Real Estate Returns and the Macroeconomy: Some Empirical Evidence from Real Estate Investment Trust Data, 1972–1991

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Abstract. **This paper explores the relationship between the macroeconomy and real estate returns. Equity REIT data are used as a proxy for real estate returns; however, the equity REIT returns are regressed against returns from the Standard and Poors 500 Stock Index, saving the residuals. These residuals, known as extra-market covariance, are used in the analysis since this technique controls for the covariance between equity REIT returns and the overall stock market. Thus, the residuals represent pure industry effects. The residuals are then employed in an unrestricted vector autoregressive model with the macroeconomic variables to test for relationships. The results show that prices, nominal rates, output and investment all directly influence the real estate series. Nominal interest rates, moreover, explain the majority of the variation in the real estate series.**

Introduction

Past real estate studies have focused most of their attention on the relationship between economic cycles and residential construction or sales activity. In contrast, there has been little research into the relationship between the macroeconomy and commercial real estate, especially real estate returns. Grebler and Burns (1982) examined the cyclical nature of nonresidential construction activity and contrasted it to the performance of residential cycles. Hekman (1985) studied the office market construction in different local markets, finding that office construction is related to rent levels and growth in service-related employment. Rosen (1984) attempted to model the San Francisco office market; however, his results were disappointing, an outcome he attributed to the inherent volatility of construction activity. Kling and McCue (1991, 1987) investigated the impact of the macroeconomy on both office and industrial construction cycles, finding that shocks to output, nominal interest rates and money supply have strong effects on office construction and that employment accounts for the majority of the variation in industrial property construction. In both instances they found that adjustments to shocks take place with a lag although the lags for industrial property were generally shorter than those for office construction.

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The work linking the macroeconomy to real estate returns is even more limited. Hoag (1980) developed a model to construct value indices for industrial property, making industrial property prices a function of national economic concomitants of value, regional economic concomitants of value and three measures of property-specific characteristics. His results revealed that while property-specific factors were significant, the national and regional factors also added to the model's explanatory power. Grissom, Hartzell and Liu (1987) used Hoag's work as a basis for their paper that developed an arbitrage pricing approach to model returns from industrial property. Their findings indicated that risk premiums for factors vary across regional submarkets and that the number of priced factors varies across regions; while their national model accounts for less than 40% of the variation in returns. Although these two studies argue for a greater role for property-specific factors in explaining real estate returns and values, it is, however, still an open question as to the role national economic factors play and the extent to which they explain returns.[1]

The purpose of this paper is to explore the linkages between the macroeconomy and real estate returns through time. More specifically, the paper determines the channels of influence followed by the macroeconomic variables, the extent to which the macroeconomic variables explain real estate returns and how real estate returns react to shocks in macroeconomy. To accomplish these tasks, we employ an unrestricted vector autoregressive model.

The major benefit of this methodology is that it has the ability to model the long lags inherent in real estate. Kling and McCue's (1991, 1987) studies employed vector autoregressions successfully in modeling office and industrial construction cycles. They found that adjustments to macroeconomic shocks take place with a lag, a result, they argued, of the "time to build" problem. The "time to build" problem is indigenous to real estate development. By its very nature, development takes time: approvals are needed, plans must be drawn, financing secured and the structure constructed. The developer, however, must make a commitment to start a project based on an estimate of what demand will be at the project's completion. As Kling and McCue (1987) and Lawrence and Siow (1985) showed, nominal interest rates have some predictive content in that changes in nominal rates today reflect agents' forecasts of anticipated output. Nominal rates, then, play a key role in office construction since they can be used as cues for anticipated output.

The "time to build" problem is further complicated by the fact that an investment in real estate is an investment in a real asset, meaning that it is not easily reversible even in the face of poor economic news. Thus, there is a tendency for construction cycles to adjust with a lag to shocks in the macroeconomy. New construction should have a positive effect on returns in the short run. For example, suppose a shock to output causes the demand for office space to rise. Developers, seeing higher demand, would begin to add space; but, adding new space takes time. Meanwhile, existing office properties may be able to raise rents or lease unused space until the newly constructed space enters the market, thus increasing their returns.

For these reasons, we have decided to link the macroeconomy to real estate returns through investment behavior. Our model of the macroeconomy is based on one developed by Lawrence and Siow (1985) to model the investment spending behavior of firms.

Our results show that macroeconomic variables explain approximately 60% of the variation in real estate returns. Nominal interest rates alone account for more than 36% of the variation, a result consistent with the school of thought that nominal rates proxy for anticipated output. Shocks to nominal rates have a significant negative influence on returns while shocks to output and investment exhibit a significant positive response. In all instances, however, the lags are, as expected, generally shorter than those reported by Kling and McCue.

