Efficiency of the Market for Residential Real Estate

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I. INTRODUCTION

While an extensive literature exists on the efficiency of securities markets, research addressing the efficiency of the real estate market is limited. The perception is widely held that such markets may not be efficient.[1] In a recent empirical study using some of the same data employed in our analysis, Hamilton and Schwab (1985) conclude that expected appreciation rates in residential real estate markets are systematically biased by the failure of market participants to incorporate past appreciation rates into their expectations. Their analysis, however, is exclusively based on the 1974–1976 period to project appreciation rates for the 1976–1979 period. As we demonstrate below, their analysis, though it implies systematic estimation errors ex post for the time period they study, does not generalize to other periods. Thus, their finding is not a sufficient basis for concluding that the market is not efficient ex ante.

The focus of this paper is on the market for single-family residential real estate, where the potential for inefficient pricing is, arguably, most severe. Despite obvious differences between real estate markets and the securities market, our central thesis is that the real estate market is efficient in the sense that current prices will fully reflect available historical price information.

The notion that profitable trading strategies cannot be developed on the basis of past price information is referred to as the "weak form" of the efficient markets hypothesis. This notion of market efficiency is generally supported by empirical research in the market for financial assets, but has not been tested on real estate data. In the context of the real estate market, the weak form efficient markets hypothesis implies that historical transactions data on housing prices provide no economically exploitable information to current investors. The implication tested in this paper is that it should not be possible to develop trading rules based on past prices that systematically will enable an investor to out-perform the market by investing in selected real properties.

This paper presents results of empirical tests of the efficient markets hypothesis based on housing price data for 57 metropolitan areas. This study improves on previous research by specifically accounting for implicit rental flows.[2] After incorporating rental service flows into the analysis, our evidence suggests that past prices do contain information relevant to predicting future prices. However, once transactions costs are considered, various filter strategies or trading rules cannot be profitably used to outperform an invest-in-the-market strategy for urban housing investments.

II. SOURCES OF INEFFICIENCY IN REAL ESTATE MARKETS

When consideration is given to the accumulated evidence that supports the efficient markets hypothesis, it might be assumed that

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[1]Most existing research on real estate market efficiency is either descriptive, with an emphasis on explaining the Capital Asset Pricing Model (CAPM) or illustrative, using hypothetical real estate data. See Miles and Rice (1978), Gau and Kohlhepp (1978), Roulac (1978). Some authors, including Roulac and Draper and Findlay (1982), have related the efficient markets model to real estate, but without empirical testing.

[2]Previous empirical tests of the weak and semi-strong forms of the efficient markets hypothesis carried out by Gau (1984, 1985) used a time series of asset prices of income-producing properties located in a Canadian real estate market. Gau's results are consistent with those reported here.

the theory logically would apply to the real estate market and that empirical tests of its validity in real estate are unnecessary. However, while the model may be generally accepted, efficiency of the real estate market has not been demonstrated. Unlike the securities market or markets for more liquid real assets and commodities such as precious metals and grains, the real property market is not centralized or standardized. Furthermore, properties trade infrequently, which makes the calculation of holding period returns difficult. These data limitations make the risk and return comparisons between real property assets or between real property and financial assets difficult. The problem is compounded by the unique characteristics of real property and the local orientation of the market, which require specialized knowledge of the factors that affect risk and return. Thus, an investor seeking to discipline the real estate market would face a relatively difficult problem in simply identifying over- or under-valued properties.[3]

An additional source of inefficiency relates to the availability and quality of information. Many investors participate in the real estate market infrequently, and reliance on rule-of-thumb techniques of valuation is common. Strong form tests of market efficiency suggest that superior or "inside" information would allow some investors to earn superior returns. It is, therefore, highly plausible that the real estate market may yield excess returns to those with access to inside information. However, the mere presence of high transactions and information costs is not a sufficient basis for the presumption of inefficiency in any market. Fama (1970) points out that available information can be reflected in prices even in the face of high transactions costs.[4]

The weak form of the efficient markets hypothesis implies rational rather than adaptive expectations on the part of investors. Market inefficiency means that prices only gradually "adapt" to underlying changes in supply and demand. The adaptive expectations view of the real estate market has been widely postulated to have one of two effects. The market either underreacts so that prices move to the new "correct" level too slowly, or it overshoots, resulting in an "affordability" problem such that a subsequent reversal is needed in order to reach the "correct" price level.

