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Price Reversal, Transaction Costs, and Arbitrage Profits in the Real Estate Securities Market

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Abstract

This paper studies the return reversals of exchange traded real estate securities using an arbitrage portfolio approach. Using the approach, we find that there exist significant return reversals in such securities. These return reversals could be exploited by arbitrage traders if trading costs can be ignored. However, the arbitrage profits disappear after deducting trading costs and taking into account the implicit cost of bid-ask spread. Thus, the real estate securities market is efficient at weekly intervals in the sense that one could not exploit the price reversals via some simple trading rules.

Key Words: real estate, arbitrage, transaction cost, trading profits

Recent research in real estate finds that returns for exchange traded real estate securities are predictable at monthly and quarterly intervals (see Liu and Mei, 1992, 1994; and Mei and Lee, 1994). There are two explanations for this return predictability. First, the predictability is attributed to systematic time-variation of risk premiums due to changes in market conditions and investors' perception of risk. Second, it is the result of some form of market inefficiency due to market overreaction or imperfection in market microstructure. This paper extends their work by documenting return reversals for real estate securities at a higher frequency level (weekly).

Return reversals at weekly intervals are interesting because they provide a simple way of differentiating the two hypotheses above on return predictability. It is easy to imagine that economic conditions and investors' perception of risk should remain relatively unchanged at daily or weekly intervals while much less so at monthly or longer intervals. Thus, any evidence about weekly return reversals points strongly to the direction of market inefficiency rather than time-varying risk premiums.

Weekly return reversals are also interesting because they provide information on the magnitude of imperfections on the market microstructure. Since short-term return reversals often create short-term arbitrage trading profits in the absence of trading costs while they vanish in presence of them, trading profits provide a good measure of market liquidity and transaction costs.

Using the methodology developed by Lehmann (1990), this paper first documents the return reversals in real estate security markets and then constructs arbitrage portfolios (zero investment) to exploit the opportunity. Next, we adjust trading profits according to reasonable assumptions about bid-ask spread and transaction costs. We then discuss some implication of our findings for market efficiency and liquidity.

The paper is organized as follows. Section 2 dicusses the methodology. Section 3 provides some data description. Section 4 gives the empirical results and section 5 concludes.

1. Empirical Methods

The study of real estate market efficiency has always been an important issue in real estate financial research. However, due to the lack of systematically collected transaction data, previous studies have largely ignored the issue. A notable exception is the two market-efficiency test papers by Hoag (1980), in which he studied the issue using constructed real estate price series. Gau (1984) also collected data from Vancouver apartments and commercial property sales to study the time-series behavior of real estate prices. He found little evidence of market inefficiency.

Recently, Gyourko and Keim (1992) studied the relationship between exchange traded real estate securities and the underlying real estate assets and found the returns on the two classes of real estate assets to be highly correlated. Their study opens some new possibilities for real estate market research since price data on exchange traded real estate securities are available daily and monthly, thus making it possible to use more elaborate statistical procedures. Recent examples include Chan, Hendershott, and Sanders (1990), and Liu and Mei (1992, 1994). Unfortunately, most of these studies have concentrated on monthly or quarterly real estate pricing behavior while little attention is given to daily or weekly behavior. It is not difficult to imagine that the daily or weekly real estate market may be inefficient because though there may exist market overreaction, the costs of collecting and processing information so often may be prohibitively high. On the other hand, at monthly or longer intervals the lower cost of collecting and processing information may result in a fairly efficient exchange traded real estate market.

To study the weekly return behaviors of exchange traded real estate assets, this paper employs the arbitrage portfolio approach of Lehmann (1990). This approach complements the time-seris approach of previous studies by explicitly calculating the trading profits associated with the exploitation of the existing market inefficiency. This allows us to make a distinction between statistical inefficiency and economic inefficiency. If return reversal or predictability in real estate market cannot be translated into economically significant abnormal returns, then we have to recognize that the market is still efficient in the sense that there is no free lunch or easy profit in the market. In this paper, we first document return reversals in real estate security prices, and then we construct an arbitrage portfolio to see whether there exist arbitrage trading profits.