The next section discusses the data and the model. A section on the methodology follows. The fourth section discusses the results, followed by a short conclusion.

Data and Model

One unique aspect of this paper is the real estate data series employed. Any research into real estate returns faces data problems. While some consider commingled real estate fund data the best source, questions have been raised about the use of appraised values. In addition, there are not enough data points available to use commingled real estate fund data in a vector autoregressive model.

Employing equity real estate investment trust (hereafter REIT) data is the only other alternative; yet, this source is not without problems. Since, as financial claims, REIT data are influenced by stock market movements, some have argued that REIT data may overstate the variability of the underlying real estate. In this paper we attempt to contain the stock market effect by controlling for the covariance with the market.

The single index return generating model, often called the market model, assumes that the covariance of security returns can, for the most part, be explained by the tendency of stocks to move together. King (1966), however, showed that there are other sources of covariance, most notably industry effects, that account for about half the movement in price changes compared to 31% for the market. Rosenberg (1974) demonstrated that the residuals of the market model are influenced by these other sources of covariance, calling them "extra-market covariance".

Following Rosenberg's outline, we regress the monthly equity REIT index, a value-weighted index compiled by the National Association of Real Estate Investment Trusts, against the Standard and Poor's 500 stock index, saving the residuals. Exhibit 1 shows the regression results. These residuals represent the extra-market covariance

Exhibit 1
Regression Employed to Calculate the Equity REIT Residuals
Period: 73,1 to 91,12

Dependent Variable	Constant	S&P 500 Index	*R*-squared
Equity REIT Index	−.01409 (−1.64)	.6492 (12.89)	.42

Exhibit 2
Summary Statistics
Period: 73,1 to 91,12

Variable:	Prices	Nominal Rates	Output	Investment
Mean:	90.317	7.886	114.59	116.78
Standard Deviation:	28.480	2.583	17.93	39.94

and are assumed to be attributed to a second underlying factor, the industry effect. Thus, by controlling for the market, we are able to produce a series that mimics a real estate return series. One potential problem could be the presence of individual REIT effects; however, since the index is a weighted average of all equity REITs, individual REIT effects should be diversified away. Thus, we are left with a return that is based on the common covariance between REITs, in essence an industry effect.

As noted earlier, we link these REIT industry returns to the macroeconomy through a model of firm investment behavior first proposed by Lawrence and Siow (1985). Their model includes prices (*P*), short-term nominal rates (*R*), output (*Q*) and investment (*I*). (For simplicity, we will designate the residual returns from the equity REIT index as *RE*.) We use the Consumer Price Index to represent prices, the three-month Treasury bill rate for the short-term nominal rate, the Federal Reserve's Industrial Production Index for output and the McGraw Hill Construction Contract Index as a proxy for investment. Exhibit 2 shows the summary statistics for the economic variables. Output, prices and the investment index are all seasonally adjusted. All data series except interest rates were first logged; then, any potential seasonal frequencies were removed by 12th differencing.[2]

Empirical Methodology

We estimate a vector autoregressive model (hereafter, VAR) for the period from May 1974 to December 1991.[3] The typical procedure in such an analysis is to treat all variables as potentially endogenous, then to regress each variable on lagged variables of itself and the remaining variables. The VAR model can be written as:

$$Y_t = A + \sum_{k=1}^{15} B_k Y_{t-k} + U_t \,, \tag{1}$$

where $Y=(P_t, R_t, Q_t, I_t, RE_t)$ is the vector of variables at the time period t, the Bs are the 5×5 coefficient matrices, A is the 5×1 constant coefficient vector and U is the 5×1 serially uncorrelated random disturbance vector. A lag length of fifteen was chosen.[4] Thus, each series is regressed on fifteen lags of itself, fifteen lags of each of the four variables and a constant. For example, the output equation is:

$$Q_t = a_3 + \sum_{k=1}^{15} b_{31k} P_{t-k} + \sum_{k=1}^{15} b_{32k} R_{t-k} + \sum_{k=1}^{15} b_{33k} Q_{t-k} + \sum_{k=1}^{15} b_{34k} I_{t-k}$$

$$+ \sum_{k=1}^{15} b_{35k} RE_{t-k} + U_{Q,t}. \quad (2)$$

Since the regressors are the same in each individual equation, the coefficients can be estimated by ordinary least squares. Typically, the results of this estimation are used to calculate the critical values of the *F*-test of the hypothesis that the coefficients for all lags are zero. Rejecting the hypothesis for a particular variable implies that lags of that variable contain information that would be useful in predicting the dependent variable. Thus, the *F*-statistics can be used to determine the channels of influence between the variables.