The first effect, based on adaptive expectations, appears to stem from a belief that investors will tend to extrapolate on the basis of recent experience. Thus, rapid price appreciation this year would give rise to an expectation of rapid appreciation next year. Hence, relative returns across markets should be positively correlated over time. The second effect reflects a commonly held view that rapid price appreciation results in real estate being overpriced relative to the incomes of purchasers. Thus, an investor might conclude that excess returns could be made by taking advantage of the resulting cyclical nature of real estate prices.[5]

The recent past provides an appropriate period for testing the efficiency of the real estate market. The thesis of this paper, which is consistent with market efficiency, is that the high rates of appreciation in real estate values and high rates of return that investors may have earned, for example, in the 1970s, were the result of largely unanticipated changes in the market. This is in contrast to the two adaptive expectations effects discussed above, which imply that investors could have capitalized on market imperfections to earn abnormal rates of return during such a period.[6]

The view that high rates of return are the result of unanticipated changes in the market has been articulated by Markusen (1979) and by Adams, Milgram, Green, and Mansfield

[3]See Roulac (1978) and Draper and Findlay (1982) for discussion of these problems.

[4]Experimental evidence on the functioning of markets with little knowledge available to market participants supports this contention. See Smith (1982).

[5]Significant autocorrelation of actual returns is not inconsistent with market efficiency. *Ex post* actual returns may exhibit significant correlation over some time interval even though expected returns would not. This is a problem for studies of real estate market efficiency. The infrequency of trading provides insufficient data to justify testing efficiency by simply correlating returns over time. Further, correlation of raw returns over long time intervals would be expected even in an efficient market due to such factors as changes in inflation rates and changes in tax rates.

[6]The view that inflation during the 1970s reduced the user-cost of owner-occupied housing, thus increasing demand and causing housing prices to rise, is not inconsistent with market efficiency. As long as such changes were not anticipated, the result could be a series of serially correlated returns ex post, even though the market response to new information was efficient.

(1968).[7] In another article, Davies (1977) describes the results of a semi-strong form study of market efficiency. He examines a structural shift in the pattern of land prices in a Canadian city after 1969 and relates the shift to a more restrictive land use policy first discussed at that time but not adopted until several years later.

III. TESTS OF REAL ESTATE MARKET EFFICIENCY

Any test of market efficiency involves the comparison of actual rates of return with rates that would be expected in an efficient market. To conduct such a test requires specifying (at least implicitly) an assumption about the expected return. Several different assumptions have been widely adopted, such as that the expected return is constant over time, that the expected return is non-negative, or that the expected return on one asset or portfolio equals the average for the market. Given that an assumption such as this is necessary, tests of market efficiency are unavoidably joint tests of the expectation assumption as well. Rejecting the null hypothesis implies either that the market is inefficient or that the assumption about expected returns is incorrect.

The nature of real estate market data precludes tests based on the relatively simple assumption that expected returns are constant. In contrast to securities market studies where returns may be measured daily, the returns in real estate markets must be computed over long intervals such as a year. The assumption underlying the hypothesis that expected returns are constant is that factors such as inflation rates and tax rates are unchanging. Such an assumption is clearly not appropriate for tests applied to data spanning several years. To address this problem, it is necessary to focus the analysis of market efficiency on relative returns. Factors such as inflation rate changes would affect all returns similarly and thus are controlled for by comparisons of relative returns.

Two different approaches have previously been employed to examine the weak-form-efficiency of securities markets based on relative returns across securities. The first is to examine directly the cross-sectional correlation of relative returns or abnormal returns over time and the second is to implement a trading rule based on previous relative returns. Both approaches are employed below.

A. Correlation of Returns

In this section we employ the hypothesis that expected returns conform to a market model and test whether abnormal returns (after adjusting for market effects) in one period can be used to predict abnormal returns in subsequent periods, implying adaptive expectations and market inefficiency. The approach follows the basic methodology developed by Fama (1965) of attempting to systematically predict abnormal returns over time on the basis of prior returns. Our analysis of real estate market efficiency is made more difficult by the fact that individual properties trade infrequently so that returns for uniform holding periods cannot be observed directly.

To address the problem of unequal holding periods we adopt a portfolio approach using FHA Section 203(b) data on residential property values of existing houses. These data are available annually for 1967 through 1982 and are complete for 57 metropolitan areas. Property values are reported as price per square foot of interior housing space and are based on the average of actual transaction prices for existing houses where FHA financing was used.[8] The change in market value for a metropolitan area from one year to the next is correctly interpreted as the capital appreciation component of a one-year holding period return for a representative FHA-financed house. Since holding period returns are com-

[7] They note that large speculative gains may come about when there are unanticipated changes in expected rent, date of development, or holding costs. Consequently, relating observed rises in the price of land over time to changes in conditions such as the growth in demand for land is difficult. To the extent that such growth is anticipated, it will be built into property values and will not affect the movement of price over time.

