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A Theoretical Analysis of Real Estate Returns

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ABSTRACT

In this paper, we consider two hypotheses for the recent performance of real estate returns. The first is the random event argument that real estate is positively correlated with unanticipated inflation but that structural change in expected returns due to a change in the perceived sensitivity of returns to unanticipated inflation has not taken place. The second is the hedge demand argument that formulates the structural shift hypothesis. The paucity of real estate and other expectations data as well as the general identification problem make it extremely difficult to distinguish between these hypothesis. Our tests consist of estimates of inflation betas for various asset categories overtime as well as estimates of the hedge vector, $S^{-1}C$. Although some support for the hedge argument is found, the results are not strong enough to reject the random event argument and conclude that a decline in the required return on real estate due to a relative increase in inflation beta drove returns during the 1970's.

DURING THE LAST DECADE, real estate has been identified by many investors, often institutional investors, as one of the few noncommodity vehicles likely to provide an adequate hedge against inflation. At the same time, that inflation itself has been more rapid, most other (traditional) asset categories have failed to keep pace—a phenomenon with relatively poor academic explanation. Using Post-World War II return data for the computation of efficient sets of securities, real estate often assumes an unreasonably large portion of a portfolio because it has frequently had higher returns with comparatively less risk *and* has been an effective source of diversification. It is well known that such calculations can be misleading due to the fact that the available data is insufficient to obtain accurate estimates of the moments of return. Thus, even if the true moments of returns are stationary, real estate could simply have had high unexpected returns because of a positive correlation with unanticipated inflation, but with no necessary implication of structural change. We argue a more subtle problem is that standard efficient set calculations fail to reflect the demand for securities to hedge changes in the investment opportunity set. Therefore, another possible explanation of the data is that this component of demand secularly shifted in favor of real estate in recent years thus causing above normal returns that have been mistakenly captured in efficient set calculations. While anecdotal evidence favors the latter argument, market efficiency in forming expectations tends to favor the former.

The balance of this paper provides a thoeretical and empirical examination of these arguments. Section I develops a thereotical model of asset pricing to reflect the demand for securities, and it also develops several hypotheses from the pricing model that seek to explain the behavior of real estate returns in recent

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years. Section II provides empirical evidence on the questions raised. Section III concludes the analysis.

I. A Model of Asset Pricing and Related Hypotheses

We wish to develop a pricing model that is simple enough to clarify the central issues but general enough to capture the impact of a stochastically changing opportunity set. Models of this latter type were first rigorously developed in continuous time by Merton [2] and are generally regarded as more reasonable characterizations of economic equilibrium. This is because they allow explicit assumptions regarding the impact of economic variables (called state variables) on security means, variances, and covariances (moments). The advantage of a continuous time approach is that the corresponding mathematics allow strong conclusions to be obtained regarding relationships connecting the model's variables even though the magnitude of the individual variables may be difficult or impossible to compute. The central observation coming from this work is that in a multiperiod equilibrium in which security moments are stochastic, it is no longer the case that optimal investor portfolios are necessarily nominally mean-variance efficient. Instead, at each point in time the optimal portfolio will be a weighted sum of a nominally mean-variance efficient component (that may change through time) plus a component to hedge the change in security moments (that also may change through time) where the weights may change depending on the investor's wealth, time, and the state variable(s) themselves, such as inflation.

To develop a simple but representative model, we shall assume a world in which there are K investors with nominal wealth endowments $W_k(0)$, $k = 1, \cdots, K$, with total wealth (across individuals) denoted W. Each investor maximizes the expected utility of terminal wealth, $U_k(\cdot)$. With no loss of generality, we assume that all individuals possess the same end-of-period, T. There are N risky assets and an instantaneously nominally risk free asset that is not necessarily constant. Nominal security prices are assumed to follow Ito processes in which means and standard deviations depend on time and the only state variable in the model, the general price index, $I(t)$. $I(t)$ is also assumed to follow an Ito process whose mean and standard deviation depend on time and the level of the index itself. Real wealth and real security prices are thus given by $W_k(t)/I(t)$ and $P_i(t)/I(t)$, respectively. To summarize our assumptions thus far:

A1 $r = r(I, t)$ — Instantaneously risk-free rate

A2 $\dfrac{dP_i}{P_i} = u_i(I, t)\, dt + s_i(I, t)\, dz_i$ — Security prices

$$i = 1, \cdots, N$$

A3 $\dfrac{dI}{I} = u_I(I, t)\, dt + s_I(I, t)\, dz_I$ — Price index

A4 $W(t) = \sum_{k=1}^{K} W_k(t) 0 \le t \le T$ — Wealth

A5 $U_k\left(\dfrac{W(T)}{I(T)}\right)$ — Utility of real terminal wealth

In order to achieve an overall optimum, at each point in time each investor selects the optimal (column) vector of holdings of risky asset proportions in his total portfolio, denoted $X_k(t)$. Denoting a column vector of ones by $\underline{1}$, the percentage in the risk free asset for investor k at time t is $1 - \underline{1}'X_k(t)$. The indirect utility function for investor k is the expected utility of real terminal wealth optimized over $X_k(t)$, $0 \leq t \leq T$. That is

$$J^k(W, I, t) = \text{Max}_{X(t)0\leq t\leq T}\, E\left\{U_k\left(\frac{(W(T)}{I(T)}\right)\right\}. \tag{1}$$

We shall also employ the following notation: let $C(I, t)$ be the column vector of instantaneous covariances of nominal security returns with instantaneous inflation (dI/I); $S(I, t)$ is the instantaneous $(N \times N)$ covariance matrix of nominal security returns; $X_m(t)$ is the vector of market proportions, i.e., the portfolio of risky securities equal to the market overall; $u(I, t)$ is the (column) vector of nominal mean security returns.

The model that we have laid out is a straightforward application of existing theory. Utilizing the normal solution techniques produces the following formula for investor k's optimal percentage allocations to the N risky assets at time t:

$$x_k(t) = \frac{-J^k_w}{W_kJ^k_{ww}}\, S^{-1}(\underline{u} - r\,\underline{1}) - \frac{IJ^k_{IW}}{W_kJ^k_{ww}}\, S^{-1}C \tag{2}$$

where functional dependence of terms on t, I, and/or W has been supressed for simplicity. Subscripts of J denote partial derivatives. Thus, the mean-variance efficient portion is $S^{-1}(\underline{u} - r\,\underline{1})$ with weight $-J^k_w/W_kJ^k_{ww}$, and the hedge term is $S^{-1}C$ with weight $-J^k_{Iw}I/W_kJ^k_{ww}$.

In order to interpret this result, first note that the hedge component $S^{-1}C$ is that linear combination of the risky asset returns that causes the uncertain component of return to be the optimal statistical prediction of the uncertain portion of instantaneous inflation. That is, if we could isolate the uncertain portion of instantaneous inflation and "regress" it on the uncertain components of risky asset returns, $S^{-1}C$ would be the vector of regression coefficients. The weight on the hedge term is precisely that combination of variables and partial derivatives that causes the presence of the hedge term to eliminate the impact of inflation from the expected change in expected utility. Thus, the mean-variance term places the portfolio in an optimal position assuming security moments are the same in the future as they are now, while the hedge term seeks to offset the impact on future investment returns (security moments) of an unanticipated change in inflation.

In order to develop formula (2) into a market equilibrium, we aggregate (2) over investors and rearrange to find that, in equilibrium

$$u_j = r + (u_m - r)b_{j,m} + (u_I - r)b_{j,I} \quad j = 1, \cdots, N \tag{3}$$

where

$b_{j,m}$ = the beta of security j with respect to the market;
$b_{j,I}$ = the beta of security j with respect to inflation;
u_m = the expected return on any portfolio whose market beta is 1 and whose correlation with inflation is zero;

u_I = the expected return on any portfolio uncorrelated with the market and whose inflation beta is 1.

The model (3) holds at each point in time although each term may depend on t, $I(t)$, and/or $W(t)$. Under the usual regularity conditions on $J(W, I, t)$, $u_m - r$ is positive. In contrast, $u_I - r$ is positive if J_{IW} is negative and negative if J_{IW} is positive. That is, inflation risk implies a higher required return on a security if the impact of inflation on utility is worsened as wealth increases. Conversely, if the inflation impact on utility is improved as wealth increases, inflation risk is sought in a security so that the required return is less.