The intuition behind Lehmann's costless arbitrage portfolio strategy is the following: Building a costless portfolio in which the capital needed to cover the long position in securities that recently suffered lower-than-average returns (losers) is exactly offset by the short position in securities that lately experienced higher-than-average returns (winners), rolling the portfolio for some particular length of time, and unloading it by the end of the period, investors can reap net positive profit without investing money if the proper time duration that the market needs to realize return reversals can be identified.

Following Lehmann, we consider applying such a return reversal portfolio strategy to exchange traded real estate securities? Suppose there is a portfolio consisting of N stocks and extending in time dimension over T trading periods? The ith stock's return in period $t-k$, where t is the current time period, is denoted to be $R_{i,t-k}$, and the corresponding return of the equally weighted stock portfolio in that period is represented by

$$\bar{R}_{t-k} = \frac{1}{N}\sum_{i=1}^{N} R_{i,t-k}. \tag{1}$$

The return reversal portfolio, at the beginning of time period t, is built from all the N stocks, while the weight of each stock in the portfolio, designated by $w_{i,t-k}$, is in direct proportion to the difference between the return of that particular stock k period ahead, $R_{i,t-k}$, and the return of the equally weighted stock portfolio, $\bar{R}_{t-k}$, in that period, namely

$$w_{i,t-k} = \alpha(R_{i,t-k} - \bar{R}_{t-k}). \tag{2}$$

Thus, the total investment of the portfolio, which is constructed at the beginning of period t based on the return information of period $t-k$, is

$$W_{t-k} = \sum_{i=1}^{N} w_{i,t-k} = \alpha \sum_{i=1}^{N} (R_{i,t-k} - \bar{R}_{t-k}) = 0. \tag{3}$$

where α is a parameter, which we argue should subject to the following two constraints. First, to exploit the opportunity of return reversals, α must be negative, meaning long in past losers and short in past winners, in order to realize profits on the return reversals. Second, it has been shown in equation 3 that the total investment in the portfolio is zero, implying equal amounts of capital being invested in long and short positions. To set up a performance yardstick, the portfolio is to be normalized to a $1 .00 investment in each of the two positions. Under the two constraints, we are able to determine that

$$\alpha = -\left(\sum_{R_{i,t-k}-R_{t-k}>0} (R_{i,t-k} - \bar{R}_{t-k})\right)^{-1}, \tag{4}$$

which shows the investment in the long and the short position to be

$$\sum_{R_{i,t-k}-R_{t-k}>0} |w_{i,t-k}| = \sum_{R_{i,t-k}-R_{t-k}<0} |w_{i,t-k}| = 1. \tag{5}$$

The profit of the portfolio at the end of period t is given by

$$\pi_{t,k} = \sum_{i=1}^{N} w_{i,t-k}R_{i,t} = -\frac{\Sigma_{i=1}^{N}(R_{i,t-k} - \bar{R}_{t-k})R_{i,t}}{\Sigma_{R_{i,t-k}-\bar{R}_{t-k}>0}(R_{i,t-k} - \bar{R}_{t-k})}. \tag{6}$$

Then, the average profit on this strategy over T periods is the arithmetic mean of each period's profit.

$$\bar{\pi}_k = \frac{1}{T} \sum_{t=1}^{N} \pi_{t,k}. \tag{7}$$

And finally the total profit for a time horizon of M period is

$$\pi_{m,k}^{M} = \sum_{t=(m-1)M+1}^{mM} \pi_{t,k}. \tag{8}$$

Obviously, any abnormally high return without accompanying risk is a sign of market inefficiency. In particular, for short periods, which warrants the constant expectation assumption and for some time horizon M, if the strategy never loses money, we have to doubt market efficiency.

2. Data, Estimation and Problems

This paper deals with the abnormal returns in exchange traded real estate securities: we extracted daily returns from all stocks related to the real estate market (from July 2, 1962 to December 3 1, 1990, using the CRSP tape [Center for Research on Security Prices] maintained by the University of Chicago). We concentrated on NYSE and AMEX stocks because the number of real estate related stocks traded over-the-counter is too small to yield statistically meaningful results.

Over the sample period, a total of 195 exchange traded real estate stocks were listed on the NYSE and the AMEX. But there were only 132 stocks trading at the end of the sample period.