Once the coefficient matrices have been estimated, then the response of one variable, for example the REIT return series (*RE*), to a positive shock in another variable, say, prices (*P*), can be mapped. That is, the response to the shock in prices is traced by simulating the model under the initial conditions that all past values of all variables are zero except for P_0 and $U_{P,0}$ which are set equal to the standard deviation of $U_{P,t}$. These impulse responses provide pictorial information on the length, intensity and direction of a response to a shock.[5]

Runkle (1987) has criticized VAR studies for their failure to make statements about statistical significance of their results.[6] In order to address this issue, we use Monte Carlo integration to compute the first moments and variances of the orthogonalized impulse responses for the VAR model. We take 500 draws from an inverse Wishart distribution for the residual covariance matrix; and, conditional on each draw from the Wishart distribution, we draw a random coefficient matrix for the VAR coefficients and calculate a set of impulse responses for each equation. Thus, 500 "pseudo" impulse response paths are calculated for each equation, allowing the mean response and two standard deviation bounds to be determined. This procedure is described in detail in Doan (1992).

If the innovations are contemporaneously uncorrelated, the sum of the squared responses of the REIT index (*RE*) to a unit response in prices (*P*) is the portion of the variance of *RE* accounted for by innovations in *P*. Since in practice the sum must be truncated at some finite forecast horizon, it is actually the portion of the within-sample forecast error of *RE* accounted for by innovations in *P*. As long as the series is stationary and the forecast horizon distant enough (we use forty-eight months here), the forecast error approximates the variance. Thus, vector autoregressions also allow us to estimate the variance of *RE* and the proportion of that variance accounted for by innovations in *P*. In a similar manner, one can approximate the proportion of the variance in *RE* accounted for by its own innovations. While the *F*-tests, noted earlier, are indeed useful, the impulse responses and variance decompositions tell something about the strength of the relationships, adding depth to the analysis.

Empirical Results

Exhibit 3 shows the critical values of the *F*-tests on the lags of the VAR model. The results show that all the macroeconomic variables are significant in the real estate

Exhibit 3
F*-Tests Significance Levels
Period: 74,5 to 91,12

	Explanatory Variables				
Equation for:	*P*	*R*	*Q*	*I*	*RE*
P	.0000	.0240	.1309	.0885	.3218
R	.3725	.0000	.1819	.0271	.5855
Q	.4246	.2146	.0000	.2280	.0015
I	.2105	.0357	.1425	.0000	.0144
RE	.0273	.0492	.0020	.0284	.0000

*The null hypothesis is that the lag coefficients for each explanatory variable are zero.

equation, implying that they all influence the real estate series directly. This result stands in contrast to those reported by Kling and McCue for office and industrial construction. Their results show indirect effects with some macroeconomic variables influencing the real estate series through other macroeconomic variables.

Note also that the real estate variable is significant in both the investment and output equations, suggesting a feedback relationship. The relationship between the real estate series and prices and nominal rates is more direct. Since the real estate variable is not significant in either the price or nominal rates equation while those two variables are significant in the real estate equation, these two variables are said to "Granger cause" the real estate variable, meaning that there is information in price series and nominal rates that would be useful in predicting the real estate series.

Exhibit 4 shows the variance decompositions. They represent the within-sample forecast error variances in one variable accounted for by innovations (shocks) in the others. If there is little interaction between the variables, the diagonal element of this table would have values close to 100%. Examination of these results shows that this is not the case.

Since the *F*-tests show that all the macroeconomic variables were significant in the real estate equation, these variance decomposition results provide some depth to the analysis by allowing us to determine their relative importance. Nominal rates explain over 36% of the variation in the real estate series, by far the largest of any of the macroeconomic variables. This could be an interest-rate effect, or it could be that nominal rates are reflecting agents' forecasts of future output. Some evidence for the latter explanation is the fact that nominal rates explain a relatively high 34.1% in the output equation and 29.6% in the investment equation.

In contrast, prices explain very little of the real estate series, only 7.5%. Output and investment also explain little. In light of the feedback relationship noted from the *F*-tests results, this is not a surprise. The feedback relationship implies that these variables are determined contemporaneously; thus, the role of lagged values is diminished. Further, if nominal rates proxy for output, then one ought to see nominal rates explaining more variation in real estate returns.

