A look at real estate duration

Duration is a function of lease contracts and market conditions.

David J. Hartzell, David G. Shulman, Terence C. Langetieg, and Martin L. Leibowitz

The analysis of duration, or the sensitivity of an asset's value to changes in interest rates, has followed an interesting path since the development of duration concepts for investments outside the fixed-income area. The duration concept has been extended to common equities, liability structures, and the management of the pension surplus. In this article, we use the effective duration concept to analyze real estate, with a look toward consolidating the contractual differences between real estate holdings and the equity duration model. This topic is particularly relevant in the measurement of total portfolio duration for portfolios with a significant real estate content.

Real estate duration can be determined using methods similar to those for common stocks, such as the dividend discount model (DDM). As with common equity, however, empirical estimates of duration vary considerably between the traditional dividend discount model and newer techniques. We analyze these differences, using examples that differ in their ability to pass through inflation to net income. In particular, we model the speed of adjustment to inflation in lease contracts. This factor determines how quickly total returns adjust to inflation-induced changes in interest rates and, hence, the effective duration of the asset class.

We analyze duration under a number of scenarios, which differ by inflation adjustment assumptions. First, we define real estate as an investment vehicle, with a particular focus on the microfactors affecting real estate performance. Second, we describe the different rental adjustment processes used as inputs to duration calculations. The results show that different lease rollover assumptions result in different durations. Third, we discuss the impacts of a change in real interest rates. Finally, we present our conclusions and implications of the analysis.

REAL ESTATE DEFINED

Equity real estate has the same attributes as common stock and can be viewed as an industry segment within a broad securities index. As a result, the equity duration model is applicable. An investor receives a stream of payments called net rents and holds a claim on the residual value of the asset.

Real estate is also characterized by three factors that differentiate it from common stock. Real estate represents an unusually large segment of the economy, which is subject to its own cycle and is a major factor of production in all industries. Hence, investors can diversify within real estate with relative ease, which is not possible for other given industry groups. For example, it is easier to diversify away unsystematic risk in real estate than in almost any of the S&P industry groupings. Even though there is a general real estate "cycle," the heterogeneity of local markets, as well as the different lease and economic characteristics of the various property types, creates the potential for risk reduction through diversification within the real estate portfolio (Hartzell et al., 1986).

Second, the contractual nature of the cash flows, which are determined by the property's leasing

Reprinted by permission from The Journal Portfolio Management, Fall 1988. All rights reserved.
structure, means that equity real estate embodies some debt aspects. We can generate differing maturities and bond-like cash flows by altering the terms of the portfolio of leases.

Finally, real estate rents and values are determined by replacement costs that approximate inflation. This offers investors the long-term potential to receive rates of return indexed to inflation.

Three factors affect the indexing of returns and, therefore, the duration of real estate: the lease structure, the supply and demand cycle for real estate, and product deterioration or enhancement over time. The two polar extremes for lease structure are fully-indexed leases and non-indexed leases. The former allows the full pass-through of inflation into rents on a periodic basis. The pass-through can be accomplished contractually by indexation clauses in leases or by rolling over short-term leases in markets where real estate supply and demand conditions remain unchanged. From this perspective, hotel leases provide the ultimate inflation sensitivity, because they can be adjusted overnight; such leases also create vacancy risk, because these short-term contracts are typically not renewed.

At the other extreme are financing leases, where lease rates remain unchanged for a decade or more. The only way to pass inflation through to the investor with this type of lease structure is to release the space at the expiration of the lease, at which time the capital value of the asset would adjust to reflect the new level of rents. The trade-off here is between a non-indexed rent stream and a guaranteed occupancy level for the term of the contract. Reality in the real estate marketplace is somewhere between the two extremes; even with indexed leases, there is sufficient friction to prevent a full pass-through of inflation.

