Real-Time Valuation: Breathing New Life into Moribund DCF Modeling

by

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Abstract: By using readily available daily information on the time value of money, namely the Treasury yield curve, and by applying risk premiums appropriate to commercial real estate tenant leases, the single discount rate shortcut predominant discounted cash flow (DCF) models can be improved upon. By utilizing the Treasury yield curve, real-time valuation is possible. The Real-Time Valuation (RTV) model proposed here also produces useful statistics to aid portfolio construction and monitoring such as duration and explicit risk assessment. These statistics are unavailable in current formulations of real estate DCF models.

Key words: Valuation, discounted cash flow forecasting, time value of money, time-varying discount rates, real estate risk assessment, tenant credit risk, duration

When the first computer-based discounted cash flow (DCF) programs were created in the 1970's, some shortcuts were taken for computational ease. Because the basic routines of DCF have not changed appreciably in nearly 30 years, many of those shortcuts have persisted. Faster computers and, more importantly, a better understanding of the nature of commercial real estate as a hybrid asset that may be analyzed by techniques commonplace in stock and bond markets provide an opportunity to reconsider DCF modeling with modern technology and analytics.

One shortcut that verges on being a serious mistake was to use a single discount rate for cash flows regardless of how distant in the future those flows occurred. A superior approach (and one that received scant attention when Blackadar proposed his Dynamic Capitalization Model in 1984 and 1986) would be to incorporate the term structure of interest rates most commonly expressed by reference to the Treasury yield curve, which shows for any business day the yield for a risk-free government asset at a particular future point in time. Real estate assets are certainly not risk-free, but property managers or owners intimately familiar with tenants will find it relatively simple and easy to add a suitable risk premium to the Treasury yield curve to account for the risk of a real estate asset or lease.[1]

This is the basic idea behind the proposed Real-Time Valuation (RTV) model.[2] To estimate property value in the RTV model, an appraiser or analyst would take the following steps:

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1 The proposed RTV model relies upon the conceptual notion that leases are bond-like and have default characteristics and cash flows that can be analyzed by means similar to bonds. The bond-like character of leases has been gaining traction for many years but is not universally accepted or acknowledged nor are the implications of bond-like characteristics fully appreciated in academia or industry. For a more complete discussion of this subject, see Graff (1999).

2 Various aspects of the RTV model have been discussed previously in Greig and Young (1991 and 1995). This article improves upon the technique of discounting current and future leases, provides a computer-based model for computations, and discusses institutional portfolio construction and monitoring implications of using the model in preference to the current DCF model. Demonstration versions of the

1. Determine the risk premium for each of five credit ratings, A through E with A being the lowest risk.
2. Add the risk premiums to the Treasury yield curve.
3. Assign each property's lease a credit rating based on the five-category scale.
4. Discount each monthly net lease cash flow at appropriate risk-adjusted rates for the term remaining to obtain the present value of existing leases.
5. Also, account for the rollover of leases into perpetuity to obtain the present value of future leases.
6. Sum the present values of existing and rollover leases to get the present value of each space and the value of the property in total.

The RTV model produces more than just an estimate of property value and, as such, can be used for more than valuation. The RTV model can provide statistics useful for strategic and tactical planning, portfolio assembly and management, and comparative analysis. Duration, weighted average risk, risk profiles, loss potential from defaults, and measures of discount rate and rental growth rate elasticities are some of the statistics that fall out of the RTV model. By contrast, these measures are entirely absent or unobtainable from current formulations of DCF.

Unlike the current DCF model where discount rates are presumed to be derived from real estate market information, the RTV model makes explicit use of the market information used across the economic spectrum, namely the Treasury yield curve.

To make effective use of the Treasury yield curve, the appraiser or analyst must interpolate yields for each month of each property lease. Although the U.S. Department of the Treasury publishes yield curve data each business day, these data are estimated only for ten points from 1 month to 20 years. To resolve this interpolation problem, the RTV model employs a simple, third-order polynomial regression equation that tracks the Treasury yield curve with remarkable precision. Back tests of this equation are shown in the paper and a separate computer model for interpolating the Treasury yield curve is available for teaching or testing purposes.

