Interest Rates and Real Estate Values:  
The Diverging Effects of Real Rates and Expected Inflation

By

Kuntara Pukthuanthong and Richard Roll

July 1, 2011

Abstract

Higher interest rates are commonly believed to reduce real estate values, but corroborating evidence is underwhelming. There is a sensible theoretical explanation, which also suggests heterogeneity across countries. In the United States, but not in Canada, nominal interest on residential housing mortgages is a deductible expense for the personal income tax. Consequently, the inflation component of nominal interest should have a negative impact on Canadian real estate, but its effect should be strictly less negative in the US and could even be positive. We provide a simple theoretical model of this divergence. Then, using real estate investment trusts and expected inflation imputed from inflation-indexed bonds in both countries, we find a material and significant empirical difference. In Canada, increases in nominal interest rates driven by inflation have a strongly significant negative impact. In contrast, the US inflation impact is actually positive and significant when controlling for market-wide equity and is insignificant when controlling also for size, book-to-market, and momentum. Unlike expected inflation, real interest rates have a similar and strongly negative impact on real estate values in both countries.

<table>
<thead>
<tr>
<th>Authors’ Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pukthuanthong</strong></td>
</tr>
<tr>
<td><strong>Address</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Voice</strong></td>
</tr>
<tr>
<td><strong>E-Mail</strong></td>
</tr>
</tbody>
</table>

Acknowledgement

We have benefited greatly from discussions with Steve Cauley, Bhagwan Chowdhry, Harry DeAngelo, Stuart Gabriel, Robert Geske, Astrid Schornick, Selale Tuzel, and from comments by participants at the joint UCLA/UCI/USC finance conference in April 2008 and the Western Finance Association meetings in July 2008. We are grateful to Andrey Pavlov for providing data on Canadian REITs. Finally, we thank the Ziman Center for Real Estate at UCLA both for assembling the database on U.S. REITs and for a research grant sponsoring this research.
Interest Rates and Real Estate Values:
The Diverging Effects of Real Rates and Expected Inflation

July 1, 2011

Abstract

Higher interest rates are commonly believed to reduce real estate values, but corroborating evidence is underwhelming. There is a sensible theoretical explanation, which also suggests heterogeneity across countries. In the United States, but not in Canada, nominal interest on residential housing mortgages is a deductible expense for the personal income tax. Consequently, the inflation component of nominal interest should have a negative impact on Canadian real estate, but its effect should be strictly less negative in the US and could even be positive. We provide a simple theoretical model of this divergence. Then, using real estate investment trusts and expected inflation imputed from inflation-indexed bonds in both countries, we find a material and significant empirical difference. In Canada, increases in nominal interest rates driven by inflation have a strongly significant negative impact. In contrast, the US inflation impact is actually positive and significant when controlling for market-wide equity and is insignificant when controlling also for size, book-to-market, and momentum. Unlike expected inflation, real interest rates have a similar and strongly negative impact on real estate values in both countries.
Many journalists, homeowners, and real estate brokers seem to believe that higher mortgage interest rates reduce real estate values.\(^1\) An increase in mortgage rates implies higher monthly payments for new borrowers, who are presumably less able to afford a home.\(^2\)

But empirical support has not been overwhelming. For example, Poterba (1984) finds that higher inflation in the 1970s accompanied an increase in real house prices during a period of high nominal interest rates. Moreover, housing is a good hedge against actual inflation (Gyurko and Linneman 1998; Huang and Hudson-Wilson 2007).

Piazzesi and Schneider (2007) also point to the puzzling lack of empirical support for a monotonically negative connection between mortgage rates and house prices. They respond with a model that delivers a housing boom when interest rates are either abnormally low or high! This requires two types of investors, some with significant inflation “illusion” who confuse nominal and real interest rates and others, more rational, who understand the difference between real and nominal interest rates. The model explains why house prices were high in the 1970s, when mortgage rates were high, and also why they were high in the early 2000s, when mortgage rates were low.

In the United States, there is another influence that could attenuate or neutralize the negative impact of mortgage rates on housing prices, even without resorting to irrationality: mortgage interest is fully deductible in the calculation of ordinary income taxes (below an upper constraint that is not binding for most borrowers.) Indeed, for

\(^1\) Examples abound. For instance, *USA Today* published an article entitled “Buyers get squeezed out of housing market” on June 14, 2007, which said *inter alia*, “…over the long term, higher [mortgage] rates are likely to depress home sales and prices…” Experts agree. Former Fed chairman Greenspan, in an interview on September 21, 2007 stated, “…low interest rates in the past 15 years were to blame for the house price bubble….” (Reuters.)

\(^2\) In support of the public’s belief, irrational money illusion is offered by Brunnermeier and Julliard (2008) as an explanation for a negative relation between nominal interest rates and housing prices. They find empirical evidence that the house-price/rent ratio varies with nominal interest rates but with not real interest rates, which they interpret to signify widespread money illusion that would favor a policy of housing price stabilization.
many Americans who itemize, mortgage interest is the single largest deduction on their income tax returns.³

To see why mortgage interest deductibility could reduce or even reverse the supposed negative association between interest rates and real estate values, recall that a nominal interest rate consists of at least two parts, a real rate of interest plus the anticipated rate of inflation.⁴ Clearly, if an increase in mortgage interest rates is caused by a corresponding and equal increase in real interest rates, the impact on value is unambiguous; as with any other asset, real housing values should decline.

But if an increase in nominal rates is caused mainly or entirely by an increase in expected inflation, the ensuing real value effect is less obvious. The inflation component of nominal interest compensates the lender for erosion in the purchasing power of the principal. When inflation is high, the real value of the mortgage loan principal declines steadily over time. Consequently, nominal mortgage interest deductibility in a high inflation environment implies that the borrower can essentially deduct a large portion of the real value of the original principal over time, which is much more than the real interest deduction.

**REIT prices: Legitimate substitutes for housing prices**

Our main objective is to uncover the actual differential impact of mortgage rates on house prices in Canada and the United States. For this purpose, the ideal set of data would consist of (1) residential real estate prices in the two countries, (2) real interest rates and expected inflation rates embedded in mortgage yields, and (3) control variables unrelated to interest rate components. As usual, perfect data are not available. There are no high frequency price series for residential real estate (futures markets for residential real estate

---

³ In aggregate, mortgage interest deductions amount to the third largest decrement in Federal Treasury income revenues, after corporate pension fund and health contributions (Geier 2006.) See also http://www.irs.gov/taxstats/indtaxstats/article/0,,id=133414,00.html

⁴ This is the well-known Fisher relation, named after Irving Fisher (1930). Nominal rates might also contain embedded risk premia, but abstracting from them is convenient for the present discussion.
are in their infancy in the U.S. and do not exist elsewhere) and all mortgage yields are nominal (in Canada and the U.S.)

Nevertheless, there are some sensible empirical proxies. U.S. and Canadian TIPs and nominal bonds provide market consensus term structures for real interest rates and expected inflation. Residential real estate returns can be proxied by returns on real estate investment trusts (REITs). We provide evidence that these proxies are acceptable and are the best available.

One of the most venerable propositions in economics developed by Alfred Marshall is that the prices of substitute goods are related (Marshall, 1997). For instance, when the price of pears increases, so does the price of apples, even though the underlying cause (e.g., blight on pear trees) has no direct impact on apple trees. At first, one might think it is more problematic to use REITs as a residential property proxy than to use TIPs and nominal Treasury bond rates as mortgage yield proxies. Our defense relies on a basic underlying idea: that all types of real estate are substitutes. Single family housing is a substitute for apartments; even commercial real estate can be converted to other uses. Thus, any change in the value of one type of real estate should be well correlated with changes in values of other types.