[8] The 203(b) data on price per square foot are available separately for both new and existing houses. Analysis based on new houses is not appropriate since the difference in new house prices over time does not reflect a rate of appreciation for holding an asset. Rather, it is a rate of price change for new products over time.

puted annually, systematic trends in the use of FHA financing would be negligible and, thus, are not expected to materially affect estimated rates of appreciation.[9]

A more complex issue concerns the fact that the return from an investment in residential real estate includes an implicit or explicit rental service flow analogous to the dividend payment on a share of stock.[10] Observable holding period returns reflect only the appreciation component of the total return. Two different approaches are used to deal with the unobservability of rental service flows. The problem is first addressed statistically using observed appreciation rates in a market model. Subsequently, we incorporate a rental return proxy variable into the analysis on a subset of the original data.

In the first approach we estimate the relationship between the appreciation component of the holding period return in each metropolitan market, and the average appreciation rate across all 57 markets by OLS regression. The model which describes our hypothesis about market efficiency is as follows:

$$G_{it} = \alpha_i + \beta_i G_{Mt} + \varepsilon_{it} , \qquad [1]$$

where G_{it} is the observed appreciation rate in market i for holding period t, G_{Mt} is the contemporaneous average appreciation rate over all markets, α_i and β_i are statistically estimated parameters, and ε_{it} is a residual error term. This model is estimated separately for each metropolitan market and residuals are interpreted as unanticipated holding period returns.[11] Our efficiency hypothesis implies that $E(\varepsilon_{it}) = 0$ for all t. Thus, market inefficiency implies that unanticipated returns from one period can be used to predict subsequent returns. The efficiency hypothesis is tested by correlating residuals across years.

Since only the capital appreciation component of the return is being used to estimate β_i, an errors-in-variables problem may result. This is because the rental flow, as a component of the total return, may be correlated with the estimate of the unanticipated return. Given that expected rental flows and expected appreciation rates would tend to be negatively correlated and that rental rates may change over time only gradually, serial correlation of residual error terms could result and lead to rejecting incorrectly the efficient markets hypothesis. The problem does not arise if rental rates fluctuate at random over time or the number of separate assets comprising the market portfolio is large enough so that errors in the market return wash out.[12] Given that market appreciation is calculated as the average appreciation of portfolios in 57 separate metropolitan areas, the latter assumption appears reasonable. Since we cannot say with certainty that an errors-in-variables problem does not arise, this test of market efficiency is one directional. The finding of no predictable abnormal return implies efficiency. But a finding of significant autocorrelation, by itself, is not sufficient to reject the efficient markets hypothesis.

Results and descriptive statistics of estimating equation [1] are presented in Appendix A for each separate metropolitan market. Abnormal returns are estimated as the residuals from those regression results. Table 1 presents cross-sectional correlation coefficients of various lag intervals based on statistically esti-

[9] Other potential problems arising from use of the Section 203(b) data for this analysis are that the data is for owner-occupied housing, and that price per square foot may not be a good proxy for housing value. None of these problems would significantly affect the analysis. The problem with using data on owner-occupied housing is that the buying and selling activities of owner-occupants across metropolitan areas are unlikely to discipline relative prices very much. Returns are more likely to be equated by the trading activities of landlords who cannot take advantage of FHA financing. However, as long as owner- and renter-occupied housing are good substitutes for a significant fraction of the market, the FHA price data would be a reasonable proxy for the value of rental housing. The fact that price per square foot may not proxy well for housing value is also not a problem since we are concerned with price changes over time and not with price levels. As long as the housing mix does not change systematically over time for different markets, our findings will not be affected by use of price per square foot as a proxy for value.

[10] Real property investments also generate cash flow tax shelter effects but these can reasonably be ignored in the analysis since the tax advantages are essentially uniform across metropolitan markets.

[11] This interpretation is reasonable since, for holding periods of one year, rental service flows are essentially fully anticipated.

[12] See Frish (1934) for the original discussion of the effects of errors-in-variables on parameter estimates or Johnston (1984) for a summary.

TABLE 1
CROSS-SECTIONAL CORRELATION OF LAGGED ABNORMAL HOLDING PERIOD RETURNS DETERMINED BY REGRESSING APPRECIATION RATES ON AVERAGE APPRECIATION RATES ACROSS MARKETS

Ending Year	Lag Interval (Number of Years Preceding) 1	2	3	4	5	6	7	8	9	10
1982	−.47*	.09	−.24	−.43*	−.16	.05	−.00	−.06	.22	.12
1981	−.14	.48*	.56*	.18	−.12	.15	−.15	−.32*	−.52*	−.36*
1980	−.69*	−.54*	−.33*	−.29*	−.23	−.31*	.29*	.31*	.26*	.18
1979	.33*	.29*	.19	.07	−.11	−.33*	−.27*	−.29*	−.25	−.20
1978	.24	.08	.31*	−.01	−.01	−.23	−.46	−.32	−.20	−.45*
1977	.30*	.46*	−.32*	−.35*	−.30*	.12	−.40*	−.14	−.18	
1976	.12	−.07	−.43*	−.03	.16	−.18	−.20	−.11		
1975	−.41*	−.21	−.48*	−.07	−.29*	−.10	−.10			
1974	.08	.07	.06	.09	−.01	−.28*				
1973	.09	.04	.08	−.04	.31*					
1972	.29*	.05	.14	.27						
1971	−.13	−.10	−.13							
1970	−.10	−.13								
1969	.20									

