REIT-Based Pure Property Return Indexes

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/141,029, ""Pureplay" REIT-based Property Price Indexes," filed December 29, 2008, the entire contents of which are incorporated herein by reference.

BACKGROUND

Technical Field

The present application is directed generally to REIT-based property return indexes and in particular, creating indexes of property market returns according to target characteristics of properties held by the REITS.

Description of Related Art

Growing quantities of commercial property equity assets are being held by publicly traded securitized real estate companies, known as Real Estate Investment Trusts (REITS). Public stock exchanges are generally regarded to be more efficient and liquid than traditional private property markets, in which real estate assets trade directly in privately negotiated transactions. However, REITs' diversification across geographic regions and types of property usage, as well as REITs' leverage, inhibits analysts' abilities to use REITs' liquidity for making targeted investments according to desired characteristics of property holdings.

SUMMARY

According to a first aspect of the present invention, there is provided a method comprising: identifying valuation data comprising a plurality of estimated asset values corresponding to one or more of location information and property type; identifying a group of two or more characteristics, wherein the characteristics belong to one of a property type group and a regional group; for each respective real estate investment trust of a plurality of real estate investment trusts: compiling respective return data from the respective real estate investment trust, identifying respective holding data regarding each property of a respective plurality of properties of the respective real estate investment trust, wherein the holding data comprises one or more of location information and property type, categorizing, by a processor of a computing device, two or more properties of the respective plurality of properties by a first characteristic of the group of two or more characteristics to generate a respective first property segment, wherein the two or more properties are categorized based in part upon the respective holding data, categorizing, by the processor, two or more properties of the respective plurality of properties by a second characteristic of the group of two or more characteristics to generate a respective second property segment, wherein the two or more properties are categorized based in part upon the respective holding data, and determining, by the processor, for each of the first property segment and the second property segment, respective asset data, wherein respective asset data is based in part upon the valuation data and the respective return data; determining, by the processor, a first relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, according to a respective exposure of the respective real estate

investment trust to the first characteristic; determining, by the processor, a second relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, according to a respective exposure of the respective real estate investment trust to the second characteristic; and determining, by the processor, a return index, wherein the return index is determined according to: the first relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, the second relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, and the return data of each respective real estate investment trust of the plurality of real estate investment trusts.

According to the second aspect of the present invention, there is provided a method comprising: compiling respective return data from each real estate investment trust of a plurality of real estate investment trusts at a frequency; for each real estate investment trust of the plurality of real estate investment trusts, determining, by a processor of a computing device, for each holding of a plurality of holdings of the respective real estate investment trust, respective asset data; determining, by the processor, a model comprising a first target characteristic and a second target characteristic; for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a first exposure of the respective asset data relevant to the first target characteristic and a second exposure of the respective asset data relevant to the second target characteristic; applying, by the processor, the model to the plurality of real estate investment trusts to produce a return index reflecting returns by each of the first target characteristic and the second target characteristic, wherein applying the model comprises: for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a respective first coefficient of the respective real estate investment trust based at least in part on the first exposure of the respective asset data of the respective real estate investment trust, wherein the respective first coefficient reflects a weight of the respective real estate investment trust in the return index by the first target characteristic, for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a respective second coefficient of the respective real estate investment trust

based at least in part on the second exposure of the respective asset data of the respective real estate investment trust, wherein the respective second coefficient reflects a weight of the respective real estate investment trust in the return index by the second target characteristic, and determining, by the processor, the return index based at least in part on the respective first coefficient of each real estate investment trust of the plurality of real estate investment trusts, the respective second coefficient of each real estate investment trust of the plurality of real estate investment trusts, and the respective return data from each real estate investment trust of the plurality of real estate investment trusts.

The target characteristics can be property market segments. The compiled REIT return data can reflect total returns or capital returns. In the latter embodiment, the generated index is a price index. The processing can be regression, direct calculation, and/or mathematical constrained optimization. The predetermined frequency can be one of monthly, daily, and real-time. Property holdings lacking the target characteristics for each REIT used to compile REIT return data can comprise less than a predetermined percentage of the REIT's total property holdings. The predetermined percentage can be one of 30%, 40%, and 50%. The Weighted Average Cost of Capital (WACC) accounting identity can be used to de-lever the generated REIT return data. The processing can account for multicollinearity among the target characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects, features, and advantages of the present disclosure will become more apparent by referring to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is an exemplary block diagram of a computing system for generating the REIT-based pure property return indexes;

FIG. 2A-2E are exemplary graphical depictions of REIT-based pure property price return indexes according to usage type sectors;

FIG. 3 is a table demonstrating exemplary Variance Inflation Factors (VIFs) across target property segments; and

FIG. 4A-4D are exemplary graphical depictions of REIT-based pure property price indexes that account for VIFs.

