present model). Thus, we compute the following ratio, which we'll label "PriceOverAppr(i,t) for Property "i" sold in Quarter-t. For each $i = 1, 2, \dots, N(t)$ of the Quarter-t sold properties:

$$\text{PriceOverAppr}(i,t) = (\text{SalePrice}(i,t)/\text{SF}(i,t)) / (\text{ApprVal}(i,t-2)/\text{SF}(i,t-2))$$

We then take the (unweighted) arithmetic average PriceOverAppr(t) across the N(t) properties sold in Quarter-t:³²

$$\text{PriceOverAppr}(t) = \text{AVERAGE}_i[\text{PriceOverAppr}(i,t)]$$

intuitive and transparent than average price per sold property. However, this potential feature of the TBI was never implemented.

³¹ See explanation for this in footnotes in Section 3 of the main body of this paper.

³² If one wanted to construct a value-weighted estimate of the price/appraisal difference, you would first pool across all the sales within the quarter the sales prices and prior appraised values and square footage, and then perform the division and take logs on this pooled aggregate. As noted in Appendix A, this procedure risks any given quarter being overly dominated by one or a few large individual property sales, and this could add noise into the resulting TBI. It is also not necessary for deriving a "value weighted" TBI in the sense of using NCREIF's population-based value-weighted NPI as the "representative property" to which the price/appraisal differences are applied to derive the TBI (as described in Appendix A).

Step 4) Construction of the NTBI Price Index for Quarter t:

We next want to use the PriceOverAppr(t) value we have just computed to “convert” the NPI cumulative capital return index into the NTBI. We do this by first downloading the NPI capital value index (levels) from the NCREIF database, and setting this index to have a value of unity (or 100) in 1984Q1, the base period of the TBI.³³ Include in the series all the accumulated capital value levels starting two quarters prior to the TBI base period, so you will have a complete quarterly history of the NPI capital values from 1983Q3 through the current quarter indexed to 1.00 (or 100) in 1984Q1.

We then multiply each of the quarterly value levels of the NPI capital index times the price/appraisal ratio we just compute for the quarter two periods subsequent, for each quarter t = 1983Q3...current Quarter-t (or from 1993Q3 for the sector indices). This step is represented as follows:

$$NTBI(t) = NPI(t-2)*PriceOverAppr(t)$$

In fact, the entire history of the NPI and TBI up until just prior to the current Quarter-t will already have been computed and recorded the previous quarter (and initially MIT will transmit this history to NCREIF), so the only change or updating that will be going on in this step is the adding on the new current Quarter-t value.

The result is an NTBI capital value index that is indexed to an inception value of unity (1.00, or 100) as of 1984Q1 (or 1994Q1 for the sector indices). You can then compute the implied price-change returns in the usual manner, for each Quarter “t”:

$$g_{NTBI,t} = NTBI(t) / NTBI(t-1) - 1$$

Note that Step 4 can be applied either to the EWCF version of the NPI capital value index or the VWNOI version, in exactly the same manner, depending on whether one wants the NTBI to be based on the EWCF definition of capital (price change) returns or the VWNOI definition, as discussed in Appendix A.

Computation of the total return index:

The above procedure describes how to construct the NTBI price index or capital value index. The construction of the corresponding total return index is very similar, only with an extra step to include the cash flow (or net operating income) component into the return, as demonstrated in the previously-described Excel example file (see the worksheets in which the total return index is computed). In brief, the procedure is as follows.

First, go back to the place in *Step 4* where you had the NPI cumulative capital value index set to a starting value of 1.00 (or 100) in 1984Q1. Think of these values as the value, in (say) hundreds of dollars per square foot, of the NTBI’s “Representative Property” each period since 1984Q1. Now fill in a new column with the corresponding income (cash flow or NOI, depending on

³³ For the sector indices the base period is 1994Q1.

which form of NPI capital index you are using) in dollars per square foot, by multiplying the previous quarter's cumulative capital value level from the NPI (Representative Property value/SF) times the NPI *income* return (either cash flow or NOI based) for the current quarter. This computation may be expressed as follows:

$$CF_{NTBI,t} = NPI(t-1) * y_{NPI,t}$$

where “ $y_{NPI,t}$ ” is the NPI's income return for Quarter t.³⁴

Next, compute the NTBI total return in each Quarter t in the usual fashion employing the NTBI capital value levels computed previously and the cash flow (or income) values derived just above.³⁵

$$1 + r_{NTBI,t} = (NTBI(t) + CF_{NTBI,t}) / NTBI(t-1)$$

Finally, set the NTBI total return index to an inception value of 100 (or whatever value you want) in 1984Q1, and grow it cumulatively forward by chain-linking in the usual manner:

$$NTBI_Total(t) = NTBI_Total(t-1) * (1 + r_{NTBI,t}).$$

³⁴ We don't need to “correct” cash flow or income information for transaction/appraisal differences, because presumably the cash flow and income information in the NPI is accurate and objective, not subject to appraisal or reporting effects.

³⁵ We don't need to explicitly employ the time-weighted denominator in this step because the NPI indices that underlie this computation already reflect such time-weighting.