As such, to proxy for residential real estate returns, we employ observed market returns on real estate investment trusts (REITs) in both the U.S. and Canada. Most REITs do not invest in single-family houses, but rather in apartments, offices, shopping centers, etc.; hence, any empirical power within our approach admittedly depends on strong return correlations across property types.

Theoretically, as we will show below, the impact of inflation on residential real estate, working through the tax deductibility of mortgage interest in the US and the non-deductibility in Canada, should be different in the two countries. Because they are substitutes, inflation should also affect the values of Canadian and U.S. REITs differently, even REITs that own non-residential properties. Whatever the reason that the
price of one good is influenced, the prices of substitutes follow. When substitutes are
assets, the Marshallian effect is even quicker to operate since asset values anticipate the
future. Again, the approach is conservative because weak correlations between single-
family house prices and REIT prices would make it less likely to uncover significant
patterns.

There is one major advantage of using REITs to measure real estate returns; they are
marked to market continually because they trade actively. This is definitely not true of
residential real estate since repeated sales of the identical property are rare and assessed
valuations are notoriously sticky. The poor quality of residential real estate price series
has long been a matter of concern for researchers; (see, inter alia, Ross and Zisler 1991;
Freddie Mac 2008.) Indeed, it seems likely that REIT prices track the true but
unobservable values of residential real estate more closely than any other currently
available indicia.

When futures contracts on residential properties become more actively traded, perhaps
this problem will be alleviated. At the moment, perhaps the widely-followed indicators
of US residential real estate are provided by Standard & Poor’s corporation, which
publish the S&P/Case-Shiller\textsuperscript{®} Home Price Indices (SCS) monthly.\textsuperscript{5} These indices are
based on repeat sales of identical properties and are essentially three-month moving
averages of actual sale prices lagged one month; (see Standard & Poor’s [2007]), a
procedure invented by Case and Shiller (1987). Clearly, indices constructed in such a
fashion could deviate materially from traded assets such as REITs.

Alternative indicators include house price indexes from FHFA, the Federal Housing
Finance Agency, which were first released on a monthly basis in May 2009. FHFA
indexes were employed by Brunnermeier and Julliard (2008) in their paper on money
illusion and house prices, but the indexes were then available only quarterly. The recent
monthly series are based on purchases; i.e., they do not depend upon appraisals obtained
during refinancings, as did the earlier quarterly data.

\textsuperscript{5} The indices can be obtained from their web site, www.indices.standardandpoors.com.
Figure I plots the FHFA national index (non-seasonally adjusted) along with the SCS national index and an equal-weighted index of REIT prices from January 1991 through May 2009.

Both the FHFA and SCS indexes are obviously much less volatile and more serially correlated than REIT prices. During the 220 months from February 1991 through May 2009, the monthly log return volatilities of the three indexes (standard deviation in percent per month) are 0.509%, 0.945%, and 5.37% for the FHFA, SCS and EW REIT indexes, respectively. The respective first-order serial correlations in log returns are .657, .949, and .250. So REIT returns have more than ten times the volatility of FHFA returns and more than five times the volatility of SCS returns. They are also much less autocorrelated. The SCS return autocorrelation is most likely extremely large because the index is constructed as a moving average.

We mimicked the SCS index construction method using REIT data in an effort to estimate their true underlying correlation. To accomplish this, we first took the equal-weighted average of US REIT returns, constructed a corresponding index of REIT levels, and then calculated a three-month moving average of the levels lagged one month. We then compared this pseudo-REIT index with the SCS® U.S. National Home Price Index monthly over the available sample, May 1991-May 2009. The correlation between the two index levels is 0.971 with a p-value of 0.000, which suggests that they are trending similarly over time despite their wide divergence in volatility. The correlation between their monthly percentage changes (i.e., returns) is 0.469, again with a p-value of 0.000. Although the return correlation is far from perfect, this seems hardly surprising given the methods employed.

We also subjected the pseudo-REIT index and the SCS® National Index to a cointegration test. For both indexes, one cannot reject the hypothesis of a unit root at the

---

6 The data begin in January 1991, but three months are lost from taking the moving average and one month is lost by the single lag. The final month is lost in computing a monthly return.
5% level of significance, so cointegration is an acceptable technique. The Dickey-Fuller test for a unit root in the residuals from the cointegrating regression, with a constant but without a trend, just rejects the null hypothesis at the 10% level. This implies that the indexes are cointegrated. With a probability of roughly 90%, REIT prices and Case-Shiller residential prices have a stable long-run relationship. This is a sufficient and legitimate reason for using REITs as a proxy for residential real estate.

To our surprise, the null hypothesis of a unit root can be rejected at the 5% level for the FHFA series, so we did not look at its cointegration with the other indexes.

For short-term measurements of real estate fluctuations, the FHFA and SCS indexes are problematic because almost all known market-based asset returns have much larger volatilities. Their long-term trends might correspond to true real estate values, but monthly variation, being so small, can at best be only weakly correlated with changes in potential explanatory variables such as real interest rates and inflation. There is little variation to explain and, in fact, no significant variation is explained over monthly intervals. If residential real estate data were marked to market in real time, it seems likely that the explained variation would be substantially higher.

Cotter and Roll (2011) provide a comprehensive analysis of REIT characteristics and compare them to the SCS indexes of residential real estate. Consistent with what we showed above, Cotter and Roll also find that SCS index returns do not display nearly as much variability as typical financial asset returns. They report further divergences in the real estate indicators where only three principal components explain 90% of REIT return variance whereas five to six components are required to explain 90% of the variance in SCS indexes. They show strong evidence that REITs are forward looking and are able to help predict the SCS residential real estate indexes while the converse is not true; i.e., the SCS series cannot predict future REIT values.

---

7 As we have verified in unreported tests.
Overall, a very strong case can be made that REIT prices are superior to any other available data on real estate values. REIT prices are market-determined in real time and hence are based on the consensus beliefs of investors about real property values. True, they differ in some respects from residential real estate, but there are no reliable high frequency data for the latter. Substitutability should be very good among all types of real estate. Indeed, this is borne out by the fact that REIT values and residential property values, as measure by the S&P/Case-Shiller indexes, are cointegrated over long periods. Hence, REITs offer the best and perhaps only hope of uncovering significant effects from interest rates over short observation intervals, when market reactions are likely to stand out most prominently. REITs have an additional advantage in our application: they are available in both the U.S. and Canada, unlike the S&P/Case-Shiller indexes or the FHFA indexes.

**Numerical illustration of the real tax benefit of mortgage interest deductibility**

In this section, we present a simple numerical illustration of nominal mortgage interest deductibility in a high inflation environment implying that the borrower can essentially deduct a large portion of the real value of the original principal over time, which is much more than the real interest deduction. Consider a typical thirty-year fixed-rate level pay mortgage with an original face amount of $100,000. Also assume a real interest rate of 2% and two different inflation scenarios, 3% and 10%. For ease of illustration, these rates are in percent per annum, continuously compounded, and are then converted into monthly mortgage discount rates. At the end of the first year, the real value of the outstanding principal on the mortgage in the low (high) inflation environment would be $95,615 ($90,160). At a 45% marginal tax rate, roughly the marginal rate for high income earners in high tax states such as California and New York, the net gain in the real value of the housing loan, (the gain from the reduction in the real value of the principal less the after-tax interest payments), would be $1,647 ($3,218.) The homeowner/borrower would have gained almost twice as much in real terms in the higher
inflation environment.\textsuperscript{8} If conditions remain unchanged, this differential benefit of inflation tax deductibility continues for a number of years.\textsuperscript{9}

At lower marginal tax rates, the inflation benefit is less pronounced; indeed, at a marginal tax rate of about 22\% for this example, there is no net difference; at still lower tax rates, the effect is reversed, thus favoring the lower inflation environment. The explanation is that the nominal interest rate contains both real and inflation components, but the reduction in the real value of the outstanding principal is determined only by the latter. The principal balance’s real gain exceeds the nominal after-tax interest payments only at a sufficiently high marginal tax rate.

