Duration Dependence in Real Estate Investment Trusts

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Abstract

Hazard models are used to test for duration dependence in the market for real estate investment trusts. Duration dependence implies an ability to predict the turning points of a cycle. In a sense, these models attempt to predict the timing of mean reversion of the market indices. Since the only sample information used in these tests is the length of time between turning points of the cycle, this methodology avoids the more challenging task of modeling the quantitative values of the series, and should provide relatively robust results because of the relatively weak structure imposed on the estimation process. Empirical evidence of duration dependence is found for all samples except mortgage REIT expansions.

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1. Introduction

The cyclical behavior of real estate investment trusts (REITs) has become an increasingly important topic with their growth as an investment vehicle for portfolio managers. While studies by Gardner (1993), Pyhrr, Roulac, and Born (1999), and Witkiewicz (2002) examine the cyclical behavior of real estate properties and their returns, there has been a limited amount of research on the cyclical behavior of REITs. Studies by Mei and Gao (1995), Graff and Young (1997), and Nelling and Gyourko (1998) all find evidence of price reversals in REIT stocks. Cooper, Downs, and Patterson (1999) suggest that this might be a reflection of investor over-reaction, which introduces the possibility of profitable trading based on a contrarian strategy. Chandrashekaran (1999) and Stevenson (2002) have documented performance persistence or momentum effects in REIT returns with mixed results regarding the duration of such effects. In general, the empirical evidence suggests that performance persistence exists in the short-term, but dissipates in the longer-term as mean reversion occurs.

The objectives of the papers cited above are ambitious. They test for both predictability of REIT returns and profitability of the resulting trading strategies. Stevenson (2002, pg. 48) recognizes that this requires a relatively structured approach, and comments that "tests of effects such as momentum and mean reversion are effectively joint tests of both the effect under investigation and the specific model selected." He adds that "The contrasting findings in relation to momentum and performance reversal effects ... highlight the sensitivity of the findings to the data and sample periods used." Recognizing the importance of these statements, the current paper will employ a relatively unstructured approach to test for predictability of the REIT market. This methodology, which tests for duration dependence in cycles, was originally employed by Sichel (1991) to test the predictability of business cycles, and was subsequently adopted by Cochran and Defina (1995) to test the predictability of cycles in the U.S. stock market. This paper will also use daily data on equity, hybrid, and mortgage REITs. Use of daily data provides a particularly challenging test of predictability, in that time aggregation often makes an index more predictable by reducing its volatility.

Tests of duration dependence, when applied to cyclical data, are concerned with the ability to predict the turning points of a series. The only sample information used in these tests is the length of time between turning points. This strategy avoids the more challenging task of modeling the quantitative values of the series. The advantage of this choice is that much less structure is imposed when conducting the test. The disadvantage, of course, is that the quantitative information in the series is not utilized. As always, the appropriate degree of structure to be imposed on an estimation problem is a difficult choice. In general, greater structure tends to provide more precise estimates, but at the expense of potential bias when the structure is inappropriate. This dilemma is illustrated no more clearly than the choice between parametric and non-parametric methods.

Sichel's (1991) use of parametric hazard models to test for duration dependence in business cycles was motivated by the relatively low power found with non-parametric methods. Zuehlke (2003) extended these results with a generalized hazard function that allowed non-linear log-hazard profiles. Cochran and Defina (1995) used the methodology of Sichel to examine predictability of cycles in the U.S. stock market. Their findings closely mirrored those of Sichel. To the best of our knowledge, duration dependence in the market for REITs has not been investigated in the literature.

This study closely parallels those of Sichel (1991), Cochran and DeFina (1995), and Zuehlke (2003) in analyzing the cyclical behavior of REIT prices using parametric hazard functions. The essential question is whether there is any predictability in the cycle length of REIT prices. A finding of positive duration dependence implies that as the duration of the cycle lengthens, the probability that the cycle will end increases. If so, then the current duration of a cycle provides useful information with which to predict the next turning point. In a sense, the hazard methodology may be thought of as attempting to model the timing of episodes of mean reversion.