In a world without inflation, or one where inflation impacts future security moments but the correlation of returns with uncertain inflation is zero (i.e., so the $b_{j,I} = 0$), formula (3) would reduce to the usual CAPM for a nonstochastic opportunity set. In the latter case, inflation would exist but would not be a source of priced risk because exposure to uncertain inflation could not be managed, or in other words, securities would not differ according to their ability to influence inflation risk in the portfolio. Hence, such risk could not be priced in individual securities. In the present case, uncertain security returns are correlated with uncertain inflation so that this source of risk is partially manageable and the inflation beta enters the formula. The coefficients of the betas in formula (3) depend on the parameters of the investors' utility functions, aggregate wealth, and the price index. Explicit computations would thus require specification of all functional forms of the diffusions and the solution of one or more nonlinear partial differential equations. Such full solutions are generally not sought except in the simplest cases, and we will not seek one here. Instead, we will follow a more intuitive line of reasoning in the next section where several hypotheses regarding model parameters are developed.

We believe that much of the behavior of real estate over the last decade can be interpreted in terms of Equation (3), the multiperiod pricing model. This period was generally characterized by a more rapid rate of inflation than was experienced in prior years and by mounting concern that the combination of factors including inflation and the U.S. corporate tax code were diminishing productivity and incentives to invest. These developments were consistent with the relatively poor performance of U.S. equities over the period, an asset that economists would otherwise be inclined to regard as a good inflation hedge because of the ability of corporations to pass through inflation to earnings. Real estate, on the other hand, enjoyed increasing demand as institutions and households alike sought additional participation in this market to hedge inflation risk given neutral expectations, or to prosper directly given expectations of continued inflation.

Rather than force these phenomena into a single period model, formula (3) implies a potential interpretation in terms of changes in the model parameters. On the one hand, all model parameters could be stationary. Indeed, the inflation terms could even be zero. The large positive returns on real estate would then be interpreted as a random event generated by a positive correlation with unanticipated inflation. On the other hand, the perceived inflation beta of real estate could have risen during the 1970's while the perceived inflation beta of stocks declined, leading to a relative increase in the demand for real estate as a hedge asset. If hedge demand for real estate increases in this way, we know from Equation (2) that J^k_{IW} must be positive, and hence (from Section I) $u_I - r$ will be negative. But with $u_I - r$ negative, an increase (decrease) in the inflation beta implies a decline (increase) in expected return, all else constant. Thus, decreases in the expected return on real estate would be associated with prices being bid up thus producing the high returns that were observed. Conversely, increases in the expected return on stocks would be associated with prices being bid down thus producing weak returns.

II. Empirical Analysis

Section I outlined possible explanations for the recent performance of real estate. First, no structural change in expected return has taken place. Instead, real estate is simply positively correlated with unanticipated inflation which randomly increased causing an unexpected asset price response. Alternatively (and in addition to this effect), we can view inflation as a source of priced risk and look for secular changes in inflation betas and asset allocation as evidence of changes in required returns that could also have driven actual returns.

At the outset, we must acknowledge the difficulty in distinguishing between these hypotheses. The problem is that both explanations posit a positive correlation of unexpected inflation and real estate returns. Consequently, we must distinguish between an observed correlation likely to have been produced by a simple structure (the random event hypothesis) versus one produced by a more complex process (the hedge demand hypothesis). Specifically, if we examine subperiods of time and find that neither the inflation betas nor the hedge vector, $S^{-1}C$, have changed, then there is no evidence in favor of the hedge demand argument. If there is significant change, however, we cannot immediately conclude that the hedge demand hypothesis is correct since this could merely represent nonstationarity in the simple correlation structure. The identification problem is that an ex ante shift in hedge demands that takes place during an inflationary period could generate a large change in the measured correlation of inflation and return. This may or may not reject the random event argument depending on whether or not the change is extreme enough to challenge the reasonableness of that basic approach. The implication, however, is that significant observed changes in coefficients over both inflationary and noninflationary periods are necessary to provide a reasonable test of the hedge argument, let alone support. Support requires evidence that the changes in parameters predict the realized returns in a more parsimonious way than merely a statement about the realized correlation of inflation and return. This in turn requires knowledge of the pricing formula 3 that is still more difficult to obtain, namely the coefficient $u_m - r$ and $u_I - r$.

Data

It is well known that statistical analysis using publicly available real estate data is tenuous at best. The appraisal process and incomplete sampling are common problems. In this regard, our work is subject to the same paucity of data that has plagued others. Further, our work is limited insofar as broadly defined real estate returns are unavailable. We would expect observed relationships to be somewhat muted, given both the incomplete adjustment of appraisals as well as the unique characteristics of the particular real estate series chosen.