It seems possible, then, that there could be a non-linear association of nominal interest rates and housing prices consistent with the theory of Piazzesi and Schneider, but for an entirely different (and rational) reason. If periods of low nominal interest rates are sometimes also periods of low real interest rates, housing prices should boom. If periods of high nominal interest rates are associated with higher inflation and improved tax benefits from homeownership, housing prices should also boom, particularly if real interest rates are low. To sort this out empirically, good measures of real rates and inflation would be extremely useful. This paper imputes real interest rates and expected inflation rates from indexed and nominal bonds and then assesses their separate effects on housing values.

Before proceeding with further details, we should mention two other considerations that could conceivably mitigate the homeowner tax benefit induced by higher inflation. First, as inflation increases, taxable lenders will demand more than proportionately higher nominal interest rates to defray their increased effective taxes. Since nominal interest

\textsuperscript{8} Even this difference is slightly understated because it does not take into account the lower real value of mortgage interest payments later in the year, which are reduced more in the high inflation environment.

\textsuperscript{9} After about nine years in the illustration of the text, the benefit would disappear if the homeowner persists with the original mortgage, because the real value of the remaining principal balance would have declined much further under high inflation. However, refinancing and borrowing more would restore much of the benefit. Borrowing more should be feasible because the original mortgage’s remaining outstanding balance should represent a very low loan/value ratio (under high inflation) since the nominal house value should have increased (with inflation.)
income is taxed at ordinary rates, lenders can remain whole in real terms only if nominal rates are high enough to offset the inflation tax. If effective tax rates were the same for mortgage lenders and borrowers, it seems possible that higher inflation would have no net beneficial impact on real housing values. True, mortgage interest would still be tax deductible for the borrower, but the equilibrium nominal rate would be so much higher than at lower inflation that the overall effect would be neutral.

These supply and demand effects of mortgage lenders and borrowers would be difficult to disentangle if we were limited to a single country and a given tax regime, but here we intend to exploit major tax differences between Canada and the United States. Canada does not allow mortgage interest to be deducted from ordinary income tax for residential homeowners.

Canadian lenders, like U.S. lenders, owe taxes on nominal interest income, so the two countries are symmetric from the perspective of the suppliers of loans. But the borrower asymmetry suggests that, whatever the impact of inflation on mortgage rates, the impact of inflation on housing values will be algebraically less (more negative) in Canada than in the U.S. If lenders have lower tax rates on average than borrowers (perhaps because lenders are dominated by tax-exempt financial institutions such as pension funds), inflation could even have a positive impact on U.S. housing while it should be unambiguously negative in Canada.

Another consideration involves capital gains taxes. As mentioned earlier, the nominal gain on the house itself will be taxed at the capital gains rate when it is eventually sold. This clearly reduces the incentive to purchase a house just when the tax shelter represented by mortgage rates is high (in the U.S.) But any Canada/U.S. difference in capital gains treatment seems likely to be less important than the mortgage deductibility treatment, merely because capital gains tax rates are relatively low in both countries.

---

Currently, capital gains in Canada are taxed at half the ordinary rate while the highest long-term capital gains tax rate (Federal only) is 15% in the U.S. and there is a $500,000 one-time tax exclusion for homeowners.
can be postponed almost indefinitely by real estate exchanges, or can be evaded in bequests.

The next section provides a theoretical framework, an analytic model of housing and mortgage demand and supply. It highlights the variety of phenomena that one could conceivably see in real estate values and associated interest rates given the tax regimes of Canada and the United States.

As mentioned, our basic inferences are drawn from time series regressions of real excess REIT returns on changes in real interest rates and changes in expected inflation rate after controlling for real excess returns on a broad equity index and for the Fama/French (1992, 1993) and Carhart (1997) factors. We find that changes in real interest rates are negatively associated with real estate returns in both countries and have similar quantitative effects. The control variables also have similar influences in the two countries. Expected inflation, however, is very different. It is strongly negatively associated with Canadian real estate values. Its influence in the U.S. is positive in some specifications and insignificant in others. This evidence is consistent with a mitigating influence of mortgage tax deductibility in the U.S. acting through the inflation channel.

A Theoretical Perspective

To clarify the various forces that impinge on the connection between inflation and real estate values, it is convenient to formulate a simple theoretical structure. To render the analysis more tractable, we assume that the effective tax rates of mortgage lenders and borrowers can be captured by single values, $\tau_B$ for borrowers and $\tau_L$ for lenders.\(^{11}\)

Let $y$ denote the prevailing mortgage yield\(^{12}\) and let $I^e$ denote the anticipated rate of inflation. Then the after-tax expected real yield for mortgage lenders can be written

---

\(^{11}\) Of course, in reality, there is a plethora of effective tax rates among both lenders and borrowers, from which we abstract for illustrative purposes.

\(^{12}\) Again, for simplicity of illustration, this is a single number.
\[ \rho = \frac{1 + y(1 - \tau_L)}{1 + \Gamma} - 1. \]  

(1)

If the supply of mortgage capital is perfectly elastic, then any change in expected inflation will result in no change whatsoever in the after-tax expected real yield. This implies that the pre-tax nominal mortgage yield, \( y \), must respond quite a bit to changes in expected inflation so as to offset the implicit inflation tax on nominal interest. Hence, given perfectly elastic supply, the response of mortgage yields to inflation can be obtained by taking the total derivative of (1) and setting it to zero; i.e., \( \partial \rho = 0 \). After some manipulation, this results in the following expression for the response in nominal yields to expected inflation:

\[ \frac{\partial y}{\partial \Gamma} = \frac{1 + y(1 - \tau_L)}{(1 + \Gamma)(1 - \tau_L)} = \frac{1 + \rho}{1 - \tau_L}. \]  

(2)

Since \( 0 \leq \tau < 1 \) and presumably \( \rho > 0 \), \( \partial y / \partial \Gamma > 1 \); i.e., there is more than a 1:1 response of mortgage yields to expected inflation (because of the tax treatment of nominal interest.) Indeed, the response could be substantially larger than 1:1 if tax rates are high. For example, if mortgage lenders are fully taxable in such high tax states as New York and California, where marginal tax rates are about 45%, even if real yields are close to zero, one might have \( \partial y / \partial \Gamma \approx 1.8 \); an increase in expected inflation of one percentage point could drive mortgage yields up by 180 basis points. In the higher-taxed Canadian provinces such as Québec and British Columbia, the tax rates are slightly lower but are still around 40%.

There are several reasons to think, however, that the impact of inflation on mortgage yields will not be so high. First and foremost, many sources of capital such as pension funds are not taxed at all and other sources such as foreigners can avoid paying. Even fully taxed lenders have lower marginal rates if their incomes are not in the highest bracket or they live in low-taxed states or provinces. Comparison of tax-exempt municipal bonds and Treasuries generally show effective tax rates below 20%, though this comparison is complicated because municipal bonds have credit risk. Treasury inflation-protected bonds (TIPs) can also be used to impute effective tax rates because the
inflation tax on their yields is lower than for nominal bonds. Roll (2004, Table VIII) estimates tax rates between 10% and 18% using TIPs with the longest sample records.