Superimposed on the lease structure are market risks generated by real estate supply and demand conditions that historically have been more of a national, rather than local, phenomenon. These market risks require a fully-diversified real estate portfolio to have a time diversification dimension, as well as product and geographic diversification dimensions. Real rents fluctuate in response to local supply and demand conditions, which are influenced by national economic conditions. Consequently, rents may increase at rates higher or lower than the underlying rate of inflation in the short run. This obviously influences the ability of real estate to pass through inflation-based returns to its owners. In the long run, however, competition erodes abnormal returns, as long-term supply adjusts to long-run demand. As a result of recent overbuilding, "long-term" in real estate could be very long indeed.

The third aspect of real estate risk lies in the notion of product obsolescence and enhancement. Although many financial models of real estate transactions make assumptions concerning these risks, obsolescence and enhancement exist and ultimately affect the residual value of the asset. If the product maintains its attractiveness over time, then its value in equilibrium will be its replacement cost. If there is obsolescence or deterioration, however, its value would be lower than its replacement cost, preventing the residual value from fully passing through the inflation increases. Conversely, if the product improves over time because its site value is enhanced, its replacement cost would increase at a rate faster than that of inflation (Corcoran, 1987).

RELATION TO PREVIOUS RESEARCH

The adjustment in real estate returns as a result of changing inflation rates has been discussed in prior studies (Hartzell et al., 1987; Brueggeman et al., 1984). A fundamental problem with these studies concerns the quality of data that they employ, and, in a more general sense, the unavailability of real estate return data with which to analyze theoretical finance issues.

The ability of real estate to provide hedges against inflation can be determined by testing for the empirical reaction of real estate returns to changes in the expected and unexpected components of inflation. In general, studies have found that real estate provides a strong hedge against expected inflation. On the other hand, only the Hartzell, Hekman, and Miles study (1987) found a strong hedge against unexpected inflation. This study categorizes the data sample by different property characteristics, which leads to similar conclusions for various property types (office, retail, and industrial) and property sizes. Most studies do not shed light on the way changes in inflation affect real estate returns, beyond a discussion of methodology and empirical results.

One problem in previous studies is the use of appraisals to calculate the holding-period returns. The typical appraisal process that commingled real estate funds — the source of data — follow includes at least annual external appraisals, with in-house employees updating these values in the quarters between reappraisal. It is likely that the in-house appraisers merely adjust for inflation in the values of the properties, which would lead to an obvious inflation hedge finding. Such a problem is inherent in the use of any data series that uses appraised values as proxies of transaction values to calculate holding-period returns. In tests of duration, with real estate returns measured by appraisals, we find duration levels of zero.
Returns exhibited by equity real estate investment trusts (REITs) have been suggested as proxies for measuring the performance of real estate portfolios. Given the possibility of induced stock-like price volatility and the use of financial leverage for this type of security, though, most observers believe that these returns are not an accurate reflection of the nature of the underlying properties. Estimates of duration using equity REIT returns over the 1980s range from two to four years, about two-thirds of the duration of the S&P 500 over the same time period.

Given the limitations of existing real estate data sources, we propose an analytical approach to measuring effective duration. Using a realistic valuation model of market rents and lease contracts, we analyze the impact of changing inflation rates on duration and real interest rates for several different contracting regimes.

THE VALUATION OF REAL ESTATE

We begin with the premise that the rate of increase in real estate income is a function of the inflation rate modified by lease structure, real supply and demand conditions, and the degree of product enhancement or deterioration that occurs over time. In this form, real estate can be viewed as a bond whose principal is inflation-indexed and whose coupons range from zero to full indexation. Thus, the price of real estate can be reduced to the following equation:

\[
P_0 = \sum_{t=1}^{T} \left( \frac{\text{NR}}{1 + k_t} \right) + \frac{E[NR_t(1 + g_t + \bar{\delta}_t)(1 + g_t + \bar{\delta}_t) \ldots (1 + g_t + \bar{\delta}_t) \times M_t]}{(1 + k_0)^T}
\]

where:

- \( P_0 \) = present value of future cash flows generated by the property;
- \( T \) = term of lease;
- \( \text{NR} \) = net rental income on lease (fixed over \( T \) years);
- \( \text{NR}_0 \) = current level of market rents;
- \( g_0 \) = current expected growth rate in property value, which reflects the expected economywide inflation rate;
- \( \bar{\delta}_t \) = unexpected growth rate in rents in year \( t \) that reflects unexpected inflation, local supply and demand imbalances, as well as obsolescence and enhancements, which are interrelated with local market conditions;
- \( M_t \) = price-to-rent multiple in year \( T \);
- \( k_0 \) = current required rate of return; and
- \( E[\cdot] \) = expected property value in \( T \) years.

The net rent variable in the equation is determined by the interaction of the structure of the contracts underlying the real property, the supply and demand conditions within local markets, and inflation. For the former, net rents will rise or fall depending on the ability of the landlord/property-owner to roll over leases, thereby adjusting for inflation. In our annual model, for example, the interval for which lease payments are fixed can range from one year to more than twenty years. At the short end, rents adjust as announcements of inflation are made. Over the long term, rents do not adjust at all to inflation and are held constant for the entire lease term. At lease renewal, rents adjust to “catch up” for all previous inflation during the fixed contract period. Thus, the interaction of inflation rates and speed of adjustment determines the effective duration of the asset class.

With this valuation equation, we can calculate the effective duration of real estate by measuring asset price changes in response to changes in interest rates under varying types of lease contracts. In this context, an asset with an effective duration of five years would experience a 5% decrease in value in response to a 1% increase in interest rates. We assume that there is direct and instantaneous transmittal of changes in the expected inflation rate to the discount rate. Initially, we assume that the expected real rate of return is constant and that there is no unanticipated rent growth. Later, we allow changes in the underlying real rate or real estate risk premium to cause changes in the nominal interest rate.

ALTERNATIVE LEASE STRUCTURES: PERCENT MARKETS VERSUS MARKET FRICIONS

The limited availability of appropriate data to use in empirical tests of duration requires us to use an analytical valuation model. Our duration calculations are based on Equation (1), with five alternative contract terms:

- Continuous rent adjustment to the prevailing market rent;
- Rent adjustments every two years;
- Rent adjustments every five years;
- Rent adjustments every ten years; and
- Rent adjustments every twenty years.
In all five cases, we assume a ten-year holding period, which is typical for most real estate investment managers. In the case of a twenty-year lease, we have assumed a sale at the end of the tenth year, by discounting the net rents from years 11–20 and the residual value at the end of the period.

Our analysis assumes a 6% real rate of return for real estate, a rate real estate investment managers use frequently for quality assets. The real return consists of a general economic real interest rate plus a risk premium appropriate for real estate. An initial 5% expected inflation rate is also assumed for the base case. This translates into an initial discount rate (k) of 11.3%. The expected growth rate of the rental stream at the beginning of the holding period is equal to the expected inflation rate.

With continuous rent adjustment, inflation over the next year is fully embedded into next year’s rents and in every subsequent year’s rents during the holding period, as well as in the terminal value of the property. For fixed-rent contracts, the adjustment to the new rate of inflation takes place at the end of the contract term. With a contract term of ten years, for example, there is no rent adjustment to inflation during the next ten years. Nevertheless, inflation is embedded in the growth of the property value, as represented by the second term in Equation (1). This case is similar to a ten-year bond with a fixed coupon and an indexed principal.

We analyze two generic types of leasing contracts. Both types assume that the contracting term is held constant throughout the holding period. That is, at the end of an initial lease term, a new lease is put into effect with the same term as the initial one. From that point forward, the contract rolls over every T years until the end of the holding period. Further, the property, after the assumed ten-year holding period, is sold under the condition that leases have been contractually set so that their maturities will equal T in the future.