While no fool-proof answers are presently available, we have endeavored to reduce certain problems by selecting two data series with limited exposure to the appraisal process. First, the Census Bureau provides a quarterly price index of new single-family houses sold. Second, the Livingston survey of expectations includes estimates of farm prices through 1970. Other data series used included the GNP deflator, consumer price index, S&P 500 return data and returns to 20-year U.S. Treasury bonds. The Livingston survey data was further used for expected stock price returns and expected inflation rates. Specifically, expectations of the price levels 6 and 12 months hence were used to infer expected rates of return, thus eliminating problems concerning the base index value at the time of each survey. The time periods examined ranged from 1952 to 1983, with the exception of the expected farm price index, which ceased in 1970, and new single-family houses which began in 1963. The periodicity was quarterly for actual data and seminannual for Livingston data.

Regression Analysis

In light of the identification problem as well as the paucity of real estate return and other expectational data, we are forced into more judgemental comparisons that do not conclude in a formal test of hypothesis. Our analysis consists of two categories of regressions. First, we estimate inflation betas of real estate, stocks, and bonds over several time periods since 1952 (Table I and II). Second, we estimate the $S^{-1}C$ vector over similar subperiods (Tables III and IV). Our intent is to observe patterns in the coefficients that would cast support for either hypothesis. Our basic conclusion is that, while the data provide some support for the hedge demand hypothesis, the results are not strong enough to conclude that a rising inflation beta and declining required return was a cause of above normal real estate returns in recent years. Hence, we cannot reject the hypothesis that there has been no change (in particular, no decline) in expected returns on real estate because of an increase in its demand as an inflation hedge.

Table I

Beta Coefficients from Regressing Unanticipated Asset Returns on Unanticipated Inflation Computed from Livingston Data[a]

	1954–1963	1959–1968	1964–1973	1969–1978	1974–1983
Stocks	−4.60	−7.51	−9.30	−7.61	−4.19
	4.10	5.77	2.22	2.20	1.85
Bonds	0.13	−1.35	−2.29	−1.88	−1.56
	0.68	1.12	0.88	0.63	1.23
Real estate	NA[b]	NA	−0.03	−0.32	0.85
			1.17	0.71	0.58

[a] The second number in each cell is the standard error.
[b] NA, not applicable.

Table II

Beta Coefficients from Regressing Unanticipated Asset Returns on Unanticipated Inflation Defined by Regression Residuals

	1954–1963	1959–1968	1964–1973	1969–1978	1974–1983
Stocks	−3.07	−4.85	−8.13	−6.39	−4.53
	4.72	3.95	2.94	2.67	2.28
Bonds	−0.11	−0.91	−2.40	−1.79	−1.64
	0.77	0.76	1.01	0.72	1.50
Real estate	NA	NA	1.00	−0.03	1.27
			1.31	0.77	0.68

See footnotes to Table I.

Table III

Multiple Regression of Unanticipated Inflation (Defined by Regression Residuals) on Unanticipated Asset Returns[a]

	1964–1973	1969–1978	1974–1983
Stocks	−0.025	−0.027	−0.032
	0.017	0.016	0.020
Bonds	−0.049	−0.118	−0.014
	0.051	0.061	0.034
Real estate	0.018	−0.044	0.101
	0.040	0.062	0.070

The second number in each cell is the standard error.

Table IV

Multiple Regression of Unanticipated Inflation (Calculated from Livingston Data) on Unanticipated Asset Returns[a]

	1964–1973	1969–1978	1974–1983
Stocks	−0.043	−0.040	−0.045
	0.016	0.014	0.024
Bonds	−0.055	−0.144	−0.026
	0.050	0.053	0.040
Real estate	−0.020	−0.087	0.081
	0.040	0.053	0.084

[a] The second number in each cell is the standard error.