While hazard models do not incorporate the quantitative values of the series, estimates of the duration elasticity of a cycle are influenced by the relative variances of the stationary and non-stationary components of the time series. If the innovation variance of the stationary component is relatively small, the innovation variance of the non-stationary component will dominate, and REIT prices will behave as a random walk. Deviations from trend are random and cycles will not be of predictable length (i.e. duration dependence is absent). On the other hand, if the innovation variance of the stationary component is relatively large, REIT prices will have predictable cycle lengths and exhibit positive duration dependence.[1]

Section 2 describes the data and the methodology used to filter out false turning points in a cycle. Section 3 presents the methodology of hazard functions. Section 4 discusses the empirical results and section 5 provides concluding remarks.

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[1] Much of this description of the relevance of duration dependence in financial markets is drawn from Cochran and DeFina (1995).

2. Data

The data employed in this paper are daily values of the equity REIT, hybrid REIT, and mortgage REIT indices for the period January, 1999, through September, 2004.[2] The first step in the process is to determine the turning points of the REIT indices. Once a set of turning points has been established, the duration of each cycle of expansion and contraction is determined by the number of trading days between the turning points. Harding and Pagan (2002, page 368) argue, in the context of business cycles, that some subjectivity is required in order to filter 'out "false turning points", i.e. movements which are either short lived or of insufficient amplitude.' Potential turning points are identified by a sign change in consecutive values of the first difference of the series. For example, a peak in the series is established where a sequence of positive values is broken by a sequence of negative values of sufficient length and amplitude. Any sequence of negative values of insufficient length or amplitude is ignored and remains imbedded in the corresponding expansion. A trough in the series is established in a similar manner.

There is no escaping the subjectivity associated with determination of false turning points. Some authors simply impose a minimum duration for expansions and contractions. Harding and Pagan (2002) refer to these bounds as "censoring rules." Instead, we follow the suggestion of Witkiewicz (2002, page 86), who argues that the filter of Hodrick and Prescott (1997) "offers a means for ... correctly identifying the turning points" of a real estate cycle. In this paper, false turning points are established by comparing the REIT index with a smoothed sequence obtained

[2] See Payne and Mohammadi (2004, p. 1211) for description of REITs. Equity REITs hold at least 75% of their assets in income generating real estate properties; mortgage REITs hold at least 75% of their assets in residential and commercial mortgages and construction loans; and hybrid REITs share characteristics of both equity and mortgage REITs in owning properties as well as lending. Data were obtained from the National Association of Real Estate Investment Trusts (www.nareit.com).

using the Hodrick-Prescott (HP) filter. Any turning point in the original series that is of insufficient duration or magnitude to generate a corresponding turning point in the HP filtered series is considered a false turning point.[3] The advantage of this approach relative to simple censoring rules is that information on both the duration and magnitude of the reversal is considered. A reversal of relatively short duration may be classified as a turning point provided it is of sufficient magnitude.

The subjectivity associated with this procedure resides in the choice of the HP parameter, δ. Given a time series, $\{Y_t\}$, the HP filtered series, $\{X_t\}$, is the solution to

$$\min_{\{X_t\}_{t=-1}^{T}} \left\{ \sum_{t=1}^{T} (Y_t - X_t)^2 + \delta \sum_{t=1}^{T} [(X_t - X_{t-1}) - (X_{t-1} - X_{t-2})]^2 \right\} \tag{1}$$

The HP parameter δ controls the smoothness of the filtered series by penalizing excessive variability, as measured by the sum-of-squares of its second difference. As δ approaches infinity, the HP filtered series becomes linear, and all reversals are classified as false turning points. As δ approaches zero, the filtered series fits the original series to any desired degree of precision, and no reversal is classified as a false turning point. From a practical perspective, the objective is to choose δ so that the HP filtered series captures major movements in the REIT index, while eliminating noise. While this is clearly a subjective standard, the plots presented in Figures 1 through 3 suggest that this objective has been largely accomplished. A table listing the turning points of each of the REIT indices, as well as the corresponding duration of each expansion and contraction, is provided in Appendix A.