DCF Modeling: A very brief history

Before there was discounted cash flow forecasting for the income approach to value, appraisers used the "direct capitalization" method.[3] Direct capitalization required only two parameters: the stabilized net income and the overall capitalization rate. Dividing stabilized net income by the overall capitalization rate produced the value estimate. Short, simple, and serviceable in a world where rents and expenses were fairly stable and predictable.

Over time, however, commercial property valuation came to be perceived as more complicated. Leases had varying terms and conditions and sometimes included options to extend the lease. Owners adopted techniques to offset future, unpredictable operating expenses by

RTV software are available in Windows XP and Apple Mac OS X versions at http://homepage.mac.com/mikero1/MSY/software.html.

[3] In reality, direct capitalization is just a special case of discounted cash flow taken to infinity. Also, even in the current formulation of discounted cash flow forecasting, the reversion calculation that is typically performed after ten years of detailed modeling is the direct capitalization formula of V=I/r. For some discussion of these similarities, see Jaffe (1980) or Brown and Matysiak (2000).

shifting some or all of the burden to tenants in the form of "rent escalations" or "operating expense pass-thrus." Owners also found ways to profit from the success of retail tenants by collecting percentage rents and to shield themselves from unanticipated inflation with escalation clauses linked to the Consumer Price Index or similar measures.

When examined in detail, owners noticed that property operating expenses varied over time at different rates. Some operating expenses were set by contract, especially in unionized cities, utility expenses moved at paces often influenced by local factors as well as by global supply and demand; real estate taxes had peculiar patterns set by local and state practices or statutes; management fees were often tied to the gross revenue of the property, which itself was a function of the reimbursement clauses written into the leases.

Thus, throughout the 1970's as the power of computerized computations became available through service bureaus or relatively affordable minicomputers, real estate practitioners began to model lease complexity[4] over extended time horizons, typically ten years.[5] In less than a decade, the near-universal model for modeling and analyzing income-producing commercial property became the Discounted Cash Flow (DCF) model. By allowing explicit modeling of lease terms and by permitting changes in key variables to judge the impact of changes over time, DCF seemed to offer a more adaptable and accurate way to value income-producing property than the traditional direct capitalization method.

Indisputably, the general level of interest rates affect pricing of real estate debt. For example, Treasury bill rates are a common basis for rates on short-maturity construction loans. Longer maturity bills and notes influence rates charged for real estate bridge loans and the 10-year Treasury rate is often a benchmark for adjustable-rate commercial and residential mortgages. If pricing of real estate debt is influenced by interest rates, why should the pricing (valuation) of real estate equity positions be immune from similar influences?

Appraisers are often advised to derive capitalization rates (a.k.a., discount rates) from market transactions. By observing the prices paid for commercial property and by estimating the net operating income available at the time of purchase, an appraiser could calculate an estimated discount rate. Unfortunately, appraisers are seldom privy to the essential economic and financial circumstances of sold properties and, as discussed earlier, the complexity of a property's economic and financial circumstances can have a sizeable impact on the transaction price observed in the market. Without more detail about property economics, the appraiser will have difficulty resolving differences in derived capitalization rates.[6]

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4 The first published article describing lease-by-lease discounted cash flow analysis was Shlaes and Young (1978).

5 In those days, computer printouts were most often limited to 132 characters across a page, which more than any other fact explains how a 10-year discounted cash flow forecast became the norm. With 132 characters, there was just enough room to display a suitable label for each row followed by 10 columns of computed results.

6 Also, what is the appraiser to do when few transactions are available or when the time elapsed since sales is too great to serve as a reasonable basis for current valuations? This problem was acute in 1990 and 1991 when few commercial transactions occurred anywhere in the country.

Fortunately, appraisers or analysts can look to the U.S. Department of the Treasury for discount rates independent of real estate, and these discount rates are published every business day of the year.

Yield Curve Estimation

The term structure of interest rates, the yield curve, is a measure of the market's expectation of future interest rates. The present value of an amount of money to be received at some future date can be computed from the term structure of interest rates. Real estate cash flows are no more immune from this reality than cash flows from any other source. Therefore, analytical techniques applicable to fixed-income securities may be applied to real estate cash flows as well.