The stocks fell into three categories:

1. 61 Equity Real Estate Investment Trust (EREIT)
2. 32 Mortgage Real Estate Investment Trust (MREIT)
3. 39 Real estate property builders and owners

Table 1 gives summary statistics of the samples. The numbers show that with a total capitalization of $42 billion, daily trading of 4 million shares, and daily capital turnovers of $84 million, real estate related security trading has become a sizable market. More interesting is the direct documentation of negative first-order autocorrelations of individual security returns. Although the autocorrelation coefficient of -0.05 (which is an average of those of all stocks) is small, nevertheless, it is significant: a t-value oft = $\bar{\rho}_w/\sigma_{\bar{\rho}_w}$ = 4.59 shows that the individual real estate security return is negatively serially correlated at weekly intervals.

Several choices had to be made before we could start testing market efficiency using the strategy developed in section 2: first, the period, namely, how many trading days are proper

Table 1. Summary sample statistics.

Average of the Last Seven Trading Days for the Year 1990	
Total capitalization (TC)	42,000,000,000
Number of daily trading shares (S)	4,096,861
Daily capital turnover (M_c)	$84,151,000
Number of stocks in trading (N_s)	132
Over the Whole Sample Period	
Mean weekly return ($\bar{R}_w$)	0.0025
Standard deviation of weekly return (σ_w)	0.0270
Mean value of first-order autoregression coefficient ($\bar{\rho}_w$)	-0.0500
Standard deviation of first-order autoregression coefficient ($\sigma_{\bar{\rho}_w}$)	0.0109

for a period; second, the lag length, k, how far lagged a period return should we compute; and finally the time horizon, M, over which portfolio profits are aggregated. The choice of the first two are tricky because, on the one hand, we would like to have as short a period as possible to guarantee the irrelevance of time-varying market expectations in testing the market efficiency; on the other hand, we want the period to be long enough to give the market time to correct mispricings in order to profit from return reversals. French and Roll's (1986) registering of return reversion for stock returns beyond a week interval suggests a week may be sensible period length, and one period lag is appropriate for lag length. As for the time horizons to aggregate the portfolio profits, we pick up four of them, one month, three months, six months, and one year, with one year being our main concentration.

Unlike most of the previous research, we do not use the calendar week as the base period, but instead define five consecutive trading days as a trading week. There are two considerations about this choice: (1) there is no guarantee that a week is the best choice to exploit the price reversal profitability, and the use of a calendar week will make it difficult to fine tune the period length; and (2) as has been pointed out by French and Roll (1986), the stock price volatility over weekends and holidays is much smaller than when the market is open; thus the use of a calendar week actually does not employ a constant period length in calculating the period returns because for those weeks that contain national holidays, there are less than five trading days for the market to correct possible market overreaction.

The individual stock's period return is the compound rate of daily returns over all the trading days inside the trading period. All stocks that have complete return information on period t and period $t-k$ are drawn together to form a return reversal portfolio. We use period $t-k$'s return information to compute the individual security's weight in the portfolio according to equations 2 and 4. Then we can calculate the profit for each period from equation 6.

There are two problems with performing the task this way.

The first problem, computing the portfolio weight on the basis of the previous period's full period return, can create a spurious return reversal effect because of the presence of the bid-ask spread. Take a two-period case as an example: suppose period one is from day 1 to day 5 and period two from day 6 to 10. Starting with the mean of bid-ask prices, a stock's closing price below the bid-ask mean on day 5 may look like a loser in the first period. For the next period, there is a 50% chance that the stock price can land above the bid-ask mean price on the last day of the second period and look like a winner in the period, thus creating an artificial return reversal effect. The problem can be mitigated if we do not use the last day's return information to compute the portfolio weight, i.e., for a trading week of five days, we use the compound rate of return of the first four days of the previous period to compute the portfolio weight. It is argued that if the stock is sufficiently liquid, there should be no correlation between the closing price on day 4 and day 5. Thus the artificial effect is eliminated.3

Another problem concerning the estimation process is the possible existence of a selection effect. A loser from the last period, which we could have bought and held, may be excluded from our portfolio because it is delisted in the next period and gives no return information. The delisting may yield a negative return close to minus one, afflicting big losses had we engaged in a long position in the stock as our strategy suggests. The problem is alleviated somewhat when we only use stock return information from several periods before its delisting. In other words, we do not trade in any stock that has been delisted.