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[3] Harding and Pagan (2002, page 375) caution against attempting to establish turning points on the basis of deviations from trend, since it is "not possible to separate the stochastic trend from the cycle." Note that in the current application, the HP filter is not used to obtain a detrended series, but rather, to validate turning points in the original series.

3. Methodology[4]

This paper estimates hazard models for the duration of REIT cycles. If f(t) and F(t) are, respectively, the density and distribution functions for the completed duration of a cycle, then the hazard function is defined as

$$h(t) = f(t) / [1 - F(t)] \tag{2}$$

The hazard function is the conditional density function for a completed duration of t, given that current duration is t. This is the instantaneous rate of transition from one phase of the cycle to the next. A hazard model may be specified either by the choice of the hazard function, h(t), or the distribution function, F(t). It has become convention in the literature, however, to specify a hazard model in terms of its survivor function, S(t). The survivor function is just the complement of the distribution function. The hazard function and survivor function are related as:

$$S(t) = [1 - F(t)] = \exp[-\int_0^t h(s)ds] \tag{3}$$

This relationship provides a simple method of determining the distribution of completed duration for any given specification of the hazard function.

Both Sichel (1991) and Cochran and Defina (1995) adopt the Weibull specification of the hazard function. The survivor function of the Weibull model is

$$S(t) = \exp(-\alpha t^{\beta+1}) \tag{4}$$

where $\alpha > 0$, $\beta > -1$, and $t > 0$. The corresponding hazard function is

$$h(t) = \alpha(\beta + 1)t^{\beta} \tag{5}$$

or in log terms

$$\ln[h(t)] = \ln[\alpha(\beta + 1)] + \beta \ln(t) \tag{6}$$

Equation (6) illustrates the fundamental assumption of the Weibull specification; there is a linear

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[4] Much of the discussion of hazard models presented in this section is drawn from Zuehlke (2003).

relationship between the log of the hazard function and the log of duration. The parameter β is the duration elasticity of the Weibull hazard model. The Weibull hazard function is monotone in duration, and exhibits positive (negative) duration dependence when β is positive (negative).[5]

Mudholkar, Srivastava, and Kollia (1996) present a generalized Weibull model that provides much greater flexibility at the expense of one additional parameter. Their generalized model allows hazard functions that are monotically increasing, monotonically decreasing, U-shaped, and inverted U-shaped. Zuehlke (2003) uses the Mudholkar model to re-examine the evidence of duration dependence in post-war business cycles. The survivor function of the Mudholkar model is

$$S(t) = [1 - \lambda \alpha t^{(\beta+1)}]^{\lambda^{-1}} \tag{7}$$

where $\alpha>0$, $\beta>-1$, and where the sample space of t is $(0,\infty)$ for $\lambda \leq 0$ and $(0, (\alpha\lambda)^{-(1/\beta)})$ for $\lambda>0$. The survivor function of the Mudholkar model converges to that of the Weibull model as λ approaches zero. The hazard function of the Mudholkar model is

$$h(t) = \alpha(\beta + 1)t^{\beta}[S(t)]^{-\lambda} \tag{8}$$

or in log terms

$$\ln[h(t)] = \ln[\alpha(\beta + 1)] + \beta \ln(t) - \lambda \ln[S(t)] \tag{9}$$

Since the log transformation is monotonic, and the survivor function is decreasing in duration and bounded by the unit interval, the hazard function is: monotonically increasing in duration if both β and λ are positive, monotonically decreasing if both β and λ are negative, U-shaped if β is negative and λ is positive, and inverted U-shaped if β is positive and λ is negative.[6]

Even when the hazard function of the Mudholkar model is monotone in duration, its log-hazard function is generally nonlinear in log-duration. The duration elasticity of the Mudholkar

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[5] The parameters α and β in this paper correspond to μ and α-1 in Sichel (1991).