However, an inelastic supply of mortgage capital would tend to exacerbate the impact of inflation on nominal mortgage yields. Higher inflation-induced taxes on mortgage lenders might very well reduce the total supply of funds, particularly from lenders subject to higher tax rates. The resulting market equilibrium could feature a higher after-tax expected real yield. Again taking the total derivative of (1) and simplifying terms (but this time not assuming that $\rho$ is unchanged), we obtain

$$\frac{\partial y}{\partial I} = \frac{1 + \rho}{1 - \tau} (1 + \eta_{\rho}),$$

(3)

where the elasticity, $\eta_{\rho}$, gives the response of after-tax expected real yields to inflation,

$$\eta_{\rho} = \frac{\partial \rho}{\partial \Gamma^e}/(1 + \Gamma^e).$$

(4)

If this elasticity is positive, which seems plausible, the nominal yield response in (3) is strictly greater than the response in (2). However, when supply is not perfectly elastic, the overall impact of inflation on real mortgage after-tax yields, as measured by $\eta_{\rho}$, also depends on the demand for mortgage borrowing. Nominal yields must go up with inflation, but the resulting demand response by borrowers should be different in Canada and the U.S. because U.S. borrowers can deduct most mortgage interest.

When expected inflation changes, government tax collections from interest income will change per period by $\tau_L[\partial(yQ)/\partial \Gamma^e]$, where $Q$ is the outstanding quantity of mortgage debt. Expanding this derivative and simplifying, the per period change in government tax revenues from interest income will be

$$\frac{\partial(Taxes)}{\partial \Gamma} = \tau_L \frac{\partial y}{\partial \Gamma^e} (1 - \eta_Q) = \tau_L Q \frac{1 + \rho}{1 - \tau_L} (1 + \eta_{\rho})(1 - \eta_Q),$$

(5)

where $\eta_Q$ is the elasticity of demand for mortgage borrowing with respect to nominal mortgage yields,

$$\eta_Q = -\frac{\partial Q}{\partial y / y}.$$
If demand elasticity is sufficiently high \((\eta_0 > 1)\), the housing stock responds so much that tax collections actually move in direction opposite to expected inflation. However, this is hardly conceivable in the short run because the stock of housing is relatively fixed, so it seems likely that \(\eta_0 < 1\) and hence \(\partial(Taxes)/\partial I_e > 0\). Moreover, mortgage interest tax deductibility must certainly decrease the elasticity of demand in (6), so \(\eta_{Q, Canada} > \eta_{Q, USA}\), which implies via (5) that higher inflation should bring a larger increase in tax revenues from interest income in the U.S. than in Canada.

But increased taxes paid by lenders in the U.S. would be offset by decreased taxes paid by borrowers. The decrease in tax revenues from borrowers is simply \(\tau_B[\partial(yQ)/\partial I_e]\), so it has exactly the same form as (5) but with \(\tau_B\) replacing the first \(\tau_L\). Hence, for the U.S., the net change in tax collections from mortgage lending and borrowing following a change in expected inflation is

\[
\frac{\partial(\text{NetUSTaxes})}{\partial I_e} = (\tau_L - \tau_B)Q \frac{1 + \rho}{1 - \tau_L}(1 + \eta_b)(1 - \eta_0).
\]

While more inflation should unambiguously increase Canadian government tax revenue in accordance with (5) (or with (7) because \(\tau_B = 0\) in Canada, given the reasonable assumption that \(\eta_0 < 1\)), the effect in the U.S. clearly depends on whether lenders or borrower are more heavily taxed; i.e., on whether or not \(\tau_L > \tau_B\). If borrowers are more heavily taxed, government revenues could conceivably fall with higher inflation even with inelastic demand.

Aggregate tax collections from mortgage lenders and home owners should have direct implications for how real estate values are likely to respond to changing inflation rates. Clearly, if there is a net drain from the housing sector to government, real estate values should decline and vice versa. As we have seen above, increased inflation in Canada unambiguously increases government revenue and should drive down real estate values. In the U.S., there is a mitigating influence and higher inflation could actually increase real estate values in some circumstances. At a minimum, the impact of inflation should be strictly less negative on house prices in the U.S. than in Canada. This leads directly to
our basic empirical test: does inflation in Canada have a more deleterious influence on real estate values than it does in the U.S.?

In the short run, higher or lower aggregate tax collections from the housing sector should be capitalized into existing real estate values. The resulting altered values of existing single-family houses should induce changes in the value of other real estate substitutes such as apartments, vacant land and even commercial structures. Eventually, in the longer run, altered house values would presumably elicit a response in supply; but again, depending on elasticity, this time the elasticity of housing construction, the tax impact on values might dissipate at least partially over time. Demand is typically believed to be more elastic in the long run, which also serves to ultimately mitigate or reverse shorter run tax effects.

**Empirical Procedures and Data**

As mentioned earlier, the ideal set of data to investigate the differential impact of mortgage rates on house prices in Canada and the U.S. would consist of residential real estate prices in the two countries, real interest rates and embedded expected inflation rates in mortgage yields, and control variables unrelated to interest rate components. Perfect data are not available. There are no high frequency reliable price series for residential real estate and mortgage yields are nominal.

But there are some sensible empirical proxies. For real rates and inflation, the proxies should actually be pretty good because inflation-indexed bonds have existed in both countries for at least the past decade. Since inflation-indexed bonds (TIPs) are linked to broad consumer price indexes, their yields are real.\(^{13}\) Consequently, with enough points along the maturity spectrum for both TIPs and nominal bonds, it is possible to derive frequent observations of the term structures of both real interest rates and expected inflation rates.

---

\(^{13}\)To be more precise, TIPs yields are “real” with respect to official government price index changes, which may be more sticky and less volatile than true inflation; Cf. Chowdhry, Roll, and Xia (2005).
Many researchers have attempted to estimate the terms structures of real yields and expected inflation from nominal yields alone. However, such estimates are plagued by an identification problem that necessitates various simplifying assumptions, which can produce results that seem to conflict with reality. For example, Ang, Bekaert and Wei (2008), estimate a flat term structure of real interest rates; it has “…no significant term spread,” (p. 798.) But even casual observation reveals that the term structure of TIPS yields, a direct market-based measure of real yields, is generally upward sloping.

Hence, we use TIPS to obtain market-based consensus term structures for real interest rates and expected inflation. When at least four bonds are available, which is always the case for nominal bonds, a term structure is estimated using the three-factor model of Litterman and Scheinkman (1991) using the procedures in Roll (2004). This delivers estimates of the level, slope, and curvature of the term structures.14

To implement this procedure, the term structure’s shape is fit on each observation date by a non-linear regression of yield (either real or nominal) against functions of duration;

\[ Y_{j,t} = \text{Level}_t + \text{Slope}_t \cdot X_{L,j,t} + \text{Curvature}_t \cdot X_{Q,j,t}, \quad (8) \]

where \( Y_{j,t} \) is the (real or nominal) yield for the \( j^{th} \) bond on date \( t \), \( X_{L,j,t} = at + btD_{j,t} \) and \( X_{Q,j,t} = -(3X_{L,j,t}^2 - 1)/2 \) are, respectively, linear and quadratic Legendre transformations of \( D_{j,t} \), the estimated duration on day \( t \) of bond \( j \).15 The Legendre transformations are employed because they are approximately orthogonal over the range –1 to +1.16 The transformation coefficients \( a_t \) and \( b_t \) are \( b_t = 2/[\max(D_t) - \min(D_t)] \) and \( a_t = 1 - b_t \max(D_t) \), which assures that the transformed durations span the required range. The estimated regression coefficients, \( \text{Level}_t \), \( \text{Slope}_t \), and \( \text{Curvature}_t \), jointly depict the general shape of the term structure on date \( t \).