There are situations in which the existence of arbitrage opportunities are significant statistically but not economically because of financial market frictions, namely, transaction costs and the bid-ask spread. So here market friction poses another challenge to the profitability of the strategy, especially in the period of rapid turnover of the stock portfolio. The requirement of quickly rebalancing the return reversal portfolio at the end of every trading week may result in buying at the ask price and selling at the bid price. This unfavorable situation may eat up a large chunk of profit and prevent arbitraging. In this paper we try to incorporate all these trading costs into our trading strategy.

Assuming that the one-way trading cost is c percent, building and unwinding the portfolio at the start and the end of a period would incur $2c$ percent cost. The cost has to be covered by the net profit of the trading. Since all the above equations are linear, the result of deducting trading costs will be to substitute $\pi_{t,k}$ with $\pi_{t,k}^{c} = \pi_{t,k} - 4c$. $4c$ is used instead of $2c$ because the profit is from a \$2 portfolio, \$1 short and \$1 long.

It is worthwhile to mention that such a calculation of the trading cost is the upper bound, since the above consideration closes all the positions in the portfolio at the end of the period and rebuilds it at the start of next period. The corresponding trading cost is

$$
\begin{aligned}
C &= c \sum_{i=1}^{N} \left(|w_{i,t-k}| + |w_{i,t-k-1}|\right) \\
&= c \Bigg(\sum_{R_{i,t-k}-R_{t-k}>0} |w_{i,t-k}| + \sum_{R_{i,t-k}-R_{t-k}<0} |w_{i,t-k}| + \\
&\qquad \sum_{R_{i,t-k-1}-\bar{R}_{t-k-1}>0} |w_{i,t-k-1}| + \sum_{R_{i,t-k-1}-\bar{R}_{t-k-1}<0} |w_{i,t-k-1}| \Bigg) \\
&= 4c. \qquad (9)
\end{aligned}
$$

In practice, this may not be necessary because only margin adjustments to $w_{i,t-k} - w_{i,t-k-1}$ needs to be made, thus the Transaction cost

$$C^m = C \sum_{i=1}^{N} |w_{i,t-k} - w_{i,t-k-1}| \leq c \sum_{i=1}^{N} (|w_{i,t-k}| + |w_{i,t-k-1}|) = 4c. \qquad (10)$$

As Lehmann (1990) argues, the bid-ask spread may not disadvantage our strategy because there is usually a buying drive in winner stocks, which we are happy to sell. We may be able to sell them at the ask price, since we are providing the market needed liquidity. The reverse is true for loser stocks. In general, we may often be able to achieve the market price and reduce the loss due to adverse bid-ask spreads.

3. Empirical Results and the Implications

The results are summarized in Tables 2 through 5. In all of these tables, we report six summary statistics: the mean profit, $\bar{\pi}$, the standard deviation of profits, σ, its r-statistics, f-value, the maximum profit, π_{max}, the minimum profit, π_{min}, and the fraction of periods for which profits are positive. We also report the summary statistics for different return horizons: one week, one month, three months, six months, and one year.

Table 2 shows the profits from the return reversal strategy based on various lengths of trading days. Different numbers of days are used as period lengths to see the relationship between profitability and length of a period. And, hopefully, a time scale of market correction to the return reversal can also be spotted. The most striking feature about the result is that the profit is significantly greater than zero (t-statistics $\gg 2$) for all period lengths and time horizons. But still, there are differences in the degree of profitability. We do not compare the profitability among periods because the periods are different lengths. If a six-month or a one-year period were used as the time horizon for performance evaluation, the five-trading-day period (a trading week) would clearly dominate all the other period lengths with semiannual returns of 30.77 cents and annual returns of 62.2 cents on a costless stock portfolio with $1 each in both short and long position. This result is very close to Lehmann's (1990) result that used all the NYSE and AMEX stocks. He used the calendar week as his return period. The result indicates that it takes approximately one week for the market to realize return reversals, and this result is consistent with French and Roll's variance ratio test result of a strong negative return autocorrelation of individual stocks for time horizon beyond one week.