[6] The parameters α, β, and λ, in this paper correspond to $\sigma^{-(1/\alpha)}$, (1/α)-1, and λ in Mudholkar, Srivastava, and Kollia (1996).

model is

$$\frac{\partial \ln[h(t)]}{\partial \ln(t)} = \beta + \frac{1 - S(t)^{\lambda}}{S(t)^{\lambda}}(\beta + 1) \tag{10}$$

In general, the duration elasticity depends on the signs and relative magnitudes of both β and λ.

In the Weibull model, a significant estimate of β provides statistical evidence of duration dependence. In the Mudholkar model, a significant estimate of either β or λ provides statistical evidence of duration dependence. A significant estimate of λ also provides evidence of the statistical superiority of the Mudholkar model relative to the Weibull model, because a nonlinear time profile for the log-hazard function can only occur when λ is nonzero.

Sichel (1991) models the sequences of expansions and contractions separately. His log-likelihood function corrects for censoring when a cycle is still in progress at the ending date of the sample, in which case all that is known is that the complete duration of the cycle is no less than its observed value. The log-likelihood function for a sequence of expansions (contractions) with observed durations, t_i, is

$$\ln L(\alpha, \beta, \lambda) = \sum_{i=1}^{N} \left\{ J_i \ln[f(t_i)] + (1 - J_i) \ln[1 - F(t_i)] \right\} \tag{11}$$

where J_i is a binary variable that indicates whether the cycle is complete, N is the number of expansions (contractions) in the sequence, and where f( ) and F( ) are, respectively, the density function and distribution function for duration. Given that the survivor function is the complement of the distribution function, and the density function is the product of the hazard function and survivor function, this log-likelihood function may be written as

$$\ln L(\alpha, \beta, \lambda) = \sum_{i=1}^{N} \left\{ J_i \ln[h(t_i)] + \ln[S(t_i)] \right\} \tag{12}$$

where S( ) and h( ) are specified as equations (4) and (5) for the Weibull model, or as equations (7) and (8) for the Mudholkar model.

The parameters are estimated by the method of maximum likelihood (ML). The score equations for α, β, and λ are a set of simultaneous nonlinear implicit functions, and must be solved numerically. Typically, asymptotic standard errors are reported with nonlinear ML estimates. This paper follows Sichel (1991), however, and reports bootstrapped standard errors, as well as p-values for bootstrapped t-statistics, because of the relatively small sample sizes found in the REIT chronology.[7]

Two measures of "goodness of fit" are included. The first is the pseudo R^2 of Cragg and Uhler (1970), which is constructed using the Exponential hazard model as the base of reference. The Weibull and Mudholkar models allow linear and nonlinear log-hazard profiles, respectively. In contrast, the Exponential model has a constant log-hazard rate, and may be interpreted as the "intercept only" specification of the Weibull and Mudholkar models. Thus, the pseudo R^2 measure reflects the improvement in fit of the Weibull and Mudholkar models relative to a constant hazard rate. The second measure is the Kolmogorov-Smirnov (KS) statistic, which tests the validity of the assumed distributional form. The KS statistic is based upon differences between parametric and non-parametric estimates of the distribution function. The parametric estimate is the hypothesized distribution function (Weibull or Mudholkar) evaluated at the ML estimates of the parameters, while the non-parametric estimate is the empirical distribution function. The hypothesized distribution is rejected when the differences between these estimates become too large.

[7] Efron and Tibshirani (1993) give a detailed discussion of the bootstrap method. Bickel and Freedman (1981) consider the asymptotic validity of bootstrapped t-statistics.

4. Results

Tables 1 through 3 report ML estimates of the Weibull and Mudholkar models for equity, hybrid, and mortgage REITs, respectively. The top panel of each table provides estimates for expansions, while the bottom panel of each table provides the corresponding estimates for contractions. Point estimates, standard errors, and p-values are provided for each parameter. Finally, the pseudo R^2 and Kolmogorov-Smirnov statistics are reported for each model.