Summary Information

	1	2	3	4	5	6	7	8	9	10	*Total*
Mean Coefficient	−.02	−.04	−.05	−.06	−.08	−.12*	−.16*	−.13*	−.11	−.14*	
Number Positive	8	8	6	4	1	2	1	1	2	2	35
Number Negative	6	5	6	7	9	7	7	6	4	3	60

*Significant at the .05 level.

mated abnormal returns. The table includes data for all available years and for lag intervals ranging from one to ten years. Summary information at the bottom of the table provides a means of testing market efficiency with respect to residential property values. Overall, 95 correlation coefficients were computed, 35 of which are positive. Furthermore, 35 coefficients are significantly different from zero at the .05 level, including 23 negative and significant relationships.[13] Aggregate results may be misleading since observed correlation coefficients are not independent over time. Any year when a subset of the markets experienced large positive or negative abnormal returns will tend to be significantly correlated with all other years. The best example of this is 1980, where abnormal returns are significantly correlated to returns in 8 of the 10 preceding years.

Since historical accident can produce apparently systematic results, it is most useful to focus the analysis on results for specific lag intervals. For example, no systematic relationship is apparent for lag intervals of from one to three years. Twenty-two of the thirty-nine coefficients are positive. For lags of more than three years, the number of negative coefficients dominates. Furthermore, a t-test of the hypothesis that the mean coefficient is different from zero is statistically significant for lag intervals of 6, 7, 8, and 10 years. Results suggest that a negative abnormal return in one year may be used to predict positive abnormal returns four to ten years hence, but is not useful for predicting returns one to three years hence. The result is puzzling since there is no apparent reason why price adjustments would be delayed so long.

[13]The number of significant coefficients is partly a function of differences in the variance of residuals across markets.

The advantage of the regression approach is that results are applicable over a broad range of assumptions about implicit rental flows and overall returns. Since rental flows for a one-year interval are known with virtual certainty, abnormal holding period returns are fully reflected in unanticipated appreciation. Further, the model permits expected returns to vary across markets, as they might for reasons such as risk differences or differences in the proportion of capital appreciation versus implicit rental flow.

To provide additional evidence on the question of market efficiency, an alternative specification of the relationship is examined which incorporates a rental return proxy variable derived from *Census of Housing* data on median rent and property values and Bureau of Labor data on rental inflation rates by city. Initially, a 1980 base-year rental yield is estimated from the 1980 *Census of Housing* data by dividing median annual rent by median housing value in each city. Rent yields for other years are estimated by adjusting the dollar rent figure according to the rental component of the consumer price index for each city and adjusting the property value by a cumulative appreciation factor derived from the FHA 203(b) data. Sufficient data to construct the rent yield proxy variable were available for 27 of the 57 metropolitan areas.

To test the efficiency of the residential real estate market on these data, the following model is estimated for each metropolitan area:

$$G_{it} = a_i + b_i G_{Mt} + c_i\,(Y_{it} - Y_{Mt}) + e_{it} \qquad [2]$$

where Y_{it} is the rent yield in area i at time t and Y_{Mt} is the average time t rent yield across all metropolitan areas.

OLS regression results are reported in Appendix B. The coefficient (c_i) on the yield differential is generally negative and frequently significant indicating that, as expected, high rent yields give rise to relatively low rates of capital appreciation. Our efficiency hypothesis in this case implies that $E(e_{it}) = 0$ for all t. As before, the hypothesis is tested by correlating residuals across years.

Results of the analysis are reported in Table 2. Results are similar to those reported in Table 1. No significant relationship is apparent for lags of up to three years. Beyond three years the relationship is negative and significant for lags of 4, 6, 7, and 8 years. Overall, it appears that inclusion of the rent yield differential provides little additional information relative to our conclusions based on Table 1.

Based on all the above results, we find no systematic relationship between abnormal returns in one year, and abnormal returns in subsequent years for intervals up to three years. The consistency of results between the two models over all intervals indicates that our initial hypothesis of market efficiency must be qualified for lag intervals greater than three years. However, regardless of the approach used, the typical correlation is not sufficient to overcome the transactions cost of implementing a trading strategy. The maximum average negative correlation from Table 2 of .23 is reached at a lag interval of seven years. Even using this number, assuming equal variance across markets and normally distributed returns, a one-year decline in value of 20 percent would imply only a 4.6 percent relative increase seven years later. Given reasonable assumptions for the transactions cost of locating, buying and selling single-family residential real estate, profitable arbitrage is infeasible. Furthermore, given the lack of any logical explanation for the seven-year lag interval, it is likely that the negative relationship is due to historical accident and would not be replicated systematically on data for other time periods when such data becomes available.