---

14A decomposition of nominal yields into real yields and expected inflation is given in Roll (2004), which also contains time series plots of the real yield curve and the derived yield curve of expected inflation

15For constant maturity nominal Treasury yields, the duration was estimated by assuming that the yield was valid for a bond selling at par.

16They are exactly orthogonal if continuous from –1 to 1. Curvature is positive if the term structure is concave downward.
The differences between the nominal and real estimates of interest rate level, slope, and curvature provide corresponding estimates for the term structure of expected inflation plus any risk premium. Changes in the estimated levels of both the real term structure and the expected inflation term structure become our two featured variables for explaining real REIT returns. During early sample months in both countries, four TIPs bonds were not always available, so a simple average of yields is used instead. We have verified that virtually the same results obtain when simple averages of (real rates and expected inflation) are used throughout.

The possibility of risk premia in the difference between nominal and real yields would represent a problematic measurement error in some applications. In our case, however, it is unlikely to be a serious issue because we only use (monthly) changes in nominal less real yields (which, for simplicity, we call changes in expected inflation.) Risk premium seem unlikely to change much over monthly horizons. If they actually exist and change at all over such short periods, they simply inject a small measurement error into the data.

The derived series of real interest rates and expected inflation rates differ, of course, from what might have been obtained from mortgages because the latter are complicated by embedded default and prepayment options. Consequently, there is an inevitable measurement error in the levels of our derived real rates and expected inflation. These errors, though, to the extent that they do not vary dramatically over short periods, might not represent a severe problem because we use changes in rates rather than levels in the empirical work below. Theoretically, changes in rates are the correct construct to explain real estate returns.

As argued earlier, the REIT prices are superior to any other available data on real estate values. Table I gives pertinent information about REITs, TIPs, and Nominal Bond data. The sample size varies by asset type. New TIPs were issued throughout the sample period and one U.S. TIP matured. The 30-year nominal bond was not issued for part of the sample period in the U.S. Not every REIT was listed over the entire maximum sample period, so estimates for each REIT were calculated separately using the available
number of months for that security. The first control variable is a broad market index, for which we employed the Toronto Stock Exchange 300 index in Canada and the S&P 500 index in the U.S. The broadest available consumer price indexes in both countries are used to convert nominal REIT returns and nominal market index returns into real returns. Subsequently, we expand the specification to include the Fama/French (1992, 1993) and Carhart (1997) factors as additional regressors.

**Basic Empirical Results**

For each REIT j, the following time series regression was fit for all available months t:

$$R_{j,t} = \alpha_j + \beta_i (r_t - r_{t-1}) + \beta_i (I^e_{t} - I^e_{t-1}) + \beta_M R_{M,t} + \varepsilon_{j,t},$$

(9)

where $R_{j,t}$ is the observed real (i.e., CPI adjusted) excess return on REIT j in month t, $r_t$ is the estimated real rate of interest at the end of month t, $I^e_t$ is the estimated expected inflation rate at the end of month t, $R_{M,t}$ is the real excess return on a broad market index in month t, and $\varepsilon_{j,t}$ is the unexplained (residual) return. Estimated coefficients are denoted by the greeks.

Various possible econometric problems were investigated to ascertain the reliability of ordinary least squares, OLS. Possible autocorrelation was considered by using Newey/West (1987) estimated standard errors, without disclosing any material differences. This is not surprising because the dependent variable is a return, which is usually not very autocorrelated.

Table II reports cross-sectional averages from (9) along with tests of statistical significance (T-statistics) based on the assumption that the estimation errors are cross-sectionally unrelated. The table also gives other pertinent cross-sectional information.

17 The maximum sample covered May 1998 through May 2009 inclusive.
18 For Canada, we use the “Canada Consumer Price Index” from the Dominion Bureau of Statistics. For the U.S., we use the Bureau of Labor Statistics all items consumer price index. These are the same indexes used for linkage by inflation-indexed bonds of the two countries.
19 Consumer price indexes are very sluggish compared to REIT market returns, so it turns out to make little difference whether nominal or real REIT returns are employed as the dependent variable. Only the regression intercept changes materially.
20 Real excess returns are computed as \([1 + \text{nominal return} - (1 - \text{month T-Bill rate})]/(1 + \text{Inflation rate}) - 1.\)
Many of the results are similar across the two countries. The explanatory power is relatively low, which is typical for REIT return market models, but it is still significant on average. The coefficients of response to changes in real interest rates and to market equity returns are, respectively, significantly negative and positive in both countries, as one would have expected. For real interest rate changes, 78% of the coefficients are negative in Canada and 72% are negative in the U.S.; for market equity, the percentages of positive coefficients are 73% and 94%, respectively.

But the slope coefficient for the change in expected inflation is strikingly different in Canada and the U.S. It is negative and about -27.39 on average in Canada with a t-statistic of -3.0 while it is positive, 24.93, in the U.S. with a t-statistic of 4.1. In Canada, about 90% of the coefficients are negative while about 61% in the U.S. are positive. This coefficient is the only thing that seems to differ much across the two countries, which makes the difference stand out all the more starkly and seems to suggest a genuine underlying cause. The pattern is entirely consistent with mortgage deductibility of interest in the U.S. and a lack thereof in Canada.

The economic magnitude of the expected inflation effect is material; an increase in expected inflation of one percent per annum that occurs during a given month would drive REIT prices in Canada down by about 27.4 percent in that month whereas U.S. REIT prices in the U.S. would increase by almost 25 percent. This seems broadly consistent with the analysis in the theory section above because a one percent per annum change in inflation would alter annual tax collections by some fraction of one percent and the net discounted present value would be capitalized into current real estate prices.

To further elucidate the empirical results, Figure II presents non-parametric density estimates fit to the cross-sectional distributions of the T-Statistics for the interest rate-

---

21In all cases, the cross-sectional t-statistics are larger for the U.S. than for Canada, but this is quite understandable given the relatively sample sizes, 267 and 41 respectively.

22Not surprisingly, the effect of real interest rate changes is larger. A one percent increase in real rates during a month would drive down REIT prices by 30 percent in Canada and over 50 percent in the U.S. But this would be a very large change in real rates for a given calendar month.
related variables, real interest rate on the right and expected inflation rate changes on the left. For real interest rate changes, aside from variations attributable to sampling error, the distributions appear to be very similar in the two countries. They extend over roughly the same range and both have negative modes. In contrast, the expected inflation change coefficient distributions appear to be translated apart from each other, the U.S. distribution lying well to the right of the Canadian one; although there is some overlap, the Canadian distribution has a negative mode and a longer left tail while the U.S. distribution is the opposite.

Taking Account of Cross-Equation Dependence

Since most of the individual REIT return regressions were conducted with data from the same time period, it seems conceivable that estimation errors in the coefficients are correlated across equations. The most likely reason is that omitted factors, such as industry factors, are present in the regression disturbances. To the extent that cross-equation correlation is present, the significance levels previously reported are overstated. To deal with this simultaneous equations problem, the most familiar and probably simplest method is Seemingly Unrelated Regressions (SUR) of Zellner (1962).