The impulse responses are presented in Exhibit 5. They graphically depict the response of the real estate return variable to positive, one standard deviation shocks

Exhibit 4
Variance Decompositions
Period 74,5 to 91,12

Variables Explained	By Innovations in:				
	P	*R*	*Q*	*I*	*RE*
P	50.9	40.3	2.9	.5	5.4
R	15.4	32.8	10.5	6.1	35.2
Q	14.5	34.1	27.1	5.5	18.8
I	15.7	29.6	6.2	37.6	10.9
RE	7.5	36.2	9.3	6.3	40.7

in each of the other variables over a forty-eight-month period. These impulse responses are plotted with upper and lower two standard deviation bounds, allowing us to make statements about whether or not a response is significantly positive or negative. Shocks to nominal rates are significantly negative, as expected, reaching the greatest response in eleven months. Shocks to investment and output are significantly positive. Output produces its peak response in ten months while investment reaches its peak in four months.

A shock to prices results in a decline in the real estate series, reaching its low point in five months although it is not significantly negative. This result agrees with those reported by Gyourko and Linneman (1988) that showed equity REITs as poor hedges against unexpected inflation. In contrast, Hartzell, Hekman and Miles (1987), using commingled real estate fund data, reported results that argue that real estate provided a strong hedge against both expected and unexpected inflation. Even they, however, noted that the problems associated with commingled real estate fund data may have affected their results.

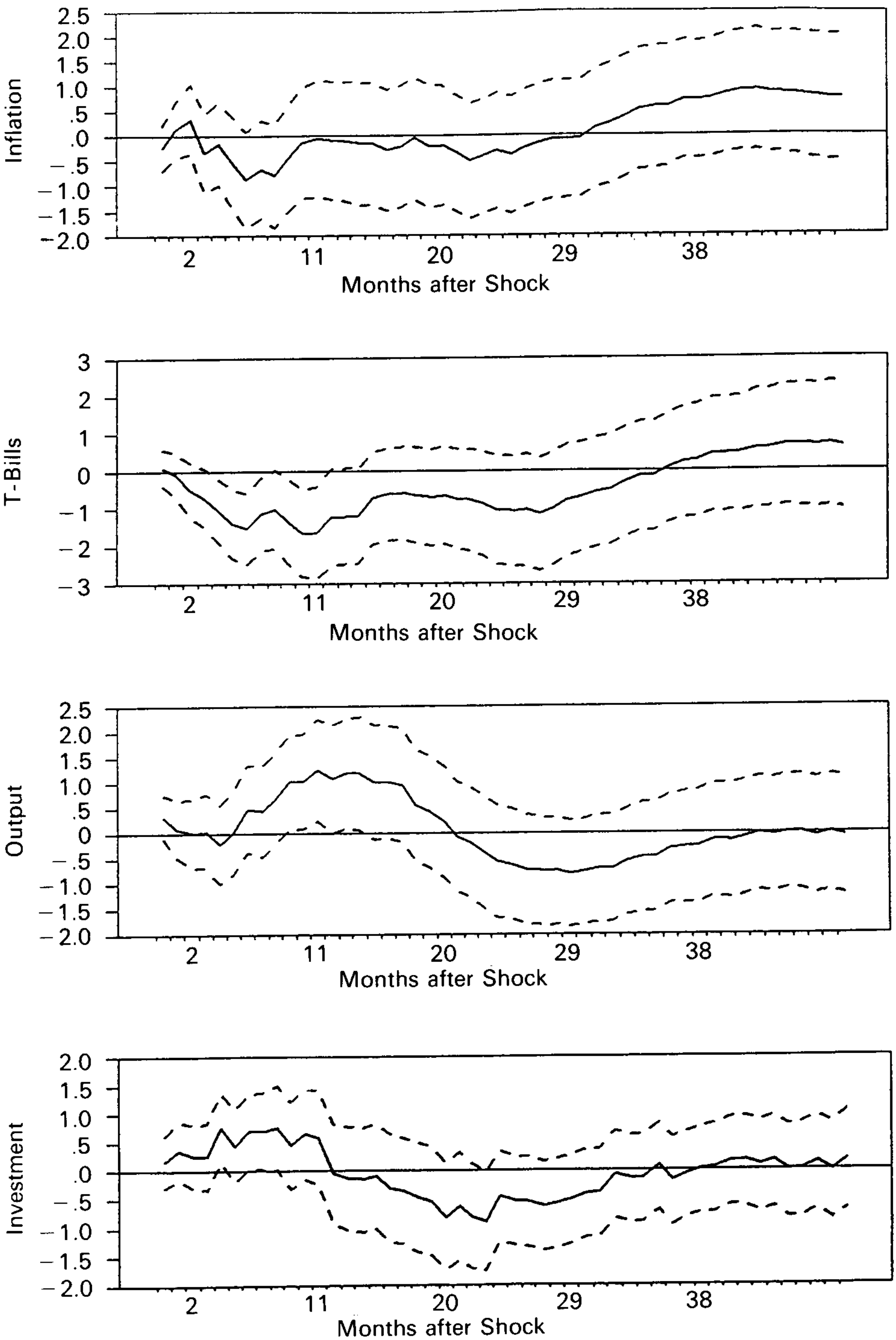
The peaks of the impulse responses are shorter than those reported by Kling and McCue, which should be expected given that we are working with returns. They also raise another issue. The fact that the adjustment takes place with a lagged effect is not consistent with an informationally efficient stock market. It remains to be seen whether one could profit from this information.