Results from both tables indicate the reason the previously mentioned conclusion of Hamilton and Schwab cannot be generalized to other years. Both tables indicate generally positive correlation coefficients for the years 1977 through 1979 and generally negative coefficients between each of these years and the 1974 to 1976 period. Such a pattern does not occur for other time periods. Thus, their finding for that period would not be expected to occur in other years.

B. Trading Rule Strategies

In this section we provide a further test of whether a profitable trading strategy can be developed based on the data as reported for

TABLE 2
CROSS-SECTIONAL CORRELATION OF LAGGED ABNORMAL HOLDING PERIOD RETURNS DETERMINED BY REGRESSING APPRECIATION RATES ON AVERAGE APPRECIATION AND RENT YIELD DIFFERENTIALS ACROSS MARKETS

Ending Year	Lag Interval (Number of Years Preceding)									
	1	2	3	4	5	6	7	8	9	10
1982	.36	−.24	.32	.26	.72	−.45*	−.11	−.33	−.14	−.32
1981	−.47*	.19	.02	−.37	−.39*	.03	−.19	.18	−.28	−.13
1980	.17	.02	.19	−.14	−.17	−.11	−.31	.00	−.30	.12
1979	.48*	.25	−.32	−.17	−.06	.01	−.70*	−.59*	.71*	−.38
1978	.37	−.02	−.52*	−.05	−.27	−.64*	−.35	.42	−.53*	.18
1977	.11	−.17	−.10	−.34	−.24	−.41*	.20	−.55*	.18	
1976	−.04	.50*	−.24	.14	.18	−.54*	−.06	−.20		
1975	.27	.47*	.19	.00	−.34	−.13	−.01			
1974	−.06	−.13	.00	−.34	−.36	.19				
1973	.06	.31	−.22	.17	−.32					
1972	.38	−.58*	.57*	−.37						
1971	−.71*	.56	−.13							
1970	−.18	.08								
1969	.56*									

Summary Information

	1	2	3	4	5	6	7	8	9	10	*Total*
Mean Coefficient	.01	.10	−.02	−.11*	−.13	−.23*	−.19*	−.15*	−.06	−.11	
Number Positive	8	8	5	4	2	3	1	3	2	2	38
Number Negative	6	5	7	7	8	6	7	4	4	3	57

*Significant at the .05 level.

lag intervals of one to three years.[14] Previous results indicate that a low rate of appreciation in real estate values in one year implies a high rate of appreciation in subsequent years.[15] If those results are economically meaningful, an investor must be able to outperform the market by acquiring a portfolio of real estate each period consisting of those assets which had the lowest rates of appreciation in a previous period. Cornell and Roll (1981) have demonstrated that markets may be efficient even when implementation of a trading strategy would result in higher gross returns. If a market is efficient, then the net return from trading would equal the net return of a buy and hold strategy.

Calculated annual rates of appreciation for the 57 metropolitan areas over the 1967 to 1982 period were used to test for the existence of an economically exploitable market imperfection. For each year, metropolitan areas were ordered by magnitude of the appreciation rate, and ten portfolios of approximately equal size were formed based on the decile groupings of these rates. A trading rule strategy of buying the *n*th decile portfolio, holding for one year, and then rebalancing based on the new decile groupings was implemented over the entire time span. Compound annual holding period appreciation returns were then computed for each decile ranked portfolio. The affordability hypothesis implies that appreciation rates would be negatively correlated with decile rank, where a rank of one

[14]The test results in this section differ from those presented above since the trading rule is implemented on the data directly. Thus the assumption that abnormal returns are normally distributed is relaxed.

[15]This is true even for short intervals based on the average correlation coefficients as reported in Tables 1 through 3.

TABLE 3
ANNUAL RATES OF APPRECIATION FOR PROPERTY VALUES FOR VARIOUS HOLDING PERIODS BY DECILE APPRECIATION RATE IN PRIOR YEAR

Portfolio Decile	Annual Appreciation Rate by Holding Period 1 Year	2 Year	3 Year	T Test 1 Year	2 Year	3 Year
Lowest	11.3%	11.0%	10.0%	1.66	1.93	(0.28)
2	9.0	9.0	9.4	0.04	0.06	(1.11)
3	8.5	9.1	10.6	(0.32)	0.13	0.55
4	8.0	8.8	11.0	(0.70)	(0.11)	1.04
5	8.6	8.8	10.0	(0.28)	(0.16)	0.31
6	10.4	9.7	11.5	1.00	0.66	1.68
7	10.7	9.6	10.8	1.27	0.57	0.79
8	8.1	8.1	9.9	(0.60)	(0.83)	(0.42)
9	8.2	8.6	9.1	(0.57)	(0.34)	(1.56)
Highest	6.9	6.9	10.0	(1.51)	(1.91)	(0.37)
Mean	9.0	9.0	10.2			

*Significant at .05 level.

reflects the low return decile from the prior year.[16] In addition, annualized appreciation rates were computed based on two- and three-year holding period strategies to determine if some interval longer than one year would be more profitable. In these tests a one-year ranking of the prior year's returns was used to determine the portfolio groupings and all possible two- and three-year intervals were examined.