Tables I and II contain the first regression tests which are estimates of inflation betas for different asset categories. Based on the theory developed in Section I, we regress unanticipated returns on unanticipated inflation. Unanticipated inflation was calculated in two ways with separate results provided in Tables I and II, respectively. First, we employed the Livingston data to calculate expected CPI inflation which was subtracted from actual. Second, we employed the residuals from an autoregressive model for GNP deflator inflation. In each table, unexpected stock returns were the S&P 500 less its expectations taken from the Livingston data. Unexpected long bond returns were provided by the component of return due solely to changes in yield to maturity. Unexpected real estate returns were provided by the residuals from an autoregressive return equation. Implicit in the constructed inflation, bond and real estate series (i.e., those not derived from expectations data) is the assumption that market expectations are formed in a fairly simple way, tending to behave as extrapolations of the past. In addition, examination of betas calculated in this way assumes either that ex ante and ex post covariances are quite similar, or that, like the implicit assumptions above, the market forms ex ante beta beliefs by extrapolating history here also.

The tables show negative values in every case for stocks using either definition of unexpected inflation and significantly negative values since 1964. The coefficients are almost always negative for bonds but less frequently significant. However, the trends in either case do not show a decreasing pattern over time pattern, and this is not consistent with the hedge demand thesis. For real estate, the estimates show a rising pattern as expected but not highly significant. Moreover, the 1978–1983 period of rapid inflation appears solely responsible for the increase.

Tables III and IV provide estimates of the vector $S^{-1}C$ over similar time periods. That is, we regress unanticipated changes in inflation on unanticipated changes in stock, bond, and real estate returns. Variables are defined as in Tables I and II. The results are generally consistent with the beta estimates in that the stock and bond coefficients do not generally decline, although they do not rise. The coefficient on real estate rises significantly, but again this is apparently due to the 1978–1983 period.

III. Conclusions

In this paper, we consider two hypotheses for the recent performance of real estate returns. The first is the random event argument that real estate is positively correlated with unanticipated inflation but that a structural change in expected returns due to a change in the perceived sensitivity of returns to unanticipated inflation has not taken place. The second is the hedge demand argument that formulates the structural shift hypothesis. The paucity of real estate and other expectations data as well as the general identification problem make it extremely difficult to distinguish between these hypotheses. Our tests consist of estimates of inflation betas for various asset categories overtime as well as estimates of the hedge vector, $S^{-1}C$. Although some support for the hedge argument is found, the results are not strong enough to reject the random event argument and conclude that a decline in the required return on real estate due to a relative increase in inflation beta drove returns during the 1970's. It must be added though, that considerable changes in measured correlations took place during the late 1970's.

The issues that we have considered have important implications for portfolio diversification. The failure to reject a simple structure and the associated tendency toward long-run stability of movements may imply that simple models such as Fogler [1] may provide sufficient guidance toward strategic portfolio allocations. Moreover, a meaningful role for real estate is not simply a product of recent years experience.

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DISCUSSION

MEIR STATMAN*: Fogler et al. [5] address a puzzle. Returns on real estate in the post-World War II period have been high relative to returns on other assets such as stocks and bonds. Yet the risk of real estate, measured by the variance of its own returns or by the covariance of its returns with those of other assets, has been low.

Fogler et al. discuss two possible solutions for the puzzle. The first is that high unexpected rates of inflation lead to high realized returns on assets which are highly correlated with inflation, such as real estate. The second solution for the puzzle is more intriguing.

Fogler et al. suggest the possibility that the high realized returns on real estate are the result of *changing investor perceptions* about the degree of sensitivity of real estate returns to inflation (i.e., the inflation beta of real estate). If true, it is possible that investors acting on these changed perceptions bid up real estate prices and returns. As noted by Fogler et al., the empirical tests are not strong enough to lead us to favor one explanation over the other. Nevertheless, one finding is that real estate inflation betas during 1978–1983 were relatively high.

While Fogler et al. tests are inconclusive, their hypotheses have considerable merit. The idea that perceptions have something to do with market prices is common among market practitioners, but it is rarely discussed in the academic literature. However, no good grounds exist for excluding the effect of perceptions on prices from financial models.

Why do asset prices change? Do asset prices change only when new information arrives, or is it possible that factors such as cognitive biases, changing perceptions, or changing fashions play a role in determining asset prices? The mere finding that investors cannot "beat the market" does not support the view that prices change only when new information arrives, any more than it supports the view that prices are determined by random movements or changing fashions. Moreover, there is evidence that prices change when no new information arrives.

For example, Roll [9] found that prices of orange juice futures display considerable volatility, yet no information factor (e.g., weather, substitute product prices, export demand) was identified that could explain more than a small part of the daily price movements. Earlier, Shiller [12, 13] found that bond price variability is too great to be explained by rational anticipations of future interest

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