The first contract regime, which we call the “market frictions regime,” assumes an equal rent for all lease terms. Contracts with different terms are not present value equivalents unless the expected inflation rate is equal to zero, but the market frictions regime is typical of existing rent contracts in major markets where there is often little difference between rents on contracts with different terms. One explanation for this is the possible presence of substantial periods of vacancy, leasing commissions, and other contracting costs. The potential cost of those market frictions is much greater with short-term leases than with long-term contracts. Consequently, benefits arising from inflation may be reduced with a long-term fixed-rent contract, but substantial costs resulting from market frictions are avoided.

The second contract type, which we call the “perfect markets regime,” sets the fixed rent such that the present value of the rent payments until the leases roll over is equal to the present value of the expected inflation-indexed rent payments over the same time period. At the end of the investment horizon, the property value is equal to the market value of a fully-indexed cash flow stream, which is also the value of a perpetual floating-rent contract. The assumption is that the two contracts have equivalent present values. Given information asymmetries and market frictions related to local market supply and demand conditions, as well as inflexibility in setting lease terms, this case is more theoretical than real.

A graphic example serves to clarify this cash flow generation process. Figure 1 shows the cash flows earned by the property for a floating-rent contract and a five-year fixed-rent contract in the perfect markets regime. Assuming the base case, where expected inflation is 5% throughout the holding period, the present value of the five-year fixed-rent contract is $114.84, which is equal to the present value of a five-year rental stream starting at $105 that increases annually at the 5% expected inflation rate. After the initial five-year contracting period, the fixed rent is increased to $146.56. The present value of this second five-year annuity is equal to the present value of the floating-rent contract, which starts at $134.01 in year six ($105 × 1.05^5 = $134.01), and is again indexed to the 5% expected inflation rate. A similar process is employed for leases with terms not equal to five years.

Figure 2 shows the rents for the fixed-rent and
floating-rent leases in the market frictions regime. The fixed-rental stream is equal initially to the initial year's indexed-rent flow of $105. For the sixth year, the indexed rent rises to $134.01, and the fixed rent is set equal to this amount for the remaining five years of the holding period.

To illustrate the effect of a change in expected inflation, suppose that the rent contract is determined on the basis of a 5% inflation rate, and a shock occurs causing inflation expectations to increase to 6%. The effect of this change on the rental stream depends on the lease term, which determines how long it takes until rents can adjust to the inflation rate.

Figure 3 shows the rental stream for the market frictions regime before and after the instantaneous increase in inflation expectation from 5% to 6%. As the five-year contract is put into place prior to the shock, the base rent remains at $105 for the first five years. In year six, the new fixed rent — given that inflation has been rising at 6% — is $141.85. This is obviously higher than the fixed rent of $134.01, because the new contract adjusts to catch up to 6% versus 5% inflation. A similar adjustment takes place in the perfect market regime to preserve the "present value equivalence" in years 6–10.

PRICE SENSITIVITY TO CHANGES IN THE EXPECTED INFLATION RATE

A floating-rent or fully-indexed contract has a base payment in year zero of $100. With an expected inflation rate of 5%, the first-year payment is expected to be $105, the second-year payment $110.25, and so forth. The property value with a perpetual floating-rent contract is $1667 for our example, with a 5% expected inflation rate and 11.3% discount rate. This translates into a capitalization rate — equivalent to a dividend yield — of 6.3% on income in year one.

An instantaneous increase in the expected inflation rate to 6% after the lease contract is entered into would have no effect on value, because the lease is assumed to be fully and immediately indexed to inflation. This automatically increases income in year one to $106 and the discount rate to 12.36%. Consequently, there is no effect on asset value from a 100 basis point change in inflation, and the value of the property remains at $1667. Thus, the effective duration in the fully-indexed case is zero in both simulations.

A ten-year fixed-rent lease obviously leads to a different conclusion. In this case, the lease income remains unchanged at $105 during the life of the lease, but the residual value at expiration increases at the rate of inflation. This implies an initial value of the asset of $1383 and a residual value of $2253. The loss of coupon indexation results in a 17% diminution in value. We derive these values by assuming the capitalization rate in year ten is the same as in year zero.