For purposes of the valuation procedure proposed in this article, the relatively few data points along the Treasury yield curve must be expanded to include each month from 1 to 240.[7] Interpolation is necessary because the U.S. Department of the Treasury publishes estimates of the yield to maturity for just ten points: 1-month, 3-months, 6-months, 1-year, 2-years, 3-years, 5-years, 7-years, 10-years, and 20-years.[8]

The common, upwardly trending shape of the Treasury yield curve suggests that a curvilinear regression might be a good approximation. A close look at the curve shows that quite often it has two points of inflection, one between the 1-month and the 1-year points, and another roughly in the 7-year to 10-year period. Accordingly, a third-order polynomial equation is the best choice. Thus, a practical formula for the Treasury yield curve has the form:

$$\mathbf{Y = a + b\,M + c\,M^2 + d\,M^3} \qquad \text{Equation 1}$$

where **Y** is the yield rate; **M** is the natural logarithm of the maturity in years plus 1 or **ln(years+1)**; **a** is a constant; and **b**, **c**, and **d** are coefficients.

Applying Equation 1 to recent Treasury yield curve data produces results shown numerically in Exhibit 1a and graphically in Exhibit 1b. Additionally, Exhibit 1a shows actual and computed yields and the absolute and percentage errors in estimates during three typical interest rate regimes: a flat yield curve; a normal, upwardly sloping yield curve; and an inverted yield curve where shorter-maturity rates exceed longer-maturity rates. Naturally, actual versus computed results will vary with each application of Equation 1 to the data, but the relatively small errors in either basis point (bp) or percentage terms are well within the practical range of estimates of real estate discount rates obtained by conventional qualitative or quantitative means.

For a more refined and readily available estimate of monthly yields from one to twelve months, some might prefer LIBOR (London Interbank Offered Rate) rates. Currently, LIBOR rates in the U.S. are approximately 30 basis points higher than equivalent periodic Treasury yield rates. For terms greater than twelve months, interest rate swaps curves like those computed by the

7 240 months equates to the 20-year data point that in recent years has been the longest term to maturity available from the Treasury. The 30-year Treasury bond has been revived recently and the interpolation could be extended to 360 months if necessary. However, property owners have shown a preference for ever shorter leases over the last few decades.

8 Treasury yield curve daily rates are available at http://www.treas.gov/offices/domestic-finance/debt-management/interest-rate/yield.html. The cubic spline methodology used to estimate the rates is described at http://www.treas.gov/offices/domestic-finance/debt-management/interest-rate/yieldmethod.html.

International Swaps and Derivatives Association (ISDA) or a commercial data provider might be worth considering. Consistency of analysis and application of risk premiums are more important than the selection of the particular rate structure.[9]

Real Estate Risk Premiums

Few tenants in commercial property have rated, publicly-traded debt. Thus, tenant credit quality and associated premium over the risk-free Treasury rate may be difficult or impossible to determine by reference to published sources.

However, if credit quality is interpreted to mean the likelihood that the tenant will fulfill its lease obligations, a property manager or owner familiar with the tenants could give them ratings relative to one another. Exhibit 2 shows a simple five-point letter scale of A through E, in which A represents the highest quality tenant. If desired, the property manager may also add a default risk expressed in percentage terms to account for loss of rent due to possible default on lease obligations.

It should be acknowledged that property managers or owners are not currently familiar with the activity of assessing relative credit, at least in a formal way. Because risk assessment is essential to the RTV model, those who use the model must become comfortable with this task. With experience, with more attention paid to the issue, with better collection and processing of information about tenants that default correlated with financial or economic data, improvements in risk assessment can be expected.[10]

By virtue of the way in which the five risk categories have been defined, most tenants will probably fall into the C to D categories.[11] Tenants with A ratings, those have little or no risk of default and a near certain likelihood of paying rent for the full contractual term, are relatively rare. Indeed, in good times, landlords may avoid A-rated tenants who often demand heavily discounted rental rates or preferential lease terms. The table suggests appropriate risk premiums for each of the different credit ratings.

The premiums are added to Treasury yields for each maturity, although more elaborate, non-linear premiums could be accommodated. The sum of Treasury yield and risk premium represents the discount rate appropriate for the tenant's lease. Exhibit 3 shows how the discount rate would

9 Arguably, zero-coupon rates might be preferable for discounting constant lease payments because zero-coupon rates are for bonds that pay only one cash flow, which is analogous to the net lease cash flow scenario.