DETAILED DESCRIPTION

For purposes of reading the description of the various embodiments below, the following descriptions of the sections of the specification and their respective contents may be helpful:

- Section A presents an overview of the REIT-Based pure property return indexes generated according to the present disclosure;
- Section B describes exemplary methods for generating REIT-Based pure property return indexes;
- Section C describes a computing system for generating the REIT-Based pure property return indexes described herein; and
- Section D describes exemplary demonstrations of generating REIT-Based pure property price return indexes.

A. Overview of the REIT-Based Pure Property Return Indexes

In general overview, the present disclosure relates to systems and methods for generating REIT-based property return indexes, such as total return indexes and price indexes. Although REITs own diverse real estate assets across geographical regions and types of property, their holdings of properties nevertheless permit careful manipulation to yield information about underlying property valuations. In particular, REITs may be manipulated to generate de-levered indexes that reflect property returns for groupings of properties according to target characteristics. For example, properties may be grouped according to their segments of the property market. A segment may refer to a combination of property usage type sector(s) (e.g., apartment, industrial, office, retail, hotel), geographical region(s), economic region(s), and/or metropolitan region(s) that defines a segment of the overall aggregate commercial property market. In another example, properties may be grouped according to characteristics such as size, gradation of urbanity (e.g., urban, suburban, or rural), extent of subjection to supply constraints, or any other similar characteristic. As a result, the present disclosure may generate indexes that reflect property returns for the Northeastern hotel property market, the West Coast retail property market, the Midwestern industrial property market, small properties, large properties, suburban properties, urban properties, or any other such category as would be appreciated by one of ordinary skill in the art. For the purposes of this disclosure, such indexes may also be referred to herein as "targeted portfolios."

The indexes generated according to the present disclosure exhibit a number of unique and noteworthy characteristics. First, such indexes appear to lead transactions-based direct property market indexes during market turns. Such information can provide investors with opportunities to make pure, targeted investments in the commercial real estate market while retaining the

liquidity benefits of the public market via REITs. Additionally, this information may open opportunities to construct hedges in the real estate market and support derivatives trading.

Second, the indexes exhibit volatilities comparable or less than existing private market transaction-based indices, such as the Moody's/REAL CPPI, reflecting their accuracy as models. Third, the indexes can be generated at the high frequencies (e.g., daily or real-time, the latter referring to data as it becomes available via ticker tape or the like) without significant increases in noise and at various levels of granularity for the target characteristics, thereby providing more detailed information about property prices. Lastly, such indexes can be directly constructed and traded via long and short positions taken in the publicly-traded REITs that compose the indexes. This facilitates pricing of derivatives and also enables construction of exchange-traded funds (ETFs) that track or implement the indexes. Overall, the indexes of the present disclosure can provide accurate high-frequency information about property market prices and/or total returns that can be leveraged for a wide variety of financial initiatives.

B. Methods of Generating the REIT-Based Pure Property Return Indexes

To determine the returns for grouping of properties by target characteristics based on REITs, the return for each REIT at a predetermined interval of time may be modeled to account for each target characteristic. Although the models described in the present disclosure are directed to property market segments, the structure and application of the model may be reformulated according to any desired characteristics of the property holdings, as would be appreciated by one of ordinary skill in the art.

Further, the models may be adjusted to produce indexes reflecting price returns or total returns to the groupings of properties by targeted characteristics. When the compiled REIT

return data reflects capital returns, the created index tracks price returns. When the compiled REIT return data reflects total returns, including income, the created index tracks total returns.

The particular model for the return for each REIT when modeling according to five usage-type property market segments may follow the formula:

$$r_{i,t} = b_{A,t}x_{A,i,t} + b_{O,t}x_{O,i,t} + b_{I,t}x_{I,i,t} + b_{R,t}x_{R,i,t} + b_{H,t}x_{H,i,t} + e_{i,t}$$

where:

$b_{S,t}$ is the return to property market segment S at time t,

where:

$x_{A,i,t}$ = dollar percentage of assets held by REIT i in apartment segment at time t

$x_{O,i,t}$ = dollar percentage of assets held by REIT i in office segment at time t

$x_{I,i,t}$ = dollar percentage of assets held by REIT i in industrial segment at time t

$x_{R,i,t}$ = dollar percentage of assets held by REIT i in retail segment at time t

$x_{H,i,t}$ = dollar percentage of assets held by REIT i in hotel segment at time t

where:

$$x_{Ai,t} + x_{O,i,t} + x_{I,i,t} + x_{R,i,t} + x_{H,i,t} = 1$$

and where:

$e_{i,t}$ is an error term reflecting the idiosyncratic return of REIT i at time t

Although the model accounts for five property market segments, other embodiments of the model may use any number of segments or any number of groupings of properties by target characteristics.