If the expected inflation rate increases to 6%, the lease contract rents remain unchanged, but the discount rate increases by 106 basis points, and the resulting value falls to $1324. This represents a 4.26% drop in value and an effective duration of approximately 4.02 years for the market frictions case. By contrast, the change in value for a ten-year lease contracting period in the perfect markets case is 1.8%.

DEVELOPING AN EQUIVALENT MEASURE OF INFLATION PASS-THROUGH

The inflation sensitivities that we find in these calculations can also provide some insights regarding
the flow-through of inflation for real estate with different leasing structures. Given the indicated inflation sensitivities and the extension of the DDM incorporating inflation sensitivity, we can estimate an implied pass-through parameter. The price sensitivity of a floating-rent contract to a change in the expected inflation rate is equal to:

\[
\left( \frac{\text{Price Sensitivity}}{\text{to a Change in the Expected Inflation Rate}} \right) = -D_{\text{DMM}}(1 - \lambda) \Delta I \tag{2}
\]

where:

\[D_{\text{DMM}} = \frac{1}{k - \delta} = \text{duration of the dividend discount model};\]

\[\Delta I = \text{change in the expected inflation rate};\] and

\[\lambda = \text{inflation flow-through parameter}.\]

\(D_{\text{DMM}}\) represents the duration in the traditional sense. It measures the price sensitivity to a change in the discount rate, holding the cash flow stream constant. A change in interest rates caused by a change in the expected inflation rate will also increase rents. For the floating-rent lease, we have assumed complete pass-through of inflation, hence \(\lambda\) is equal to one, and the price sensitivity to a change in the expected inflation rate is zero.

For the fixed-rent lease, we determine the price sensitivity to a change in the expected inflation rate as discussed above. Having determined the left-hand side of Equation (2), we then solve for \(\lambda\) to obtain a measure of the imputed inflation pass-through. Thus, we can determine an equivalent measure of inflation pass-through, which we can use to compare contracts with level payments for fixed terms with contracts in which rents continuously adjust to reflect all or part of inflation.

Estimates of Inflation Sensitivity and Effective Duration

Given the methodology and assumptions underlying the valuation equation, the percentage change in value resulting from a 1% inflation-induced change in interest rates can be obtained for both the market friction and perfect markets cases. As mentioned above, estimates of the inflation flow-through measure are implied in these effective durations.

The results, presented in Table 1 and Figure 4, are intuitively appealing. They show that effective duration, or the price change arising from a 1% increase in inflation rates, increases with the lease term. In what we consider our typical leasing arrangement, with a five-year term, the duration of real estate is 2.1 years in the more realistic market frictions case. By contrast, under the assumption of perfect markets, the duration of real estate is only 0.6 year. This number is higher than what was found for appraisal-based returns, but at the low end of the range when REIT data were used to measure returns.

Next we look at the equivalent inflation pass-through, \(\lambda^*\), of a fixed-rent lease, which is defined as follows:

\[
\left( \frac{\text{Equivalent Inflation Pass-Through (\(\lambda^*\))}}{\text{Price Sensitivity to a Change in the Expected Inflation Rate}} \right) D_{\text{DMM}} = 1 + \frac{\Delta I}{\Delta R}
\]

As an example, in the market frictions regime the current property value for the five-year lease is $1524. If the expected inflation rate increases from 5% to 8%, the price drops to $1490, a drop of 2.23%. Using Equation (2), this results in an equivalent inflation pass-through of:

\[\lambda^* = 1 - \frac{2.23}{16.67} = 0.87.\]

In other words, a five-year fixed-rate lease has an inflation pass-through that is equivalent to a float-
ing-rent lease that passes through 87% of inflation.