When the explanatory variables are the same in all equations, the SUR coefficient estimates are exactly the same as the OLS estimate; see Greene (2000, pp. 616-617.) However, the standard errors of the coefficients are different when there is cross-equation dependence.

Using boldface characters to indicate matrices, let \( \beta \) denote the \( K \times M \) matrix of the coefficients in a system of \( M \) equations, each equation conforming to (9) with the same \( K \) explanatory variables, \( X_i \), \( (TXK) \), where \( T \) is the number of time series observations. When \( T \) is the same in all equations, the asymptotic covariance matrix of the estimates of \( \beta \) is given by

\[
\text{Cov}(\hat{\beta}_i, \hat{\beta}_j) = \sigma_{ij}(X'X)^{-1}, \quad i,j = 1,\ldots,M,
\]  

(10)
where $\sigma_{ij}$ is the estimated covariance of the regression residuals between equations i and j; (See Greene [2000], page 617.)

We are interested in the standard error of the cross-sectional mean of a particular slope coefficient, say $\beta_i$, averaged over the M equations (equations being indexed by j),

$$\bar{\beta}_i = \frac{1}{M} \sum_{j=1}^{M} \hat{\beta}_{i,j}.$$  \hspace{1cm} (11)

So the variance of the cross-sectional mean is

$$\text{Var}(\bar{\beta}_i) = \frac{1}{M^2} \sum_{j=1}^{M} \sum_{k=1}^{M} \text{Cov}(\hat{\beta}_{i,j}, \hat{\beta}_{i,k})$$

$$= \text{diag}_i [(X'X)^{-1}] \frac{1}{M^2} \sum_{j=1}^{M} \sum_{k=1}^{M} \sigma_{jk},$$ \hspace{1cm} (12)

where $\text{diag}_i(.)$ denotes the $i^{th}$ diagonal element of the argument matrix.

The SUR estimated t-statistic for the cross-sectional mean of the $i^{th}$ coefficient would then simply be equation (11) divided by the square root of equation (12). Since the explanatory variables are the same in every equation, any one of the OLS estimated equations, say j, and the OLS standard error of the $i^{th}$ coefficient can be used to obtain

$$\text{diag}_i [(X'X)^{-1}] = \frac{[\text{standard error}(\hat{\beta}_{i,j})]^2}{\text{Variance}(\epsilon_j)}. \hspace{1cm} (13)$$

Similarly, $\sigma_{j,k}$ can be obtained as the covariance of the OLS residuals from equations j and k.

The only difficulty in making SUR calculations for our data is that some firms do not have complete sample records; they were either listed after the beginning of the sample period or delisted before the end. This obliges us to compromise slightly because $\sigma_{j,k}$ can be estimated only from common observations. So, to approximate (12), we (a) calculated (13) using a firm with all sample observations; (b) obtained $\sigma_j^2$ for REIT j from the OLS standard error in its equation, $j=1,\ldots,M$; and (c) obtained $\sigma_{j,k}$ from all concurrent observations between REIT j and REIT k.\textsuperscript{23}

\textsuperscript{23}Note that the number of observations used in steps (b) and (c) could be different when there are fewer overlapping observations for j and k and both j and k lack a full sample of observations.
The resulting SUR t-statistics that account for cross-equation dependence are reported in the bottom line of Table II. Those for Canadian and U.S. real interest rate and expected inflation for the U.S. are smaller in absolute magnitude than the t-statistics reported earlier in the table, which are based on an assumption of cross-equation independence. Nevertheless, they are larger for Canadian expected inflation and market excess returns for both countries. Although statistical significance has fallen for some explanatory variable, all coefficients remain significant. For the U.S., the significance of changes in expected inflation has decreased, but the t-statistic of –2.344 still indicates a material negative effect.

The results in Table II do not show the evident differences between the independent OLS and SUR levels of significance for some mean coefficients from (9). This reveals marginally positive correlation in estimation error across equation. The results do not strongly imply that the OLS residuals are positively correlated across equations. There is a possibility at least one common factor is omitted; as a result, we later investigate whether an augmented factor model can ameliorate this phenomenon.

**Real Estate Real Returns and Nominal Interest Rates**

For several reasons, it might be instructive to consider the response of real REIT returns to changes in nominal interest rates alone, instead of responses to the two components of nominal rates, real rates and inflation. This involves an alternative to (9),

\[ R_{j,t} = \alpha_j + \beta_y (y_t - y_{t-1}) + \beta_M R_{M,t} + \epsilon_{j,t}, \quad (14) \]

wherein \( y \equiv r + I \) is the nominal interest rate. Essentially, regression (14) is the same as regression (9) with an equality constraint imposed on the first two coefficients, \( \beta_r = \beta_I \) in (9). When these two coefficients are truly different, (14) is misleading since it forces an inappropriate constraint. Keeping this in mind, Table III presents the results for (14).

The coefficient for the market equity return, \( \beta_M \), is virtually unaltered between regression (14), reported in Table III, and regression (9), reported earlier in Table II. For Canada,
the coefficient of nominal interest rates, \( \beta_y \), is negative and statistically significant, which is not surprising because both \( \beta_r \) and \( \beta_I \) were negative and statistically significant in Table II. However, the mean value of \( \beta_y \) is not a simple weighted average of \( \beta_r \) and \( \beta_I \), a point we will discuss in more detail below. For the U.S., \( \beta_y \) is negative on average but is not significant after accounting for cross-equation dependence; see the SUR T-statistic in the last row. Moreover, the mean value of the U.S. coefficient is -9.96, a third the size of Canada’s coefficient, -28.06. The adjusted R-square in Tables II and III have the same magnitude for both the U.S. and Canada. When our data ends in November 2006, the adjusted r-square for the U.S. has also been cut in half, which reflects the separate contributions of real interest rates and expected inflation that have now been suppressed.

Even without mortgage interest tax deductibility, there is little reason to think that real interest rates and expected inflation would have the same impact on real estate values. Indeed, if inflation were tax neutral, it should have little effect on the real values of real estate since nominal housing prices would appreciate with inflation. In contrast, real interest rates should strongly influence real values of all assets and our empirical results suggest that they do for real estate. For the U.S., with even greater disparate effects of real interest and inflation, a specification such as (14) that supposedly checks for the influence of nominal interest rate effects is merely measuring whether real rates or inflation were more dominant during the particular sample period under study.

When they are actually different, imposing a constraint that real interest rates and expected inflation have the same influence implies that the estimated nominal interest rate coefficient is determined by the whichever constituent happens to be more volatile during the sample. This is implied logically by the following *reductio ad absurdum*: Assume, for sake of argument, that the effects of both real interest rates and expected inflation are actually constants over time but are different. Then imagine that real interest rates themselves do not change during a particular sample. In that case, the nominal interest rate’s coefficient would be, by construction, the same as the expected inflation’s coefficient; and vice versa, if real interest rates varied and expected inflation were unchanged during another sample, the nominal interest rate coefficient would be the real
rate’s coefficient. To the extent that the relative variation in real rates and inflation changes materially over time, it follows that any empirical estimate of the nominal rate’s effect is highly sample specific. One should expect it to display considerable variation in successive sample periods and even a change in sign would not be an aberration.