When the dollar value of assets in a REIT's portfolio cannot be obtained, proxies such as rental income, total square footage, or any comparable metric may be used instead. Further,

when REITs include miscellaneous property exposures to non-targeted segments (e.g., land, garages, international assets), such exposures can be aggregated into a single "other" segment and the dollar percentages held by targeted property market segments can be adjusted to sum to one (1). In this manner, the "other" segment can be ignored and the remaining exposures can be rescaled to sum to one (1). For example, if a REIT holds 25% of its holdings in office properties, 60% in industrial properties, and 15% in parking facilities, the office exposure can be converted to 25/85% office, the industrial exposure can be converted to 60/85% industrial, and the parking exposure can be ignored. Using this model, the returns to real estate assets in the "other" segment can be transferred to the idiosyncratic return term, i.e. the error term. In some embodiments, a REIT is included in the index if the "other" segment does not exceed a predetermined percentage of the REIT's total holdings (e.g., 25%, 30%, 40%). Otherwise, the REIT may be filtered out. As a result, the present disclosure can leverage information about property market segments incorporated into an REIT, even if the REIT contains significant holdings outside the targeted segments.

To continue development of the model, the model can be expressed in matrix form as:

$$r_{levered} = Xb_{levered} + u$$

where $r_{levered}$ is a vector of length N, with each element representing the monthly return to each of the i=1...N REITs. X is an NxK matrix containing the dollar percentages of assets held by each REIT in each of the k=1...K segments. u is the idiosyncratic returns of the REITs.

As previously described, REITs exhibit idiosyncratic returns attributed to assets in non-targeted property market segments, REIT-level management, and/or idiosyncratic returns within each REIT's individual property holdings. To obtain the most accurate pure property return

index, any approach to generating such indexes would seek to minimize idiosyncratic REIT return variance.

The variance of the idiosyncratic return of a REIT can be modeled as being inversely proportional to the total dollar value of its property holdings. Further, the idiosyncratic returns may be assumed to be uncorrelated, normally distributed, and have mean zero. The idiosyncratic variance Ω of returns may be constructed according to any method of estimation. For example, Ω can be defined as an NxN diagonal matrix containing the idiosyncratic REIT return variances, with each diagonal element defined as:

$$u^2_{i,i} = \frac{1}{total_i}$$

where $total_i$ is the total dollar value of properties held by REIT i. In some embodiments, each diagonal element can be defined as:

$$u^2_{i,i} = \frac{1}{\sqrt{total_i}}$$

In this manner, property market segment returns can be estimated via generalized least squares according to the following equation:

$$\hat{b}_{levered} = \left(X^T \Omega^{-1} X\right)^{-1} X^T \Omega^{-1} r$$

An intermediate step in the above process includes the determination of the weights for REITs in a targeted portfolio, as the following matrix labeled *H*:

$$H_{levered} = \left(X^T \Omega^{-1} X\right)^{-1} X^T \Omega^{-1}$$

in which $H_{levered}$ is a *KxN* matrix where each row *k* represents a portfolio of weights of REITs which has unit exposure, i.e. 100% exposure, to segment *k* and zero exposure to every segment

other than segment *k*. The property market segment weights sum to one (1) for the target segment and to zero (0) for the non-target segments, and may represent long and short positions for the REITs. If such a portfolio were invested, the portfolio would yield a pure return to the targeted property market segment while minimizing idiosyncratic REIT return variance.

Further, instead of regression via generalized least squares (GLS), the H matrix can be determined via direct mathematical calculation and/or mathematical constraint optimization. The weights can be determined using, for example, the "Solver"® feature of Microsoft Excel, manufactured by Microsoft Corporation of Redmond, WA. One of ordinary skill can enter the formula for the variance of the targeted portfolio in an Excel cell and instruct the "Solver"® to minimize the value in the cell subject to the following requirements: i) the weights on the targeted segment must sum to one (1), and ii) the weights on all the other segments must sum to zero (0).

This presented method can be further refined to reduce the volatility of the generated index and produce more accurate data regarding property returns. In particular, REITs are typically levered, holding anywhere from 0% debt to over 50% debt. Although the estimated levered property market segment returns incorporate information about underlying property price movements, the leverage increases the volatility of the returns. De-levering the returns decreases the volatility of the index and produces return data about underlying held properties.