Figure 5 illustrates the inflation pass-through

FIGURE 5
ESTIMATES OF EQUIVALENT INFLATION PASS-THROUGH

for leases of different terms. Obviously, the amount of implicit pass-through decreases as the length of the adjustment period, or lease term, increases. Furthermore, the decrease occurs at a declining rate. The pass-through is also higher under the perfect markets assumption, because fixed-rent leases are assumed to compensate investors partially for expected inflation at the beginning of the lease term.

Price Sensitivity to Changes in the Real Rate of Return

In theory, the discount rate for real estate has three components: the expected inflation rate (I), the expected real interest rate (R), and the real estate risk premium (H). Up to now we have been concerned only with inflation sensitivity. The underlying real interest rate and real estate risk premium, however, can change as well, and these effects can be far more powerful than changes in the inflation premium. For the floating-rent contract, the price sensitivity to changes in the expected real interest rate is equal to:

\[
\left( \text{Price Sensitivity to a Change in the Expected Real Rate} \right) = -D_{\text{loop}}(1 - \gamma)\Delta R
\]  

where:
\[
\Delta R = \text{change in the expected real interest rate}, \\
\gamma = \text{sensitivity of rents to changes in real interest rates}.
\]

In a similar way, we can determine the price sensitivity to changes in the risk premium, H:

\[
\left( \text{Price Sensitivity to a Change in the Risk Premium} \right) = -D_{\text{loop}}\Delta H
\]  

where:
\[
\Delta H = \text{change in the risk premium}.
\]

The real interest rate directly affects the discount rate and also may affect the level of rents as represented in the sensitivity parameter. On the other hand, a change in the risk premium affects only the discount rate. Together, the real interest rate plus the risk premium represent the expected real rate of return on real estate. Combining Equations (4) and (5), the price sensitivity to a change in the expected real rate of return is equal to:

\[
\left( \text{Price Sensitivity to a Change in the Expected Real Rate of Return} \right) = -D_{\text{loop}}(1 - \gamma)\Delta R + \Delta H
\]  

where:
\[
R + H = \text{expected real rate of return}.
\]

In our calculations, the expected real rate of return is 6%. If a change in either the real interest rate or the risk premium caused the expected real return to increase from 6% to 7%, the value of our hypothetical real estate asset would fall from $1667 to $1429, a drop of 14.3%. As a result, changes in the discount rate caused by changes in the real rate introduce the potential for very high interest rate sensitivity or duration.

Furthermore, both floating-rent and fixed-rent contracts in either market regime have very high price sensitivities when the interest rate change is due to a change in the real interest rate or the risk premium. By comparison, a duration of 14.3 years is far higher than durations in the one-to-six range reported in Table 1 for interest rate changes caused by changes in expected inflation. In either case, however, real estate has a positive duration.

In addition, the level of real interest rates and the risk premium have implications for inflation pass-through. Table 2 and Figure 6 illustrate the impact of an inflation pass-through at 4%, 6%, and 8% real rates

<table>
<thead>
<tr>
<th>Term</th>
<th>4%</th>
<th>6%</th>
<th>8%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Year</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2 Years</td>
<td>0.97</td>
<td>0.96</td>
<td>0.95</td>
</tr>
<tr>
<td>5 Years</td>
<td>0.92</td>
<td>0.87</td>
<td>0.83</td>
</tr>
<tr>
<td>10 Years</td>
<td>0.84</td>
<td>0.76</td>
<td>0.68</td>
</tr>
<tr>
<td>20 Years</td>
<td>0.76</td>
<td>0.63</td>
<td>0.51</td>
</tr>
</tbody>
</table>

* The expected real rate of return (ROR) consists of the real interest rate plus the risk premium.
in the market frictions case. The higher the real expected rate of return, the lower the inflation pass-through for a given lease term, because the real rate has an inverse relation to $D_{DOM}$. A lower inflation pass-through is a result of discounting a given inflation-indexed residual value at a higher discount rate. Thus, a higher real rate per se diminishes the attractiveness of real estate as an inflation hedge.

CAN REAL ESTATE DURATION BE NEGATIVE?