To check the consistency of the strategy's performance, we break up the sample into three subperiods, roughly corresponding to the 1960s, 1970s, and 1980s. The macroeconomic environment during these three decades was very different, with volatile real estate market in the 1960s, oil shocks and high inflation in the 1970s, and the bull market of the 1980s. Nevertheless, it is easy to see, from Table 3, that the strategy consistently gives all positive returns for semiannual and annual horizons. One interesting feature about the results is that the profits become smaller and smaller from the 1960s to the 1980s, with profit in the 1980s the smallest of the three. The feature may be partly a reflection of active arbitraging in the market during the 1980s.

Table 2. Profits on return reversal portfolio strategies.

Weights Based on First 3-Day-Return of Previous 4-Day Trading Period							
Horizon	$\bar{\pi}$	σ	*t*-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Four days	0.0104	0.0342	12.8799	-0.1721	0.3328	0.6406	1789
One month	0.0616	0.0897	12.9471	-0.1841	0.4613	0.7675	357
One quarter	0.1705	0.1544	11.5853	-0.1335	0.5455	0.8468	111
Half year	0.3073	0.1606	14.0660	-0.0632	0.5577	0.9818	55
One year	0.5913	0.1058	29.0381	0.3981	0.8272	1.0000	28

Weights Based on First 4-Day-Return of Previous S-Day Trading Period							
Horizon	a	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0114	0.0374	11.5121	- 0.3885	0.3088	0.6478	1431
One month	0.0456	0.0896	9.5890	-0.4451	0.3469	0.7535	357
One quarter	0.1340	0.0910	15.9885	-0.0507	0.3746	0.9748	119
Half year	0.3077	0.1625	14.1720	0.0838	0.6086	1.000	57
One year	0.6220	0.0868	37.2250	0.4725	0.8272	1.000	28

Weights Based on First 5-Day-Return of Previous 6-Day Trading Period							
Horizon	$\bar{\pi}$	σ	t-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Six days	0.0150	0.0409	12.6959	-0.1978	0.3617	0.6527	1192
One month	0.0569	0.0957	10.2386	-0.1417	0.3425	0.6946	298
One quarter	0.1201	0.1565	8.3338	-0.2435	0.5228	0.8067	119
Half year	0.2200	0.1651	9.8826	- 0.033 1	0.5279	0.9107	56
One year	0.4348	0.1396	16.1795	0.2197	0.7073	1.0000	28

Weights Based on First 6-Day-Return of Previous 7-Day Trading Period							
Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Seven days	0.0148	0.0404	11.6661	-0.1620	0.2051	0.6650	1021
One month	0.0457	0.0876	9.6122	-0.2030	0.4182	0.6824	340
One quarter	0.1031	0.1196	9.1290	-0.2437	0.3220	0.8053	113
Half year	0.2508	0.1202	15.4741	-0.0501	0.4927	0.9643	56
One year	0.4922	0.1532	16.6973	0.1707	0.7248	1 .0000	28

Time horizons of one month, one quarter, one half-year, and one year are defined in a trading sense, that is, 252 trading days per year, 63 trading days per quarter, and 2 1 trading days per month. Since the whole sample period of 7168 trading days may not be an integer multiple of some horizons, the calculation of the average profit in that horizon may not use the full return information of the whole sample period. That is why the 4-day trading period has a higher one-month profit and one-quarter profit but smaller half-year profit and one-year profit than the 5-day trading period. A similar situation also occurs in Tables 3 through 5.

Holding the length of a period unchanged, e.g., a trading week in this test, Table 4 presents the strategy's profits as a function of lagged k period whose return information is used to calculate the portfolio weights. Again the result is similar to what Lehmann (1990) found. A portfolio in which the weight is based on information about the most recent period's return is most profitable. The profits diminish as the lagged period k increases. Fork ≥ 4, the profit is actually negative. Again the results indicate that the return reversal effect is most prominent at weekly intervals.

Table 3. Profits on return reversal portfolio strategies.