One of the ways to de-lever the returns is to use the Weighted Average Cost of Capital (WACC) accounting identity to obtain returns on the underlying assets (*roa*):

$$roa_{i,t} = \left(\%equity_{i,t}\right) \cdot r_{i,t} + \left(\%debt_{i,t}\right) \cdot debtrate_t$$

The equity percentage, also known as the equity ratio, is the total stockholder equity divided by the sum of total stockholder equity and total liability as of the year-end date on 10k

forms. Such ratio data can be updated at any desired frequency (e.g., annually or quarterly) for each year in the study. Further, the equity and debt percentages for each REIT can be generated using financial information about the REITs from NAREIT and annual 10k forms, by way of example. In some embodiments, when minority interests represent significant portions of REIT balance sheets, the equity and debt percentages can be adjusted to account for such holdings. However, when these holdings are insignificant, adjustments need not be made. The returns in the above formula can refer to capital returns (reflecting price changes) or total returns (including income).

The same debt rate may be used for all REITs. Further, the debt rate may be calculated according to any number of methods. For example, market-wide average yields on unsecured REIT debt may be used as a proxy for the cost of debt, and the same rate may be applied to every REIT for the year. In some embodiments, the weighted average cost of debt reported in some REITs' annual 10k filings may be used as the debt rate, instead. Another method of calculating the debt rate may follow the formula:

$$debtrate_{i,t} = (IE_{i,t} + PD_{i,t})/(.5(TD_{i,t} + TD_{i,t-1}) + .5(PS_{i,t} + PS_{i,t-1}))$$

where:

$IE_{i,t}$ = the interest expense for firm i in period t

$PD_{i,t}$ = the preferred dividends paid by firm i in period t

$TD_{i,t}$ = firm i's total debt balance (book value) in period t

$PS_{i,t}$ = firm i's preferred stock at the end of year t

Although these embodiments contemplate using the same debt rate for all REITs, de-leveraging may also be accomplished by using REIT-specific values.

Once the calculated REIT returns are de-levered, the mathematical model for returns on property market segments can be written as:

$$roa = Xb_{delevered} + u$$

and the property market segment returns and weights for REITs in a targeted portfolio can be solved according to revised formulas of:

$$b_{delevered} = \left(X^T \Omega^{-1} X\right)^{-1} X^T \Omega^{-1} roa$$

$$H_{delevered} = \left(X^T \Omega^{-1} X\right)^{-1} X^T \Omega^{-1}$$

Under these revised formulas, the estimated coefficients of *b* directly reflect the returns to the underlying property segments. Thus, regression of the REIT returns against the REIT's proportional exposures to each of the property segments produces the estimated coefficients and may be performed, for example, via a GLS approach, which minimizes the sum of the squared errors of the regression. These regressions can be calculated for intervals of varying and/or predetermined length over any period of time, thereby generating coefficients according to such intervals. For example, REIT returns can be regressed against segment exposures on a monthly basis to generate coefficients for each month. Likewise, the returns can be regressed on a daily basis to generate daily coefficients. In other examples, the returns can be regressed on a pooled basis. In further examples, the desired solution can be obtained by direct mathematical calculation and/or mathematically constrained optimization as described in more detail, above.

The targeted portfolios contained in $H_{de\text{-}levered}$ do not include the debt positions needed to offset the leverage held by the REITs, because that leverage has already been removed. Further, the optimal relative weights of the REITs in the targeted portfolio may be independent of leverage and the techniques used to de-leverage the REIT returns. As a result, scaling the

coefficients calculated via regression would produce the same portfolio with varying amounts of leverage. Further, to generate the portfolio of assets that would theoretically need to be purchased to obtain targeted property segment-specific returns, completely adjusting for leverage, the segment portfolios would need adjustment. These adjustments can be accomplished by returning to the WACC identity for each REIT:

$$hadjusted_{k,i} = (\%equity_i) \cdot h_{k,i}$$

$$debtoffset_{k,i} = (\%debt_i) \cdot h_{k,i}$$

where $h_{k,j}$ is the share (long or short) of the portfolio for target segment k to be invested in REIT j.

Another approach to modeling the returns for property market segments based on REITs is the pureplay approach, as described by:

$$\tilde{r}_i = x_{A,i}(\tilde{r}_A + \tilde{e}_{A,i}) + x_{O,i}(\tilde{r}_O + \tilde{e}_{O,i}) + x_{I,i}(\tilde{r}_I + \tilde{e}_{I,i}) + \ldots + x_{K,i}(\tilde{r}_K + \tilde{e}_{K,i})$$

where:

r_i = observed return to REIT i
$\tilde{r}_k$ = pureplay return to segment k
$x_{k,i}$ = fraction of REIT i invested in segment k
$\tilde{e}_{k,i}$ = idiosyncratic return to REIT i's property in segment k

and where:

$$\sum_K x_{k,i} = 1$$

where K denotes the last of some number of segments.