Concluding Remarks

This paper uses a model of investment behavior to explore the linkages between the macroeconomy and real estate returns. The paper employs an equity REIT series. This series, however, is unique in that it represents the output of a procedure that controls for the effect of the covariance with the stock market.

The results show that the macroeconomy explains almost 60% of the variation in the real estate series. Of the macroeconomic variables, nominal interest rates explain the greatest percentage of variation in the real state series, while the output and investment variables explain very little of the variation. The output and investment variables explain little probably because the real estate variable and these two

Exhibit 5
Impulse Responses for REIT Returns



macroeconomic variables are determined contemporaneously, meaning that there is a feedback effect between these variables. Shocks to nominal rates have a significant negative effect on the real estate return series. The impulse responses also reveal that the peaks of the lagged responses for the real estate return series are generally shorter than those reported in earlier studies using construction data. This result is not unexpected given that this study employs a return series. Securitized real estate is, by definition, liquid and so decisions to invest in it are easily reversible. The construction series used in Kling and McCue's earlier studies represents investments is real assets, making it more difficult to respond to changes in the macroeconomic environment. Still, if the market for securitized real estate is informationally efficient, one would expect even shorter responses. Thus, the impulse responses are not consistent with an informationally efficient stock market although further study is required to determine if it would be possible to exploit this condition.

This finding of a strong relationship between nominal interest rates and the real estate return series is consistent with earlier studies that found that nominal interest rates are used as a proxy for future anticipated output when agents face a "time to build" problem. Admittedly, in our study, this relationship could also be the result of a pure interest-rate effect. We make no attempt in this study to separate the two effects or to determine their relative importance. Perhaps another study that distinguishes between the incentive effect of rate declines and the effects due to their predictive power could explore this relationship further.

Notes

[1]In the case of the Grissom, Hartzell and Liu study, the factors employed in the arbitrage pricing model were not "named," being simply the output of a factor-analytic technique. Consequently, any discussion of their meaning is limited. In answer to this problem with the arbitrage pricing approach, Chen, Roll and Ross (1986), studying the stock market, showed that these factors could be identified and given some economic meaning. The factors they identified included unanticipated inflation, unanticipated growth in output, an interest-rate factor and an economy-wide risk factor. Based on their work, there has been renewed interest in the linkages between the economy and the stock market.

[2]As is customary in the finance literature, we study the residuals from a market model regression. One would expect these residuals to be stationary in a time series sense, that is, to be integrated of order zero, I(0). In a regression equation of REIT residual returns on aggregate economic variables, we want the regression residuals to be i.i.d. with mean zero. This implies that the regression residuals should be I(0). A point made by Granger (1981) is that in a well-specified econometric model, if the dependent variable is I(0), then the explanatory variables must also be I(0) if the regression residual is to be I(0). Alternatively, if the dependent variable and the explanatory variables are integrated of order 1, I(1), then they must be tested for co-integration to determine if an error correction model is appropriate. Thus, in our empirical analysis, we use the annual percentage changes of the economic explanatory variables to relate to the equity REIT residual returns in the VAR model. To make sure that all variables in the VAR model are I(0), we applied the Dickey-Fuller (1979) unit root tests to the equity REIT residual series and the annual percentage changes in the economic explanatory variables. As expected, the unit root tests rejected (at less than the .05 level of significance) the presence of a unit root in each series.

[3]The equity REIT index begins in 1972. Data points are lost due to the 12th differencing and the lags used in the VAR model.
[4]The lag length for the VAR model was determined by the matrix version of the Akaike Information Criterion described in detail in Lutkepohl (1993). The AIC criterion balances the reduction in the log determinant of the residual error covariance matrix with a penalty function for the increased number of estimated coefficients. The model whose AIC value is smallest is chosen for further analysis. A model with fifteen lags gave the smallest AIC value.
[5]See Sims (1980) or Kling and McCue (1987) for a more detailed description of the VAR methodology.
[6]Sims (1987) responded to those criticisms in some detail, arguing that they were somewhat overstated.

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