1960s							
Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0115	0.0422	5.9283	-0.3885	0.1361	0.6457	477
One month	0.0451	0.0591	8.2964	-0.09%	0.1900	0.7815	119
One quarter	0.2011	0.0908	13.6492	0.0445	0.3746	1.0000	39
Half year	0.5009	0.0539	39.4120	0.3961	0.6086	1.0000	19
One year	0.7048	0.0546	36.5014	0.6502	0.8272	1.0000	9

1970s							
Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0137	0.0322	9.2803	-0.1132	0.1337	0.6813	477
One month	0.0586	0.0572	11.1360	− 0.0457	0.2795	0.8487	119
One quarter	0.1353	0.0513	16.2751	0.0229	0.2159	1.0000	39
Half year	0.2848	0.0532	22.7297	0.2135	0.3591	1.0000	19
One year	0.5748	0.0508	32.0320	0.5191	0.6765	1.0000	9

1980s							
Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0089	0.0369	5.2870	-0.1837	0.3088	0.6164	477
One month	0.0448	0.0580	8.3963	− 0.0696	0.2776	0.8067	119
One quarter	0.0554	0.0651	5.2465	-0.0345	0.1860	0.7949	39
Half year	0.1180	0.0542	9.2404	0.0289	0.1974	1.0000	19
One year	0.1969	0.0275	20.2329	0.1590	0.2228	1.0000	9

All of the signs from Table 2 through Table 4 indicate that the market is not fully efficient if there is not trading cost. Clearly, when considering a trading week as the base period and one lag length, $k = 1$, we can realize positive arbitrage profits over the entire 57 semi-annual time segments and 28 annual ones without ever losing a penny. These results sharply reject the market efficiency hypothesis in the absence of market friction. However, as we have argued in section 3, without proper consideration of the trading costs, market efficiency can be falsely rejected. So we present the strategy's performance records with the presence of market friction in Table 5.

It is not surprising to see that with the trading cost added in, the profitability is depressed, and semiannual returns are not always positive if trading costs are higher than 0.1 percent. But still, arbitrage profit exists, especially when we extend the time horizon to a year. The return reversal strategy, on average, yields a positive profit for one-way trading costs lower than 0.3 percent. And for trading costs lower than or equal to 0.2 percent, the strategy will risklessly earn positive profits over all the 28 sample years.

It is interesting to see how much profit can be extracted from this strategy if the one-way trading cost is taken to be 0.2 percent. The daily capital turnover in this real estate market is \$84 million. Suppose we can long and short 1 percent of the market without moving the price against us. Then we can make an annual profit of

$$\pi_{annual} = 0.01\,\bar{\pi} M_c = 0.01 \times 0.2220 \times 84 \times 10^6 = \$186{,}480$$

Table 4. Profits on return reversal portfolio strategies. Different period lags (one period is five trading days).

Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Weights Based on First 4-Day-Return of Previous Period, $k = 1$							
Five days	0.0114	0.0374	11.5121	-0.3885	0.3088	0.6478	1431
One month	0.0456	0.0896	9.5890	-0.4451	0.3469	0.7535	357
One quarter	0.1340	0.0910	15.9885	-0.0507	0.3746	0.9748	119
Half year	0.3077	0.1625	14.1720	0.0838	0.6086	1.0000	57
One year	0.6220	0.0868	37.2250	0.4725	0.8272	1.0000	28
Weights Based on Return Two Periods Ago, $k = 2$							
Five days	0.0042	0.0349	4.5021	-0.1960	0.2488	0.5538	1430
One month	0.0028	0.0866	0.6051	-0.2900	0.2115	0.5350	357
One quarter	0.0008	0.1204	0.0717	-0.3384	0.3047	0.4286	119
Half year	0.0444	0.1513	2.1953	-0.2410	0.4271	0.5965	57
One year	0.1153	0.1017	5.8884	-0.1095	0.3533	0.9286	28
Weights Based on Return Three Periods Ago, $k = 3$							
Five days	0.0030	0.0338	3.3527	-0.1472	0.2500	0.5416	1429
One month	0.0142	0.0814	3.3044	-0.2104	0.3234	0.5490	357
One quarter	0.1126	0.1300	9.4080	-0.1183	0.4266	0.7899	119
Half year	0.1217	0.1382	6.5867	-0.1114	0.3666	0.7719	57
One year	0.2135	0.1178	9.4228	-0.0399	0.4387	0.9643	28
Weights Based on Return Four Periods Ago, $k = 4$							
Five days	0.0008	0.0339	0.8361	-0.3635	0.2163	0.5175	1428
One month	0.0004	0.0811	0.0866	-0.1869	0.3098	0.4734	357
One quarter	-0.0087	0.1446	-0.6542	-0.2522	0.3315	0.4622	119
Half year	-0.0532	0.1452	-2.7423	-0.3803	0.1790	0.4035	57
One year	-0.0547	0.1098	-2.5876	-0.2457	0.0984	0.3929	28