The idiosyncratic components in the pureplay model are assumed to be random, uncorrelated with each other, and have mean zero. As a pureplay model is defined as an index with unit exposure to the desired segment and zero exposure to all other segments:

$$\tilde{r}_p = \tilde{r}_A \sum_{i=1}^{N} w_i x_{A,i} + \tilde{r}_O \sum_{i=1}^{N} w_i x_{O,i} + \ldots + \tilde{r}_K \sum_{i=1}^{N} w_i x_{K,i} + \sum_{i=1}^{N} \left(w_i x_{A,i} e_{A,i} + \ldots + w_i x_{K,i} e_{K,i} \right)$$

where each w_i equals the percentage of the index's holdings in REIT i and where the constraints for a pureplay index for a single segment k can be written mathematically as:

$$\sum_{i=1}^{N} \sum_{j \neq k} w_i x_{i,j} = 0$$

$$\sum_{i=1}^{N} w_i x_{i,k} = 1$$

Substituting the above constraints into the formula for the pureplay index results in a simplified equation for the return to the pureplay index for segment k:

$$\tilde{r}_p = \tilde{r}_k + \sum_{i=1}^{N} \left(w_i x_{A,i} e_{A,i} + \ldots + w_i x_{K,i} e_{K,i} \right)$$

whose variance can be described according to:

$$VAR(\tilde{r}_p) = VAR(\tilde{r}_k) + \sum_{i=1}^{N} \left(w_i^2 x_{A,i}^2 VAR(e_{A,i}) + \ldots + w_i^2 x_{K,i}^2 VAR(e_{K,i}) \right)$$

The idiosyncratic segment variance is assumed to be inversely proportional to a REIT's dollar holdings in that segment:

$$VAR(e_{k,i}) = \frac{1}{x_{k,i} \cdot total_i}$$

Substituting this expression for segment variance into the formula for index variance results in:

$$VAR(\tilde{r}_p) = VAR(\tilde{r}_k) + \sum_{i=1}^{N}\left(w_i^2 x_{A,i}^2 \frac{1}{x_{A,i} \cdot total_i} + \ldots + w_i^2 x_{k,i}^2 \frac{1}{x_{k,i} \cdot total_i} \right)$$

Which can be simplified to:

$$VAR(\tilde{r}_p) = VAR(\tilde{r}_k) + \sum_{i=1}^{N}\left(w_i^2 \cdot \frac{1}{total_i} \right)$$

Differentiating this equation with respect to w_i for the purposes of minimization reveals that the solution is a function of the second term.

Because of the assumptions regarding idiosyncratic returns, the variance of the idiosyncratic returns in the pureplay model reduces to the same variance assumption used in the previous regression models. As the previous regression models minimized, the sum of the squared errors of the regression, the models minimized the variance of the error terms (i.e., the idiosyncratic returns). These variances are assumed values contained in Ω, as previously defined. Therefore, the regression solution yielding $H_{de\text{-}levered}$ is identical to the solution to minimizing the variance of the pureplay model with respect to the w_i. For this reason, mathematical constrained optimization yields comparable targeted portfolio weights as regression.

Further, the presently disclosed models can be modified to achieve varying levels of granularity for property market segments. In the regression model thus described, the model targets property market segments such as the apartment segment, the office segment, the industrial segment, the retail segment, and the hotel segment. In some embodiments, the model can target property market segments by geographical region instead (e.g., Northeast, Midwest, West Coast, South), which may be defined according to the National Council of Real Estate Investment Fiduciaries's (NCREIF) convention, by way of example.

Alternatively, the model can target segments according to both usage type of properties and geographical region. In these embodiments, the model can account for apartment segments specific to each region, office segments specific to each region, and so on. In further embodiments, the model can account for any grouping of properties by target characteristics, such as small properties or large properties, granularity of urbanity (urban, suburban, rural), environmental ratings (e.g., "green properties"), or the like. The model can account for any usage type, geographical region, target characteristic, or combination thereof as would be appreciated by one of ordinary skill in the art. In any of these embodiments, calculated REIT returns would be regressed against exposures to each target segment or subject to mathematical constrained optimization to obtain the corresponding coefficients.