Appreciation rates computed for property values are presented in Table 3. Despite the fact that Tables 1 and 2 gave little indication of an exploitable market imperfection, these results indicate (based on the efficiency hypothesis as stated in equation [2]) an abnormal appreciation rate for the low decile, one-year portfolio of about 2.3 percent per year. Similar results were obtained for holding periods of 2 years and no discernible relationship was observed for holding periods of 3 years. Table 3 also reports *t*-statistics for the hypothesis that the decile ranked appreciation rates are different from the mean rate. None of the portfolio abnormal appreciation rates was significantly different from zero at the .05 level. However, this is not the most powerful available test of significance.

Since the portfolios are rank ordered, it is possible to test whether abnormal appreciation rates are related to decile grouping by regression. To determine whether a profitable trading rule could be implemented based on the property value results from Table 3, separate regression equations were estimated relating annual appreciation to decile groupings for the one-, two- and three-year holding period portfolios. The annual appreciation on each portfolio was regressed against its decile ranking. One hundred and forty portfolios (1969 through 1982) were used in the one-year regression, 70 in the two-year regression and 40 were used in the three-year regression. The results are reported in Table 4.

TABLE 4
REGRESSION ANALYSIS OF ANNUAL APPRECIATION RATES ON DECILE PORTFOLIO RANKING OF PRIOR YEARS RETURNS

Holding Period: 1 Year	R^2
$ROR_1 = 10.2 - 0.23\,Decile$	
(-1.61)	.245
Holding Period: 2 Years	R^2
$ROR_2 = 10.3 - 0.25\,Decile$	
(-2.94)	.520
Holding Period: 3 Years	R^2
$ROR_3 = 10.4 - 0.03\,Decile$	
(-0.39)	.019

*Significant at the .05 level.

[16]This trading rule test is similar to one developed and successfully used by Reinganum (1981) for analysis of firm-size related anomalies in stock returns.

Appreciation rates for portfolios with a two-year holding period were significantly related to decile rankings (equation [2]). The coefficient of 0.25 in equation [2] implies an expected difference in annual appreciation between the lowest and highest decile portfolio of 2.5 percent. The magnitude for a one-year holding period is similar but the relationship is not significant.

These results suggest that the real estate market is inefficient. An investor who bought a portfolio of real estate that had low appreciation the previous year presumably could outperform a buy-the-market strategy. However, this finding is based on rates of appreciation ignoring transactions costs. Based on the regression analysis, it is clear that transactions costs would change the interpretation of these results. The most significant result from the regression analysis pertains to a two-year holding period. Annual appreciation rates ranged from 11.0 percent to 6.9 percent compared to a buy-the-market annual rate of 9.0 percent. It is unlikely that an investor could develop a strategy to acquire real estate in the lowest decile and benefit from this two percent or smaller gross appreciation rate difference. This probably would be the case even if real estate commissions could be negotiated to low levels because other financial and non-financial costs associated with real estate transactions would still remain. Therefore, apparent market inefficiencies do not provide sufficient opportunity to develop a profitable trading strategy when transactions costs are considered.

V. SUMMARY AND CONCLUSIONS

FHA data on property values for 57 metropolitan areas are used to perform a weak form test of the efficiency of the real estate market. A correlation analysis is conducted comparing the rate of appreciation in property values in one year with the rate of appreciation in subsequent years. The evidence indicates essentially no relationship of returns for lags of one to three years, and a weak negative relationship for lags of four to ten years. Expected abnormal returns are not sufficient to offset the transactions cost of a trading strategy based on the observed relationship.

The possibility of market inefficiency was used to develop trading strategies for lag intervals of one to three years. Results of these strategies are compared to a buy-the-market strategy. The expectation that a high rate of appreciation would lead to a continued high rate of appreciation was tested by acquiring a portfolio of real estate whose rate of appreciation was in the highest decile the previous period. These portfolios did not perform as well as a buy-the-market strategy. A second trading strategy was developed following the affordability approach. A portfolio of real estate whose return was in the lowest decile in one period produced an average rate of return which exceeded the buy-the-market strategy.