10 Because the task of tenant risk assessment proposed here is new, some may argue that property owners and managers will have a difficult, if not impossible, job assigning relative risk rankings. However, in test applications of the RTV model and in anecdotal reports from owners and mangers, relative risk assessment has not been difficult. Some even report that it is fun and an opportunity to think differently about what makes for stable or unstable tenancy.

11 Curiously, little is known about tenant default risk or credit quality. One would think that owners and investors would be concerned about the financial impact of risks inherent in writing long-term contracts for space, i.e., leases, but apparently there has been no systematic research on this issue. This aspect of real estate investment risk is ripe for research that conceivably could lead to improvements in accounting data collection , processing, and reporting.

be determined for net cash flow in the 48th month of a lease of a tenant with E-quality credit. The 2.30% credit quality spread from Exhibit 2 would be added to the Treasury yield for 48 months to produce an discount rate of 4.98%, in this example.

The Real-Time Valuation (RTV) Model

Calculating the value of each lease separately and then summing the individual values to produce an estimate of property value is only a bit different than the current practice of computing aggregate cash flows year-by-year by summing the annual revenues and subtracting annual operating expenses. Current practice discounts annual net cash flow into an estimate of value.

The RTV model values individual leases by bond valuation techniques that have been used for decades.[12] When treated like bonds, only three variables are needed to value leases: the pattern of net rents, the credit quality of the tenant, and the risk premium corresponding to the credit quality. This model asserts that the present value of a lease is simply the present value of the stream of net rents at the appropriate discount rate, namely the premium over the risk-free rate (Treasury rate) for each month of the term of each property lease.

Net Rent

Rents in the RTV model must be rents net of all property operating and capital expenses. Oftentimes rent will be expressed as a dollar amount per year with stipulated or contingent additional rent charged prorata by leased area for increases in real estate taxes or operating expenses over a base amount or an amount computed for a particular base year. Also, leases may include other specified charges for such items as utilities or reimbursement of building improvements over a standard allowance.

Whatever the source of revenue or offsetting expense, the RTV model lease rent must be the net rent paid by the tenant. Net rent estimates also apply to market rent assumptions.

Unreimbursed Operating Expenses

Except in fully net leased properties, some amount of operating expense and capital expenditure is typically borne by the property owner and must be acknowledged in the model. There are two possibilities. The anticipated unreimbursed operating expense amounts and anticipated future capital expenditures could be scheduled for each month out to some distant date where the analyst determines that the present value of future expenses will be de minimus.

Alternatively, the anticipated unreimbursed operating expense amounts could be apportioned to each existing lease to produce a more refined estimate of net rent. With this approach, there are two possible means of apportionment, one based on relative share of the total area leased and one based on the relative net rent of each lease. Apportionment based on area, however, is more

12 The "dynamic capitalization" model proposed by Gordon Blackadar (1984 and 1986) utilizes actuarial techniques and terminology in its view that property values are comprised of the sum of the individual lease values. Unlike the traditional DCF model in which ten or more years of net cash flow are projected and then discounted at a single rate to arrive at an estimate of present value, the dynamic capitalization model discounts each lease separately and then sums the present values to arrive at current valuation. The RTV model follows the spirit of Blackadar's dynamic capitalization.

problematic than apportionment based on rent. For example, in community or neighborhood retail centers, the drug or food stores "anchor" tenants often pay low per square foot rents while the remaining smaller stores pay considerably more rent per square foot. It is possible that apportioning unreimbursed expenses by area will result in negative net rent estimates for the anchor tenants. Because this situation cannot occur when apportionment is based on relative net rent, the RTV model uses this approach.

Rollover Leases

Once an existing lease expires, the usual presumption is that the space will be released at market rates after some period of vacancy and probably after allowances for leasing commissions and for some capital expenditures to make the space suitable for the new tenant.

All these costs can and should be considered when estimating the net market rent for each space. Also, unless there is reason to expect superior or inferior future tenant creditworthiness, the best estimate within the RTV model will be a credit rating of C, the middle of the range. However, the RTV model allows rollover leases to be assigned any appropriate credit rating if the analyst desires.