for one portfolio. Moreover, if we can build five such portfolios without moving the price, that is, continuously building and unwinding a portfolio each day of the trading week, then, the total annual profit will grow to $\pi_{total} = 5 \times 186{,}480 = \$932{,}400$. From Table 5 we can also calculate that the worst year's profit is

$$\pi_{total,w} = \frac{\pi_{min}}{\bar{\pi}} \pi_{total} = \frac{0.0725}{0.2220} \times 932{,}400 = \$304{,}500.$$

The best year is

$$\pi_{total,b} = \frac{\pi_{max}}{\bar{\pi}} \pi_{total} = \frac{0.4272}{0.2220} \times 932{,}400 = \$1{,}794{,}240.$$

Table 5. Profits on return reversal portfolio with transaction cost (weights based on **first** 4-day-return of previous **5-trading-day** period).

One-Way Transaction Cost 0.10 Percent

Horizon	$\bar{\pi}$	σ	r-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0074	0.0374	7.4623	-0.3925	0.3048	0.5975	1431
One month	0.0296	0.0896	6.2211	-0.4611	0.3309	0.6667	357
One quarter	0.0860	0.0910	10.2599	-0.0987	0.3266	0.7815	119
Half year	0.2077	0.1625	9.5656	-0.0162	0.5086	0.9649	57
One year	0.4220	0.0868	25.2549	0.2725	0.6272	1.0000	28

One-Way Transaction Cost 0.20 Percent

Horizon	$\bar{\pi}$	σ	t-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	0.0034	0.0374	3.4126	-0.3965	0.3008	0.5353	1431
One month	0.0136	0.0896	2.8531	-0.4771	0.3149	0.5882	357
One quarter	0.0380	0.0910	4.5312	-0.1467	0.2786	0.6218	119
Half year	0.1077	0.1625	4.9592	-0.1162	0.4086	0.5614	57
One year	0.2220	0.0868	13.2848	0.0725	0.4272	1.0000	28

One-Way Transaction Cost 0.30 Percent

Horizon	$\bar{\pi}$	σ	f-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	-0.0006	0.0374	-0.6372	-0.4005	0.2968	0.4731	1431
One month	-0.0024	0.0896	-0.5149	-0.4931	0.2989	0.4594	357
One quarter	-0.0100	0.0910	-1.1975	-0.1947	0.2306	0.4286	119
Half year	0.0077	0.1625	0.3527	-0.2162	0.3086	0.4561	57
One year	0.0220	0.0868	1.3147	-0.1275	0.2272	0.5714	28

One-Way Transaction Cost 0.50 Percent

Horizon	$\bar{\pi}$	σ	t-Value	π_{min}	π_{max}	$N_{R>0}/N_{obs}$	N_{obs}
Five days	-0.0086	0.0374	-8.7367	-0.4085	0.2888	0.3564	1431
One month	-0.0344	0.0896	-7.2508	-0.5251	0.2669	0.2969	357
One quarter	-0.1060	0.0910	−12.6548	-0.2907	0.1346	0.1261	119
Half year	-0.1923	0.1625	-8.8601	-0.4162	0.1086	0.2105	57
One year	-0.3780	0.0868	-22.6255	-0.5275	−0.1728	0.0000	28

But in real transactions, the one-way trading cost, which, for the most part, is the implicit cost of the bid-ask spread, is likely to be greater than 0.2 percent, especially when taking into account the small capitalization of real estate stocks and low liquidity of such stocks. (Using the common bid-ask spread of $0.125(1/8) and the average real estate security price of $9 at the end of 1990, further assuming that the market price is at the mid-point of the bid-ask prices, then the one-way implicit transaction cost is 0.125/2/9 = 0.69 percent. However, for those few very skillful traders who can get around the bid-ask spread and trade at the closing price, which is the price we use for the calculation, the transaction cost would be smaller.) For one-way trading costs over 0.5 percent, the strategy may actually lose money all the time if a year is taken as the time horizon. So when the market friction is taken into account, the return reversal arbitrage strategy makes no abnormal

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