For example, to begin constructing a model that targeted geographical and usage type segments of the property market, the following variables could be defined:

$x_{W,i,t}$ = dollar percentage of assets held by REIT i in the West region at time t

$x_{MW,i,t}$ = dollar percentage of assets held by REIT i in the Midwest region at time t

$x_{E,i,t}$ = dollar percentage of assets held by REIT i in the East region at time t

$x_{S,i,t}$ = dollar percentage of assets held by REIT i in the South region at time t

where:

$$x_{W,i,t} + x_{MW,i,t} + x_{E,i,t} + x_{S,i,t} = 1$$

To achieve finer granularity on the basis of usage type, each variable in the above preliminary model can be expanded to multiple variables covering each usage type. For example, the variable for the apartment segment represented by:

$x_{A,i,t}$ = dollar percentage of assets held by REIT i in apartment segment at time t

can be replaced with:

$x_{W,A,i,t}$ = dollar percentage of assets held by REIT i in the west in apartment segment at time t

$x_{S,A,i,t}$ = dollar percentage of assets held in the south in apartment segment at time t

$x_{E,A,i,t}$ = dollar percentage of assets held in the east in apartment segment at time t

$x_{MW,A,i,t}$ = dollar percentage of assets held in the Midwest in apartment segment at time t

However, as the number of target property market segments grows, the multicollinearity among at least some of the segments can cause excessive standard errors in the corresponding estimated segment returns. Variance inflation factors (VIFs) can quantify the severity of this multicollinearity and be used to mitigate the severity of the multicollinearity's effects. After property market segments with high VIFs are identified, these segments can be aggregated into less granular segments, thereby reducing the total number of segments against which the REIT returns will be regressed.

The VIF is derived from the equation for the variance of the regression coefficients:

$$VAR(b_k) = \frac{\sigma^2}{(1-R_k^2)\sum_{i=1}^{N}(x_{i,k}-\bar{x}_k)^2}$$

where R_k^2 is the R-squared from the regression of explanatory variable k on all explanatory variables excluding variable k. As R_k^2 gets larger, the variance of the estimated regression coefficient becomes larger. In the case of perfect collinearity, $R_k^2 = 1$ and the variance of the estimated regression coefficient is infinite. VIF is defined as:

$$VIF_k = \frac{1}{(1-R_k^2)}$$

In further embodiments, VIF can be determined as described in "Econometric Analysis," 5th edition, by Greene.

VIF captures the relationship between the collinearity of a variable and the resulting increase in variance of the estimated coefficient for the variable. The square root of the VIF measures how many times higher the standard error of the regression coefficient is as a result of collinearity. A factor equal to one implies that there is no collinearity for explanatory variable k; the standard errors are not inflated (variable k is orthogonal). A factor equal to two implies that the standard errors for coefficient k are twice as high as they would be if variable k was orthogonal. Thus, variables with high VIFs may be identified and combined. Regressing the REIT returns, performing direct calculation, or mathematical constraint optimzation in light of the modified target segments results in more accurate indexes about the property market segments.

C. Computing System

Referring now to FIG. 1, an exemplary block diagram of a computing system 100 for generating characteristic-specific, de-levered indexes of property market returns is shown and described. In general overview, the computing system 100 includes a computing device 105 with a REIT return module 110, a de-leveraging module 115, and a processing module 120. The computing system 100 also includes a database 125 that stores data used to generate the indexes. In some embodiments, the database 125 can inhabit the same computing device 105 as the modules 110, 115, and 120, although in other embodiments, the database 125 can be incorporated in an external storage device.

The REIT return module 110, de-leveraging module 115, and processing module 120 may perform any of the computations described in reference to Section B of the present disclosure. The modules may run in software, hardware, or any combination thereof. In some embodiments, the modules may include any program, application, process, task, thread, or set of executable instructions capable of performing any of the tasks described herein.

The database 125 can store any REIT or other real estate-related data pertinent to generating indexes of the present disclosure. Some examples of this data can include REIT return data, bond data, property holding data, or any combination thereof.

D. Exemplary Demonstrations of Generating REIT-Based Pure Property Price Return Indexes

Demonstrative examples of generating REIT-based pure property price return indexes are herein described. In the first example, the REITs forming the basis for the index are the publically traded equity REITS listed in the NAREIT/FTSE indices during the period 2001-2007. REIT return data was first computed on a monthly basis for the 84 months from 2001-2007 according to the following formula:

$$r_{i,t} = \frac{REIT\ price_{i,t} - REIT\ price_{i,t-1}}{REIT\ price_{i,t-1}}$$

Such return data may be computed based on property holding information supplied by NAREIT, data from public SEC 10k filings, and/or any comparable source of information. In this example, the return data is based on price-only returns that exclude dividends, thereby accounting for price movements alone. Further, the REIT prices can be adjusted for splits.