Multi-Factor Estimation

Common current practice is to use a three- or four-factor model when examining asset returns. Moreover, the SUR estimation above suggests that some factor has been overlooked when real interest rate changes, expected inflation changes, and a broad market return are used as the only explanatory variables. To facilitate comparison with many other studies using U.S. data, we now present results from an augmented model that adds the Fama/French (1992, 1993) factors plus the Carhart (1997) momentum factor. In addition to the broad market equity excess return, the two Fama/French factors are hedge portfolios, SMB and HML, which are, respectively, small minus large sized stocks and high minus low book/market stocks. The Carhart momentum factor is long stocks with high returns and short stocks with low returns over the previous twelve months. Since these latter three factors represent long/short (zero investment) positions, there is no need to correct them for inflation, unlike the REIT returns and the broad market return.

For the U.S., the Fama/French and Carhart factors are available on the WRDS data base. For Canada, these factors are not readily available so we were obliged to construct them using individual Canadian equity information and the identical methods used by Fama and French. The Canadian data are from DataStream and the sample size varies from 181 firms in January 1997 to 1094 firms in January 2009.

As reported in Table IV, the Fama/French and Carhart momentum factors are all statistically significant for the U.S. On average, U.S. REITs are positively sensitive to both the Size and Book/Market factors; even the SUR T-Statistics exceed eleven and sixteen, respectively. The SUR T-Statistic is -8.6 for the momentum factor. This
suggests that REITs and high momentum stocks are driven in opposite directions by some underlying latent influence.

For four coefficients out of six, the SUR T-Statistics are smaller (in absolute magnitude) than the corresponding simple T-Statistics that assume cross-equation independence, but the differences are not dramatic. This is comforting because there seems to be little evidence of an omitted common factor.

The results for Canada (lower panel of Table IV) are comparable to those of the U.S. Every mean coefficient has the same sign, but the statistical significance is generally a bit lower except for expected inflation. The momentum factor is insignificant for Canadian REITs.

Real interest rate changes still have a significant negative impact on real REIT excess returns even after controlling for the additional factors. For the U.S., the coefficient has decreased in absolute magnitude, from -52.00 in Table II to -42.34 in Table IV, but the SUR T-statistic has increased marginally from -4.943 to -5.018. For Canada, the coefficient has changed from -30 to -74.9 between Tables II and IV; both are statistically significant.

The big contrast is again in the influence of expected inflation. For the U.S. the mean coefficient is now negative (-6.41) but is not significant according to either t-statistic. For Canada, however, the mean is -77.84, roughly the same magnitude as the mean coefficient of real interest rate changes; the corresponding t-statistic is around -4.5, which is highly significant.

Based on these results, one can conclude with confidence that expected inflation has an impact on real excess returns for Canadian REITs but not for U.S. REITs. Contrary to popular belief, there is not a strong negative effect of increasing interest rates on real estate when the underlying cause is inflation in the U.S. The popular belief is, however,
valid in Canada. For both countries, there is a negative impact of increasing interest rates on real estate when the underlying cause is real interest rates.

As an aside, it would be interesting to ascertain whether changes in real interest rates pervasively impact all stocks, not just REITs. If they do, the full four-factor model so often used these days might be missing an important source of systematic risk; viz., changes in real interest rates. To investigate this possibility, we did a small pilot study using U.S. equities that were not REITs. We collected the same number of non-REIT stocks randomly and repeated the calculations in Table IV. Perhaps to no surprise, the real interest rate change had no influence on these non-REIT stocks; the mean coefficient was 0.26 and the SUR T-statistic was 0.275.24

Returning to real estate, the results overall for the U.S. suggest that the supply and demand effects induced by the tradeoff between, (a) tax deductibility of mortgage interest and (b) compensation to lenders for the inflation tax on nominal interest, might be close to an offsetting wash. Admittedly, measurement error, both in expected inflation and in using REITs as proxies for residential housing, might have reduced empirical power and resulted in a finding of “no effect” when we control for market, size, book-to-market, and momentum.

Similar measurement error seems likely for Canada, yet there is indeed a negative impact on real estate real values of increases in interest rates, either real or nominal. This is consistent with the Canadian inflation tax on nominal interest and the lack of an offsetting tax benefit from mortgage interest deductibility.

\[24\text{For this non-REIT sample, the expected inflation change was equally as insignificant while the market return and all three factors, SMB, HML, and Momentum, were all highly significant. The mean adjusted R-square was slightly higher too, 0.28 in contrast to the 0.25 found for REITs.}\]
Conclusions

The mortgage interest deduction in the United States effectively implies that homeowners in high inflation environments can deduct part of the real value of the principal of their mortgage loans over time. Nominal mortgage rates rise with inflation and are fully deductible for most homeowners while the real value of the outstanding principal declines over time. This suggests that increases in nominal interest rates caused by rising expected inflation could possibly have a positive impact on house prices. Moreover, previous research has found that house prices have boomed in periods of inflation, though they have also boomed in periods of low nominal interest rates, perhaps because real interest were also low at those times.

In Canada, mortgage interest is not tax deductible, so increases in nominal interest rates caused by increased inflation brings no corresponding tax benefit to homeowners. Although there are other differences between the Canadian and U.S. tax systems, it seems likely that none is more important for house prices than mortgage interest deductibility or the lack thereof.

Higher interest rates induced by inflation should, however, also reduce the real returns for mortgage lenders in both countries, so nominal mortgage yields might rise by more than the expected inflation increase to compensate lenders for the added tax burden. But this supply consideration is the same in the two countries, so whatever the overall impact of inflation on house prices might be, it seems likely to be less in the United States than in Canada.

We find empirical evidence that the effect of inflation on real house prices is indeed less in the U.S. We study real monthly returns on real estate investment trusts (REITs), which should be strongly correlated with real house prices because all types of real estate are substitutes. We impute real interest rates and expected inflation rates from nominal and indexed bonds in Canada and the U.S. and study the relation between REIT real returns and changes in these rates while controlling for broad equity movements.
Real interest rate changes have strongly negative and quite similar effects on REIT returns in both countries. In contrast, changes in expected inflation have very dissimilar effects; in Canada, increased inflation reduces REIT values significantly. The impact is positively significant in the U.S when we control market excess returns but it is not significantly different from zero when we add size, book-to-market, and momentum factors. Other empirical characteristics of REIT returns, such as the response to broad equity movements and explanatory power, are remarkably similar in the two countries, so we feel safe in concluding that some underlying genuine cause, most likely mortgage interest deductibility, is responsible for the striking dissimilarity in the impact of inflation.
References


### Table I

**Data Sources and Sample Information about Real Estate Returns (REITs), Nominal Bonds, and Inflation-Indexed Bonds (TIPs)**

<table>
<thead>
<tr>
<th>Canada</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Number Available</strong></td>
<td><strong>Maximum Number Available</strong></td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td><strong>Source</strong></td>
</tr>
<tr>
<td><strong>Maximum Period Available</strong></td>
<td><strong>Maximum Period Available</strong></td>
</tr>
</tbody>
</table>

|-------|-----|---------------------------------|----------------------|-----|---------------------------------|-------------------|

Note: All observations are monthly.

---

\(^{25}\) We thank Andrei Pavlov of Simon Fraser University for providing data on Canadian REITs through 2006. Subsequent data on Canadian REITs were purchased from Global Property Research of Amsterdam.

\(^{26}\) The Bank of Canada provides constant maturity nominal yields every three months from three months to 30 years.