Our analysis has shown that an increase in interest rates caused by an increase in the expected inflation rate or the real interest rate leads to a decline in real estate prices. Although this result is characteristic of a positive duration investment, it appears to be counterintuitive because real estate seemed to increase in value in the face of rising interest rates during the late 1970s and early 1980s. Two factors can explain this apparent contradiction.

First, although the economywide real interest rate increased during that time, the risk premium for real estate actually declined as investors switched from financial assets to other assets, such as real estate, that offered the potential for a high inflation flow-through. High and uncertain inflation increases the importance of assets that have a high inflation pass-through. The effects of rising real interest rates and declining risk premiums tend to offset one another to some degree. The net effect could even be a reduction in the expected real rate of return. This decreased return would cause investors to bid up the price of real estate as a result of their willingness to accept a lower real return. There can be a very significant price increase associated with declines in expected real rates of return.

Second, these events occurred during the period when net rents were increasing faster than the inflation rate because of very tight real estate markets. Thus, in the short run, real estate offered a pass-through factor in excess of one, which empirically gives the appearance of a negative duration. Consequently, two factors were at work that resulted in a price increase in the face of rising interest rates.

Rising real rents, rising real estate prices, and the willingness of investors to accept lower real returns became a clear signal to create more real estate. In the late 1970s and early 1980s, the development community responded with the greatest commercial real estate building boom in history. Within our framework, this reduces the growth rate of rents below expectations, thereby lowering the value of real estate and limiting the ability of the asset to permit the flow-through inflation. The negative duration aspects of real estate during the late 1970s and early 1980s were eroded by increased supply, which lowered both net rents and residual value. To protect themselves, both renters and owners also moved toward longer lease contracts, effectively lengthening the duration of real estate.

IMPLICATIONS AND CONCLUSIONS

This analysis has two implications. First, given market conditions, real estate investors have some control over the duration of the asset through the lease contracting process. Second, the duration of real estate is not always as low as investors implicitly assume it to be. Duration is a function of lease contracts and market conditions. The longer the lease contract (excluding indexed leases), the longer the duration of the asset. Real estate investors who hold assets with long leases in reality own annuities with a claim on an inflation-indexed residual.

Market conditions influence the duration of real estate in two ways: The length of the lease term contract is market-determined to some extent, and the residual value of the asset, which affects inflation sensitivity, is determined not only by the cumulative inflation over the lease term but also by market conditions at the end of the lease. To the extent that the real estate investor can control the term of the lease, the investor has some control over the duration of the position. The management of real estate duration is further augmented by the ability to structure real estate financing in conjunction with the underlying lease contract.

REFERENCES


For a floating-rent contract, the price can be calculated from the familiar Gordon–Shapiro model

\[ P = \frac{N(1 + g)}{k - g} = \frac{105}{0.113 - 0.05} = $1667 \]

The effective duration is equal to:

\[ \frac{-\delta P/k}{P} = \frac{-\Delta P/\Delta k}{P} = -\frac{1324 - 1383}{0.0106} = 4.02 \]

Equation (2) shows the price sensitivity for a floating-rate contract with continuous, rather than discrete, rent payments. In this context \( D_{\text{cont}} \) is equal to \( 1/(k' - g') \), where \( k' \) and \( g' \) are interpreted as continuous rates. We set \( k' = 0.11 \) and \( g' = 0.05 \), which produces a property value of $1667 and a \( D_{\text{cont}} \) of 16.67 for the continuous floating-rent case. We focus on the continuous case so that our estimate of inflation pass-through is consistent with the concept of inflation pass-through developed for common stocks in A Total Differential Approach to Equity Duration, Salomon Brothers Inc, September 1987. For more detail, see the Appendix to A Look at Real Estate Duration, Salomon Brothers Inc, December 1987.

The implied \( \lambda^* \) is not an instantaneous pass-through parameter. Rather, it is a pass-through equivalent parameter implied under the varying lease terms used in the simulations. The actual pass-through comes at the rollover of the leases.