Then, the REIT return data was de-levered according to

$$roa_{i,t} = \left(\%equity_{i,t}\right) \cdot r_{i,t} + \left(\%debt_{i,t}\right) \cdot debtrate_t$$

in which financial information from NAREIT and annual 10k filings were used to calculate the debt and equity percentages for each REIT. The equity and debt percentages were updated annually for each year analyzed. Further, because minority interests were relatively insignificant on the balance sheets of most REITs, the equity and debt percentages were not adjusted for such interests.

In this example, the market-wide average yields on unsecured REIT debt was used as a proxy for the cost of debt, with the same rate applied to every REIT for the year. As a result, by way of example, a 5.66% debt percentage was used for all REITs in 2007. As Boston Properties reported a weighted average cost of debt of 5.60% and Mack-Cali Realty reported a value of 6.08% in 2007, the estimate was reasonable. In other examples, the weighted average cost of debt reported in REIT annual 10k filings may have been used instead.

GLS regressions were run for each of the eighty four months spanning 2001-2007 against the apartment, office, industrial, retail, and hotel segments. The resulting segment returns were accumulated to produce the segment-specific indexes, which are plotted against the equivalent Moody's/REAL CPPI indexes (e.g., transactions price based indexes of U.S. commercial property price movements in the direct private property market) in FIGS. 2A-2E. The correspondence between the REIT-based and Moody's/REAL price indexes suggests that the REIT-based indices are indeed accurately reporting segment-specific returns to the underlying property market. Further, the annualized volatilities of REIT-based de-levered indexes are similar or lower than the volatilities of the Moody's/REAL indexes over the same period, as demonstrated by the following table:

	Apt	Office	Indust	Retail	Hotel
REIT-based Monthly Delevered Annualized Volatility	4.80%	5.84%	6.46%	5.18%	10.15%
Moody's/REAL Quarterly Annualized Volatility	8.06%	6.27%	7.05%	5.11%	N/A

As the figures demonstrate, the REIT-based de-levered data often leads the private market price movements. For example, the REIT-based Office index begins to decline in January 2007, whereas the Moody's/REAL suggests that prices in the private market did not begin to decline until after the following June.

For further refinement, each of the five property type segments was subdivided into four regional market segments, yielding a total of twenty variables. Then, for each month over the period 2001-2007, each of the twenty segments was regressed against all the remaining segments to calculate VIFs. The monthly average VIF for each segment is depicted in FIG. 3, with high VIFs in bold type. Because the hotel market segments across the four geographical regions demonstrate high VIFs, these segments can be combined into a single segment. Further, high VIFs between the Industrial South and Industrial West indicate that these two segments shall be combined, too. As a result, the 20-segment model collapses into a 16-segment model.

Then, the de-levered REIT return data is re-regressed according to the 16-segment model. FIGS. 4A-4D depict the results for the apartment, office, industrial, and retail sectors for each geographical region, again plotted against the corresponding Moody's/REAL CPPI index.

While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A method comprising: identifying valuation data comprising a plurality of estimated asset values corresponding to one or more of location information and property type; identifying a group of two or more characteristics, wherein the characteristics belong to one of a property type group and a regional group; for each respective real estate investment trust of a plurality of real estate investment trusts: compiling respective return data from the respective real estate investment trust, identifying respective holding data regarding each property of a respective plurality of properties of the respective real estate investment trust, wherein the holding data comprises one or more of location information and property type, categorizing, by a processor of a computing device, two or more properties of the respective plurality of properties by a first characteristic of the group of two or more characteristics to generate a respective first property segment, wherein the two or more properties are categorized based in part upon the respective holding data, categorizing, by the processor, two or more properties of the respective plurality of properties by a second characteristic of the group of two or more characteristics to generate a respective second property segment, wherein the two or more properties are categorized based in part upon the respective holding data, and determining, by the processor, for each of the first property segment and the second property segment, respective asset data, wherein respective asset data is based in part upon the valuation data and the respective return data; determining, by the processor, a first relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, according to a respective exposure of the respective real estate investment trust to the first characteristic; determining, by the processor, a second relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, according to a respective exposure of the respective real estate investment trust to the second characteristic; and determining, by the processor, a return index, wherein the return index is determined according to: the first relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, the second relative weight of each respective real estate investment trust of the plurality of real estate investment trusts, and the return data of each respective real estate investment trust of the plurality of real estate investment trusts.

2. The method of claim 1, wherein determining the first relative weight of each respective real estate investment trust of the plurality of real estate investment trusts comprises: establishing an NxK matrix, wherein N is a total number of real estate investment trusts in the plurality of real estate investment trusts, and K is a total number of characteristics in the group of two or more characteristics; determining respective dollar percentage asset data corresponding to each of the total number of characteristics for each of the total number of real estate investment trusts, wherein the

respective dollar percentage asset data is derived from the respective asset data corresponding to each of the total number of characteristics for each of the total number of real estate investment trusts; and populating the NxK matrix with respective dollar percentage asset data corresponding to each of the total number of characteristics for each real estate investment trust of the plurality of real estate investment trusts.