\(^{27}\) The U.S. Treasury gives 11 constant maturity nominal yields for maturities of 1, 3 and 6 months and 1, 2, 3, 5, 7, 10, 20, and 30 years. From February 19, 2002 until February 9, 2006, the 30-year bond was not issued and the data for that maturity are missing.
### Table II

**Time Series Regressions of Real REIT Returns on Changes in Real Interest Rates and Expected Inflation Rates with Real Returns on a Broad Equity Index as a Control**

Real interest rates and expected inflation rates are derived from nominal and real (inflation-indexed) term structures of interest rates in Canada and the United States using Treasury Bonds of each country. The market equity proxies are the Toronto Stock Exchange S&P Composite Index for Canada and the CRSP value-weighted index for the U.S. There are 31 Canadian Real Estate Investment Trusts (REITs) and 267 U.S. REITs in the cross-sectional sample. Data were monthly and the maximum time series sample period is May 1998 through May 2009 for the US and January 1997 through March 2009 for Canada.

<table>
<thead>
<tr>
<th>Cross-sectional statistic</th>
<th>$\beta_r$, Real interest rate changes</th>
<th>$\beta_I$, Expected inflation rate changes</th>
<th>$\beta_{M}$, Market equity real excess returns</th>
<th>Regression adjusted R-square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-30.41</td>
<td>-52.00</td>
<td>-27.39</td>
<td>24.93</td>
</tr>
<tr>
<td>Median</td>
<td>-6.70</td>
<td>-56.02</td>
<td>-10.22</td>
<td>17.83</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>69.64</td>
<td>114.10</td>
<td>59.27</td>
<td>98.87</td>
</tr>
<tr>
<td>Skewness</td>
<td>-2.010</td>
<td>-0.437</td>
<td>-1.833</td>
<td>0.877</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>3.289</td>
<td>4.742</td>
<td>4.139</td>
<td>5.685</td>
</tr>
<tr>
<td>% &gt; 0</td>
<td>21.95</td>
<td>27.72</td>
<td>9.76</td>
<td>61.42</td>
</tr>
<tr>
<td>SUR t-Stat.</td>
<td>-2.711</td>
<td>-4.943</td>
<td>-3.870</td>
<td>2.344</td>
</tr>
</tbody>
</table>
Nominal interest rate term structure levels in Canada and the United States were estimated using Treasury Bonds of each country. The market equity proxies are the Toronto Stock Exchange S&P Composite Index for Canada and the CRSP value-weighted index for the U.S. There are 41 Canadian Real Estate Investment Trusts (REITs) and 267 U.S. REITs in the cross-sectional sample. Data were monthly and the maximum time series sample period is May 1998 through May 2009 for the US and January 1997 through March 2009 for Canada.

<table>
<thead>
<tr>
<th>Cross-sectional statistic</th>
<th>$\beta_y$, Nominal interest rate changes</th>
<th>$\beta_M$, Market equity real excess returns</th>
<th>Regression adjusted R-square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Canada</td>
<td>U.S.</td>
<td>Canada</td>
</tr>
<tr>
<td>Mean</td>
<td>-28.06</td>
<td>-9.96</td>
<td>0.1434</td>
</tr>
<tr>
<td>Median</td>
<td>-8.59</td>
<td>-18.36</td>
<td>0.0205</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>49.93</td>
<td>76.37</td>
<td>0.2362</td>
</tr>
<tr>
<td>T-Statistic</td>
<td>-3.599</td>
<td>-2.130</td>
<td>3.888</td>
</tr>
<tr>
<td>Skewness</td>
<td>-1.568</td>
<td>0.873</td>
<td>1.472</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.328</td>
<td>3.586</td>
<td>0.689</td>
</tr>
<tr>
<td>% &gt; 0</td>
<td>7.32</td>
<td>34.08</td>
<td>68.29</td>
</tr>
</tbody>
</table>
| SUR t-Stat.               | -4.461       | -1.142      | 7.628       | 19.21       | 33

Table III
Time Series Regressions of Real REIT Returns
on Changes in Nominal Interest Rates
with Real Returns on a Broad Equity Index as a Control
Real interest rates and expected inflation rates are derived from nominal and real (inflation-indexed) term structures of interest rates in Canada and the United States using Treasury Bonds. The U.S. (Canadian) market proxy is the CRSP value-weighted index (Toronto Stock Exchange S&P Composite Index.) There are 267 (41) U.S. (Canadian) Real Estate Investment Trusts (REITs) in the final cross-sectional sample. The SMB, HML, and Momentum factors for the US are from WRDS and for Canada are constructed from Canadian data. Data were monthly and the maximum time series sample period is May 1998 through May 2009 for the US and January 1997 through March 2009 for Canada.

<table>
<thead>
<tr>
<th>Cross-sectional statistic</th>
<th>$\beta_r$, Real interest rate changes</th>
<th>$\beta_I$, Expected inflation rate changes</th>
<th>$\beta_M$, Market equity real excess returns</th>
<th>$\beta_{SMB}$, Small-large size</th>
<th>$\beta_{HML}$, High-low book/Market</th>
<th>$\beta_{Mom}$, Momentum</th>
<th>Regression adjusted R-square</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. (N=267)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-42.34</td>
<td>-6.41</td>
<td>0.6914</td>
<td>0.4985</td>
<td>0.7353</td>
<td>-0.2195</td>
<td>0.2520</td>
</tr>
<tr>
<td>Median</td>
<td>-41.05</td>
<td>-15.53</td>
<td>0.6303</td>
<td>0.4961</td>
<td>0.6652</td>
<td>-0.1524</td>
<td>0.2359</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>108.7</td>
<td>94.94</td>
<td>0.5163</td>
<td>0.6236</td>
<td>0.8482</td>
<td>0.5012</td>
<td>0.1901</td>
</tr>
<tr>
<td>% &gt; 0</td>
<td>29.21</td>
<td>39.33</td>
<td>95.88</td>
<td>89.14</td>
<td>23.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUR t-Statistic</td>
<td>-5.018</td>
<td>-0.757</td>
<td>19.66</td>
<td>11.79</td>
<td>16.27</td>
<td>-8.575</td>
<td></td>
</tr>
<tr>
<td><strong>Canada (N=41)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-74.80</td>
<td>-77.84</td>
<td>0.7242</td>
<td>0.2070</td>
<td>0.3835</td>
<td>0.4217</td>
<td>0.2705</td>
</tr>
<tr>
<td>Median</td>
<td>-46.72</td>
<td>-74.60</td>
<td>0.6970</td>
<td>0.0551</td>
<td>0.2760</td>
<td>0.3161</td>
<td>0.2565</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>91.96</td>
<td>111.03</td>
<td>0.3384</td>
<td>0.5562</td>
<td>0.4375</td>
<td>2.0471</td>
<td>0.1786</td>
</tr>
<tr>
<td>T-Statistic</td>
<td>-5.208</td>
<td>-4.489</td>
<td>13.703</td>
<td>2.383</td>
<td>5.613</td>
<td>1.319</td>
<td>9.696</td>
</tr>
<tr>
<td>% &gt; 0</td>
<td>24.39</td>
<td>19.51</td>
<td>100.00</td>
<td>58.54</td>
<td>90.24</td>
<td>58.54</td>
<td>97.56</td>
</tr>
<tr>
<td>SUR T-Statistic</td>
<td>-4.139</td>
<td>-4.686</td>
<td>16.456</td>
<td>3.195</td>
<td>7.388</td>
<td>1.450</td>
<td></td>
</tr>
</tbody>
</table>
The nationwide residential real estate price indexes compiled by the Federal Housing Finance Agency (FHFA) and by S&P/Case-Shiller® are plotted monthly along with a price index constructed by equal weighting monthly returns on USA real estate investment trusts.
Figure II
Non-Parametric Density Estimates of the Cross-Sectional Distributions of T-Statistics for the Responses of Real Excess Returns on REITs to Changes in Real Interest Rates and Expected Inflation Rates in the USA and Canada