Reversion When Market Rents Grow

The value of future leases adds some complication to the RTV model. In particular, when market rents are expected to grow over time, each successive renewal would be initiated at an ever increasing amount. This would suggest that the simple perpetuity model that includes the rate of growth of rent should be incorporated in the RTV model. That model is the Gordon growth model:

$$\mathbf{V = I\ /\ (\ d - g)} \qquad \text{Equation 2}$$

where **V** is the value estimate, **I** is net income anticipated expressed as a constant amount, **d** is the annual discount rate, and **g** is the annual rate of growth of net income. Equation 2 is a slight expansion of the direct capitalization formula, but it has some obvious problems as a practical, working model.[13]

As long as the annual discount rate, **d**, is greater than the annual rate of growth of net income, **g**, the value estimate is a positive, non-zero number. However, if the annual discount rate is less than or equal to the annual rate of growth of net income, the value estimate is infinite. Young (1980) discusses this problem and reaches the less-than-satisfying conclusion that because infinite or extraordinarily high value estimates are unrealistic, the traditional valuation model including the model in Equation 2 is questionable and that market forces will keep value estimates in check. While it is at least conceivable that an appraiser could derive growth rates implicit in market transactions, the derivation would require knowledge of the annual discount rate, which is itself unobservable.

Thus, unless some arbitrary rule is applied in the RTV model, there is a dilemma that cannot be resolved in favor of making market growth rate estimates explicit. Because no satisfactory rule

13 For more elaborate formulas for valuing revenue streams that grow periodically, see Brown and Matysiak (2000, chapters 3 and 4). Apparently, more attention is paid to this complication in the U.K. because there commercial property rents are commonly subject to upward-only "rent reviews."

can be devised to handle all circumstances, the RTV model assumes that the growth rate of market rent for successive rollovers is zero.

Additional Statistics

Valuation has been the focus of the discussion thus far, but other benefits derive from the methodology that are worth noting: yield measures, explicit risk measurement and assessment, lease and property duration, and elasticities or sensitivities with respect to changes in either market rent or discount rate.

Yields

Capitalization rate is a time-honored statistic. In the RTV model, the implied capitalization rate is computed as the annualized net cash flow from existing leases (the average monthly net rent including all future step increases times twelve) divided by the total estimated value of the property.

Because the RTV model values the current and future leases based on the applicable spread over Treasury yields for each month of the lease term, the RTV model allows separate yield results for current and future leases weighted by the present value of the respective current lease and residual values.

Risk Profile

In a multi-tenanted property with tenants having various risk classifications, a weighted average composite risk measure for the property can be derived along with a distribution of the risk estimates across the five-letter risk classification scheme. In the RTV model, the weighted average composite risk for the property is further subdivided into risk classifications with plusses and minuses, i.e., risk measures like C+ or B–. The risk composite is also supported by a figure expressing the weighted average of the spread over Treasuries for the current leases.

Duration

Duration is a term-of-art in bond analysis. It is a time period (often specified in months) that is considered more descriptive of a bond than is maturity. It is obtained by weighting the month in which each cash flow is produced by the debt instrument by the flow's percentage contribution to the present value (price) of the instrument. Unlike maturity, which simply tells the analyst the time lapse until the instrument's last payment, duration is a time measure that varies with the pattern of the income stream and the discount rate applicable to each flow.[14]

14 For a textbook-length treatment of duration and other fixed-income securities related issues, see Tuckman (2002). An excellent description of the value of implications of duration appears in Wurtzebach and Waller (1985). Also, several research pieces by Salomon Brothers addressed duration in the real estate context, but focused entirely on duration of the mortgage debt aspect of real estate and overlooked the possibility of employing the same techniques to either the lease or the residual components. The Solomon Brothers work is published in Hartzell, Shulman, Langetieg, and Leibowitz (1988).

Lease Durations vs. "Time Until Rollover"

The weighted average property duration is obtained by multiplying lease duration by the fraction of total value attributable to the existing leases and adding the product of the average years to lease rollover and the fraction of value attributable to the residual. Thus, weighted average property duration combines the durations of the existing leases with the durations of the spaces encumbered by those leases (i.e., the individual space residuals). Residuals can be thought of as zero-coupon equity interests that have a duration exactly equal to their terms therefore the duration of the residual is simply the number of years to rollover.