3. The method of claim 1, further comprising, for a first real estate investment trust of the plurality of real estate investment trusts: identifying one or more property holdings of the plurality of property holdings of the first real estate investment trust not categorized by either the first characteristic or the second characteristic to obtain one or more miscellaneous property holdings of the plurality of property holdings of the first real estate investment trust.

4. The method of claim 3, further comprising, for the first real estate investment trust of the plurality of real estate investment trusts: determining that a total number of miscellaneous property holdings comprises greater than a threshold percentage of a total number of property holdings of the plurality of property holdings of the first real estate investment trust; and filtering the first real estate investment trust of the plurality of real estate investment trusts out of the plurality of real estate investment trusts for purposes of determining the return index.

5. The method of claim 1, further comprising, prior to determining the return index, for each respective real estate investment trust of a plurality of real estate investment trusts: de-levering, by the processor, return data from the respective real estate investment trust.

6. The method of claim 1, wherein the property type group comprises the first characteristic corresponding to one of a usage type sector, an environmental rating, a size, an extent of subjection to supply constraints.

7. The method of claim 1, wherein the regional group comprises the first characteristic corresponding to one of a metropolitan region, an economic region, a geographical region, and a gradation of urbanity.

8. The method of claim 1, wherein the group comprises a composite group of at least two groupings.

9. A method comprising: compiling respective return data from each real estate investment trust of a plurality of real estate investment trusts at a frequency; for each real estate investment trust of the plurality of real estate investment trusts, determining, by a processor of a computing device, for each holding of a plurality of holdings of the respective real estate investment trust, respective asset data; determining, by the processor, a model comprising a first target characteristic and a second target characteristic; for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a first exposure of the respective asset data relevant to the first target characteristic and a second exposure of the respective asset data relevant to the second target characteristic; applying, by the processor, the model to the plurality of real estate investment trusts to produce a return index reflecting returns by each of the first target characteristic and the second target characteristic, wherein applying the model comprises: for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a respective first coefficient of the respective real estate investment trust based at least in part on the first exposure of the respective asset data of the respective real estate investment trust, wherein the respective first coefficient reflects a weight of the respective real estate investment trust in the return index by the first target characteristic, for each real estate investment trust of the plurality of real estate investment trusts, determining, by the processor, a respective second coefficient of the respective real estate investment trust based at least in part on the second exposure of the respective asset data of the respective real estate investment trust, wherein the respective second coefficient reflects a weight of the respective real estate investment trust in the return index by the second target characteristic, and determining, by the processor, the return index based at least in part on the respective first coefficient of each real estate investment trust of the plurality of real estate investment trusts, the respective second coefficient of each real estate investment trust of the plurality of real estate investment trusts, and the respective return data from each real estate investment trust of the plurality of real estate investment trusts.

10. The method of claim 9, wherein each of the first target characteristic and the second target characteristic is a property market segment.

11. The method of claim 9, wherein the respective return data of each respective real estate investment trust of the plurality of real estate investment trusts reflect respective total returns.

12. The method of claim 9, wherein: respective return data of each respective real estate investment trust of the plurality of real estate investment trusts reflect respective capital returns, and the return index is a price index.

13. The method of claim 9, wherein determining the return index comprises applying a regression.

14. The method of claim 9, further comprising de-levering, by the processor, the respective return data of each real estate investment trust of the plurality of real estate investment trusts.

15. The method of claim 14, wherein de-levering the respective return data comprises applying a Weighted Average Cost of Capital (WACC) accounting identity.

16. The method of claim 9, wherein the frequency is one of monthly, daily, and real-time.

17. The method of claim 9, wherein: one or more property holdings of the plurality of property holdings of a first real estate investment trust of the plurality of real estate investment trusts lack both the first target characteristic and the second target characteristic; and the one or more property holdings of the plurality of property holdings of the first real estate investment trust comprise less than a percentage of total property holdings of the plurality of property holdings of the first real estate investment trust.

18. The method of claim 17, further comprising: determining a third exposure associated with the one or more property holdings of the plurality of property holdings of the first real estate investment trust that lack both the first target characteristic and the second target characteristic; and adjusting the first exposure and the second exposure, wherein adjusting comprises removing an influence of the third exposure in determining the return index.

19. The method of claim 17, wherein the percentage is one of 30%, 40%, and 50%.

20. The method of claim 9, wherein determining the respective asset data comprises accounting for multicollinearity between the first coefficient and the second coefficient.