While this result is evidence of market inefficiency, the analysis was conducted ignoring transactions costs. The maximum expected appreciation following an affordability trading strategy was less than two percent above the market rate of appreciation. Consideration of the financial and non-financial transactions costs associated with real estate indicates that a trading strategy based on these results would not be profitable. Thus, our evidence suggests that the real estate market is efficient in the weak form sense once transactions costs are considered.

Since the analysis presented here has focused on differences across metropolitan markets for similar properties, there still remain unanswered questions regarding such issues as whether the opportunity to implement profitable trading strategies may exist across different types of property or across different locations within a metropolitan market. There may also be more complex trading strategies which could yield positive abnormal returns across metropolitan markets. Further research is necessary to resolve these issues.

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APPENDIX A

Regression of Appreciation Rates in Metropolitan Markets on the Average Rate for all Markets

	Mean Appreciation	Intercept Coefficient	Intercept t-value	Slope Coefficient	Slope t-value	R^2	Relative Standard Deviation $\sigma_i/\bar{\sigma}$
1. Detroit, MI	.083	−.126	(2.2)	2.435	(4.5)	.61	1.96
2. Toledo, OH	.075	−.092	(2.2)	1.942	(5.0)	.66	1.45
3. Indianapolis, IN	.081	−.075	(3.0)	1.816	(8.0)	.83	1.08
4. Milwaukee, WI	.093	−.061	(1.5)	1.799	(5.0)	.65	1.36
5. Baton Rouge, LA	.076	−.076	(3.7)	1.761	(9.5)	.87	1.00
6. Kansas City, MO	.070	−.071	(2.7)	1.642	(7.0)	.79	1.02
7. Rockford, IL	.076	−.058	(2.6)	1.566	(7.7)	.82	.94
8. Cleveland, OH	.071	−.063	(2.4)	1.560	(6.5)	.77	1.00
9. Newark, NJ	.077	−.053	(1.3)	1.520	(3.9)	.54	1.39
10. Birmingham, AL	.088	−.042	(1.2)	1.516	(4.9)	.65	1.15
11. New York, NY	.091	−.035	(0.8)	1.466	(3.5)	.48	1.50
12. Omaha, NB	.095	−.031	(0.9)	1.458	(4.9)	.65	1.10
13. St. Louis, MO	.079	−.039	(1.5)	1.376	(5.8)	.72	.94
14. San Antonio, TX	.089	−.029	(1.0)	1.367	(5.0)	.66	1.02
15. Des Moines, IA	.085	−.028	(1.3)	1.325	(6.8)	.78	.84
16. Pittsburgh, PA	.078	−.033	(2.0)	1.298	(8.5)	.85	.75
17. Gary, IN	.066	−.043	(2.2)	1.272	(7.2)	.80	.78
18. Dallas, TX	.091	−.016	(0.7)	1.245	(5.8)	.72	.85
19. Greenville, SC	.081	−.025	(1.0)	1.240	(5.5)	.70	.87
20. Paterson, NJ	.062	−.037	(0.9)	1.151	(3.0)	.41	1.38
21. Syracuse, NY	.065	−.033	(1.4)	1.140	(5.5)	.70	.80
22. Rochester, NY	.067	−.028	(1.1)	1.113	(4.7)	.63	.87
23. Oklahoma City, OK	.087	−.008	(0.4)	1.102	(6.1)	.74	.73
24. Philadelphia, PA	.073	−.020	(0.7)	1.082	(3.9)	.53	1.00
25. Baltimore, MD	.102	.013	(0.3)	1.036	(2.5)	.32	1.59
26. Seattle, WA	.106	.017	(0.8)	1.034	(5.0)	.65	.78
27. Cincinnati, OH	.079	−.009	(0.4)	1.024	(5.3)	.68	.74
28. Nashville, TN	.084	−.003	(0.2)	1.022	(6.7)	.77	.65
29. Davenport, IA	.084	.000	(0.0)	.980	(2.9)	.39	1.24
30. New Orleans, LA	.067	−.015	(0.9)	.958	(6.0)	.73	.65
31. Jacksonville, FL	.074	−.008	(0.2)	.953	(2.6)	.35	1.34
32. Columbia, SC	.077	−.002	(0.1)	.922	(6.5)	.77	.59
33. Columbus, OH	.077	−.001	(0.1)	.905	(7.3)	.80	.56
34. Wichita, KS	.085	.009	(0.4)	.886	(4.1)	.57	.76
35. Tulsa, OK	.092	.017	(0.8)	.879	(4.6)	.62	.70
36. Orlando, FL	.088	.018	(0.7)	.823	(3.6)	.50	.81
37. San Diego, CA	.109	.039	(2.7)	.816	(6.2)	.75	.54
38. Sacramento, CA	.096	.027	(1.9)	.804	(6.0)	.74	.53
39. Atlanta, GA	.079	.010	(0.5)	.801	(4.4)	.60	.66
40. Fresno, CA	.099	.033	(1.4)	.770	(3.5)	.49	.77
41. Memphis, TN	.088	.024	(1.1)	.748	(3.7)	.52	.71
42. Salt Lake City, UT	.096	.033	(1.4)	.740	(3.5)	.48	.76
43. Portland, OR	.093	.033	(1.1)	.700	(2.6)	.35	.98
44. Phoenix, AZ	.100	.042	(1.8)	.685	(3.2)	.44	.77
45. Houston, TX	.098	.041	(2.2)	.674	(3.9)	.54	.61
46. San Francisco, CA	.101	.044	(1.5)	.656	(2.4)	.30	1.08
47. Albuquerque, NM	.095	.041	(2.6)	.629	(4.5)	.60	.52
48. Anaheim-Santa Ana, CA	.107	.054	(2.0)	.627	(2.5)	.33	.93
49. Austin, TX	.097	.044	(1.9)	.608	(2.8)	.38	.79
50. Denver, CO	.129	.080	(1.8)	.577	(1.4)	.13	2.18
51. San Jose, CA	.112	.063	(1.5)	.573	(1.5)	.15	1.88
52. Miami, FL	.091	.047	(1.6)	.508	(1.9)	.21	1.19
53. Tampa, FL	.085	.042	(2.3)	.504	(3.0)	.41	.60
54. Las Vegas, NV	.086	.043	(2.2)	.492	(2.8)	.37	.65
55. Bakersfield, CA	.103	.064	(1.9)	.452	(1.5)	.14	1.59
56. Washington, D.C.	.105	.081	(3.2)	.275	(1.2)	.10	1.35
57. Tacoma, WA	.102	.141	(3.9)	−.451	(1.4)	.13	1.71