Lease duration is a measure of a lease's sensitivity to value change due to changes in interest rates. By analogy, the weighted average property duration is a measure of a property's sensitivity to value change due to changes in interest rates. As a measure of a property's exposure to rollover risk, lease duration is superior to the more conventional measure of average number of years until rollover because duration incorporates the time-value of the lease payments into its calculation. Thus, two properties having a similar average number of years until rollover, but differing markedly in lease duration, would have different exposure to rollover. The property having the shortest duration would be the least exposed and least risky.

Other things being equal, properties with shorter lease durations would be less subject to changes in value due to changes in interest rates.

Capital Sensitivity Coefficients

Commercial income-producing property can be viewed as an asset with two components: current leases that are bond-like with fixed payments and terms, and future leases that have payments that could be higher or lower than current rents. All other things being equal, the principal drivers of value change over time will be changes in discount rates, changes in market rents, and the passage of time that alters the share of value attributable to current and future leases.

Capital sensitivity is the degree to which value will change with respect to changes in discount rate and market rent. From Sykes (1980) and Sykes and Young (1981), these capital sensitivity coefficients are defined as:

$$\mathbf{S_i = \frac{I_m}{Vr(1+r)^n}} \qquad \text{Equation 3}$$

and

$$\mathbf{S_r = -1 - \frac{n}{(1+r)}\left[r - \frac{I_c}{V}\right]} \qquad \text{Equation 4}$$

where $\mathbf{S_i}$ is the capital sensitivity with respect to changes in net rental value, $\mathbf{S_r}$ is the capital sensitivity to changes in discount rates, $\mathbf{V}$ is the current property value, $\mathbf{I_c}$ is the rental value at current rents, $\mathbf{I_m}$ is the rental value at market rents, $\mathbf{r}$ is the overall discount rate, and $\mathbf{n}$ is the average time until rollover weighted by lease value.

Logically, a property whose leases have a short period until rollover will have greater sensitivity to changes in net rental value than properties with longer term leases. This statistic is analogous to the duration discussed above but has a simpler use in practice. If, for example, a property had a sensitivity coefficient for rental value, $\mathbf{S_i}$, of 0.600, then a 1% change in market rent would produce a 0.6% change in property capital value. The maximum sensitivity coefficient for rental rate, $\mathbf{S_i}$, of 1.000 occurs immediately before lease renewal when the sensitivity coefficient for discount rate, Sr, is at its absolute minimum of –1.000.[15]

The sensitivity coefficient for discount rate, $\mathbf{S_r}$, is always negative due to the inverse relationship between capital value.

Implications for Real Estate Investors

Institutional real estate owners and managers are facing increased pressure to value properties more frequently than once a year. Quarterly valuations will soon be the norm and valuations when significant property or macroeconomic shifts occur may be desired. The RTV model is ideal for timely, more frequent valuations in an automated fashion.

Additionally, the property valuation approach embodied in the RTV model allows measurement of significant differences in the risk and performance characteristics of individual properties that are invisible or only hinted at by conventional analytical techniques. These measures allow for strategic investment planning and for purchase or sale decisions based on individual property or portfolio characteristics such as duration, credit mix, and sensitivity to changing economic circumstances rather than on more coarse property type or geographic characteristics, which reveal no economic characteristics for investment decision-making.

By application of individual lease risk assessment based on a tenant's relative credit quality and a risk-premium over the Treasury yield curve, property risk can be made explicit. When applied to different properties, the RTV model reveals material differences in the proportions of total value that consist of bond like (lease) components and equity like (equity residual) components. How a property's value will respond to changes in interest rates or market rents becomes evident when duration or sensitivity coefficients are produced. By contrast, conventional physical attributes such as property type or geographic location or any of the statistics commonly derived from DCF models offer no guidance with respect to key drivers of performance.