APPENDIX B

Regression of Appreciation Rates in Metropolitan Markets on the Average Rate and the Difference from Average Rental Rate for all Markets

	Intercept		Appreciation Rate		Rent Differential		
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	R^2
1. Detroit, MI	−.118	(1.8)	2.282	(4.3)	.38	(0.1)	.70
2. Toledo, OH	−.050	(1.0)	1.588	(4.4)	−3.93	(0.9)	.73
4. Milwaukee, WI	−.078	(1.8)	1.556	(5.0)	−4.64	(1.7)	.70
6. Kansas City, MO	−.137	(3.0)	1.467	(8.1)	−4.50	(2.1)	.85
8. Cleveland, OH	−.035	(1.6)	1.252	(6.5)	−6.62	(2.3)	.82
9. Newark, NJ	−.051	(0.5)	1.389	(4.1)	.34	(0.1)	.59
11. New York, NY	−.011	(0.1)	1.374	(3.9)	−.95	(0.2)	.58
13. St. Louis, MO	−.053	(0.7)	1.158	(4.9)	−1.46	(0.5)	.67
16. Pittsburgh, PA	−.119	(3.5)	1.081	(10.2)	−9.84	(3.1)	.91
17. Gary, IN	−.061	(2.6)	1.063	(7.6)	−4.11	(1.7)	.85
18. Dallas, TX	−.065	(2.3)	.901	(5.4)	−8.14	(2.8)	.82
20. Paterson, NJ	−.090	(1.1)	1.159	(3.5)	2.21	(0.8)	.50
21. Syracuse, NY	−.094	(1.8)	.912	(5.2)	−4.80	(1.5)	.78
22. Rochester, NY	−.108	(2.4)	.881	(4.8)	−6.21	(2.2)	.74
24. Philadephia, PA	−.126	(1.8)	1.067	(4.8)	−5.27	(1.8)	.66
25. Baltimore, MD	−.033	(0.5)	1.052	(2.7)	−2.40	(1.2)	.38
26. Seattle, WA	.130	(3.9)	.768	(5.3)	−9.05	(3.4)	.80
27. Cincinnati, OH	.011	(0.5)	.975	(5.5)	−5.10	(1.1)	.73
37. San Diego, CA	.287	(2.5)	.813	(6.5)	−14.18	(2.1)	.78
39. Atlanta, GA	−.012	(0.7)	.756	(6.1)	−8.18	(2.9)	.78
43. Portland, OR	.005	(0.2)	.673	(3.1)	−8.17	(2.2)	.50
45. Houston, TX	.039	(0.8)	.575	(3.2)	− .50	(0.2)	.50
46. San Francisco, CA	.299	(2.9)	.586	(2.8)	−11.19	(2.5)	.52
48. Anaheim, Santa Ana, CA	.279	(3.4)	.629	(3.4)	−13.10	(2.7)	.57
50. Denver, CO	.065	(1.4)	.636	(1.7)	−1.98	(1.1)	.20
51. San Jose, CA	.326	(2.7)	.568	(2.0)	−13.68	(2.2)	.39
56. Washington, D.C.	.120	(2.3)	.274	(1.2)	−2.82	(0.7)	.12