When designing investment plans, institutional investors often circumscribe their portfolios with a limited set of dimensions such as property type, location, size, or level of mortgage debt. By using the dimensions of property duration and explicit risk assessment inherent in the RTV model, investors are presented with new ways to design portfolios and to monitor performance and conformity to the plans. For example, an investor might have a preference for minimizing exposure to low credit tenants. Another investor might prefer properties that are very responsive to changes in market rent in markets or in property type sectors where market rents are expected to rise at above normal rates. Conversely, an investor might opt for properties with steady, predictable performance to avoid the vagaries of value or income fluctuation in a changing interest rate and market rent environment. The statistics provided by the RTV model are uniquely helpful in these situations.

In short, the statistics produced by the RTV model offer investors the opportunity to fine-tune portfolio construction with greater confidence and reliability. Properties with desirable financial and economic characteristics can be identified with greater clarity and monitored more

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[15] In fact, if a property is overrented, i.e., the market rental value is less than the current lease rental value, the sensitivity coefficient for discount rate will fall below –1.000 (e.g., -0.950).

consistently over time with the array of statistics of the RTV model that are impossible to glean from the current DCF model.

Conclusions

The Real-Time Valuation model proposed in this article corrects a serious shortcoming of the extant Discounted Cash Flow model. In particular, the Real-Time Valuation model uses tenant-by-tenant, credit-based spreads over the Treasury yield curve as the basis for discounting current and future rental streams to present value at an appropriate risk-adjusted rate.

In addition, the Real-Time Valuation model produces a number of desirable statistics absent from current DCF models including explicit and relative risk rankings, lease and property duration, yields on current and future income, and sensitivities with respect to changes in market rental rates and discount rates. These statistics can assist owners and investors in the design of strategic investment plans and tactical decisions to buy, sell, or hold. Differences among properties analyzed with the Real-Time Valuation model are more apparent, measurable, and quantifiable than differences among properties analyzed with the current Discounted Cash Flow models where value, property type, and location are effectively the sole distinguishing characteristics.

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Exhibit 1a
Actual and Computed Treasury Yields
During Three Common Shape Regimes

	Maturity	Yield Actual	Yield Computed	Computed – Actual Error in B.P.	Computed – Actual Error in Percent
Flat Yield Curve:					
January 2, 1990					
	1 month	7.83	7.84	0.01	0.13
	3 months	7.83	7.84	0.01	0.13
	6 months	7.89	7.84	-0.05	-0.63
	1 year	7.81	7.85	0.04	0.51
	2 years	7.87	7.87	0.00	0.00
	3 years	7.90	7.89	-0.01	-0.13
	5 years	7.87	7.91	0.04	0.51
	7 years	7.98	7.93	-0.05	-0.63
	10 years	7.94	7.95	0.01	0.13
	20 years	7.97	7.97	0.00	0.00
Normal Yield Curve:					
January 2, 2004					
	1 month	0.88	0.88	0.00	0.00
	3 months	0.93	0.92	-0.01	-1.08
	6 months	1.02	1.02	0.00	0.00
	1 year	1.31	1.32	0.01	0.76
	2 years	1.94	1.95	0.01	0.52
	3 years	2.47	2.49	0.02	0.81
	5 years	3.36	3.31	-0.05	-1.49
	7 years	3.90	3.87	-0.03	-0.77
	10 years	4.38	4.44	0.06	1.37
	20 years	5.21	5.20	-0.01	-0.19
Inverted Yield Curve:					
March 1, 2006					
	1 month	4.45	4.50	0.05	1.12
	3 months	4.60	4.59	-0.01	-0.22
	6 months	4.75	4.67	-0.08	-1.68
	1 year	4.74	4.74	0.00	0.00
	2 years	4.71	4.75	0.04	0.85
	3 years	4.68	4.71	0.03	0.64
	5 years	4.63	4.63	0.00	0.00
	7 years	4.60	4.59	-0.01	-0.22
	10 years	4.59	4.57	-0.02	-0.44
	20 years	4.74	4.75	0.01	0.21

Exhibit 1b
Actual and Computed Treasury Yields
During Three Common Shape Regimes

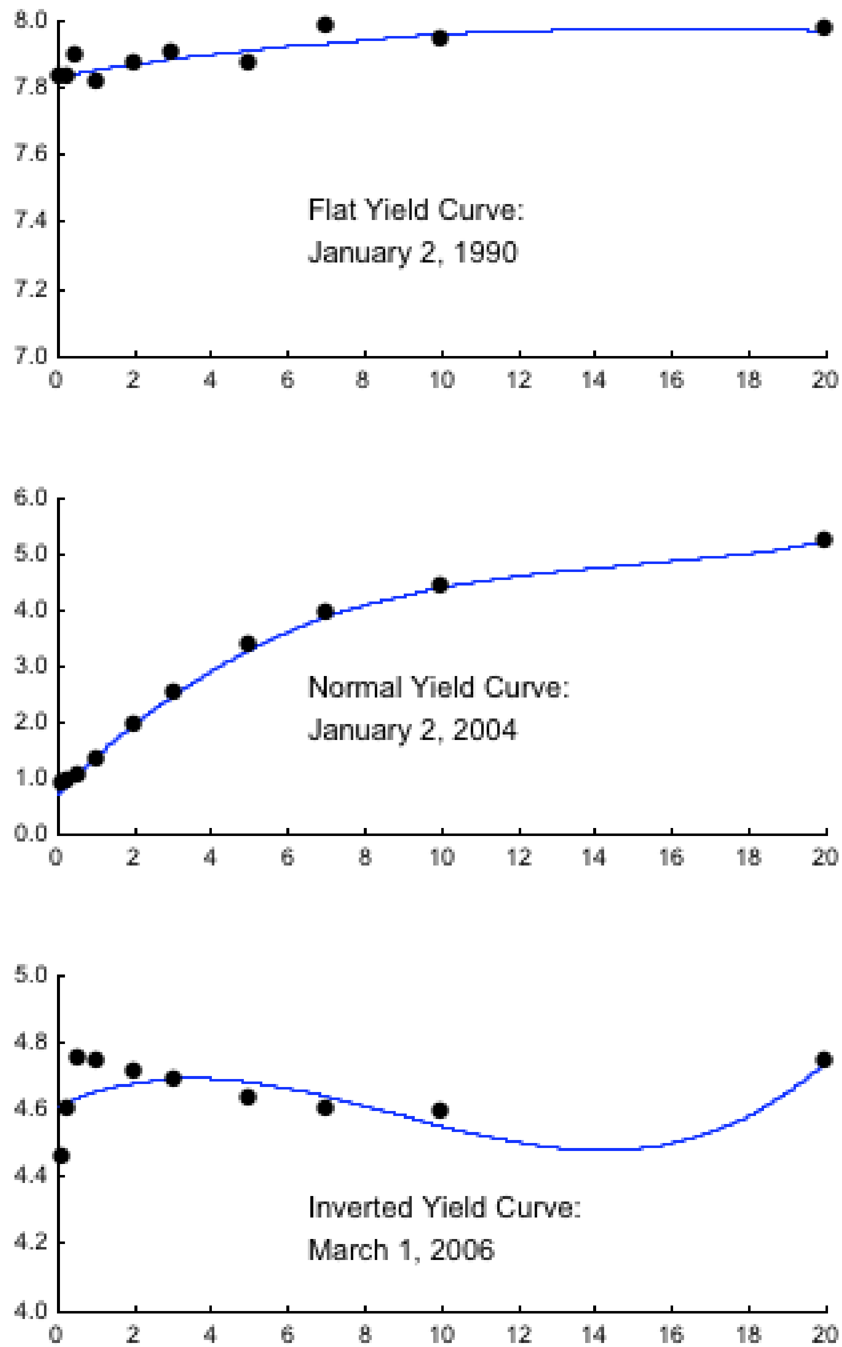

Exhibit 2
Example Tenant Credit Quality and Risk Premium Scales

Credit Rating	Description	Risk Premium Over Treasuries	Default Risk
A	Highest possible rating; better than commercial credit (e.g., government office). Virtually no default risk.	0.75%	1%
B	Best commercial credit. Very low probability of default.	0.95	4
C	Good commercial credit. Moderate probability of default.	1.40	8
D	Lower commercial credit. Real potential for default.	1.90	14
E	No credit or little business experience. New or undercapitalized startup.	2.30	22

Exhibit 3
Yield Curve on January 2, 2003, and Risk Premiums