Evidence of duration dependence is provided by statistically significant estimates of β in the Weibull model, or statistically significant estimates of either β or λ in the Mudholkar model. The estimates presented in Tables 1 through 3 provide evidence of positive duration dependence for all cases except mortgage REIT expansions. In each of these cases, there is an estimate of either β or λ, or both, that is statistically significant with an α level not exceeding 10 percent.

The parameter λ controls the curvature of the Mudholkar log-hazard function and provides a test of the sufficiency of the Weibull (linear) specification. The estimate of λ is significant, at an α level not exceeding 10 percent, for both expansions and contraction of the hybrid REIT index, and for contractions in the mortgage REIT index. In these cases, there is statistical evidence of a nonlinear time profile for the log-hazard profile. For both expansions and contraction of the equity REIT index, and for expansion of the mortgage REIT index, the hypothesis that the Weibull specification is sufficient cannot be rejected at conventional levels. It is worth noting, however, that for expansions of both the equity and mortgage REIT indices, the estimate of λ does have a p-value of approximately 13 percent.

From a modeling perspective, it is not clear that the Mudholkar model should be discarded just because the estimate of λ fails to achieve the 10 percent standard. While we might prefer a more precise estimate of λ in these cases, the Mudholkar model may still be providing a useful improvement in fit. This idea is confirmed by the values of the pseudo R^2 measure, which are uniformly higher for the Mudholkar model. The values of the pseudo R^2 range from 1 to 45 percent for the Weibull model, and from 59 to 97 percent for the Mudholkar model. The Kolmogorov-Smirnov statistic is designed to detect empirical inconsistencies with the hypothesized distribution. In this application, there is little statistical evidence to suggest a rejection of the either the Weibull or Mudholkar distributions. The p-values of the KS statistics are all well above conventional choices for α.

Finally, Figures 4 and 5 plot the Weibull and Mudholkar log-hazard profiles for equity REIT expansions and contractions, respectively. The plots for hybrid and mortgage REITs are qualitatively similar, and so are not reported here. In all cases, the Weibull log-hazard has a positive and constant duration elasticity, whereas the Mudholkar log-hazard has a positive and increasing duration elasticity. These plots illustrate the qualitative nature of the improvement provided by the Mudholkar model. Where a non-linear log-hazard profile is found, it is in the form of positive and accelerating duration dependence.

5. Conclusion

The hazard models estimated in this paper provide evidence of positive duration dependence, and hence an ability to predict turning points of the cycle, for all samples except mortgage REIT expansions. The results are likely to be robust because of the relatively weak structure that is imposed on the estimation process. We can only speculate about the source of this market inefficiency. Scott (1990) argues that because information about the value of property holdings is difficult and expensive to obtain, the prices of REIT stocks may not reflect the true value of the underlying properties. Along these lines, though the creation of the umbrella partnership REIT organizational structure in 1991 provided flexibility in purchasing property, the lack of transparency within such a structure made valuation difficult (see Damodaran et al, 1997 and Ling and Ryngaert, 1997). Consequently, investors with specialized knowledge of real estate may find profitable opportunities in the market for REITs. Whether this information can be exploited to develop profitable trading strategies is a final unanswered question.

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Table 1: Parameter Estimates for Equity REITs						
Expansions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00121	0.00155	0.22889	0.00035	0.00065	0.30422
β	0.42341	0.25051	0.06473	0.76928	0.41991	0.05481
λ	0	--	--	0.14530	0.11974	0.13215
CU-R^2	0.1511	--	--	0.6543	--	--
KS	0.1501	--	0.9653	0.1754	--	0.8875
Contractions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00050	0.00052	0.18251	0.00001	0.00001	0.45712
β	0.89410	0.32820	0.01304	4.47238	1.45610	0.00902
λ	0	--	--	0.00240	0.00362	0.26406
CU-R^2	0.4497	--	--	0.9663	--	--
KS	0.2846	--	0.3350	0.1672	--	0.9182

Note: SE denotes bootstrap standard errors. P-value denotes the marginal significance level of a one-sided test using the bootstrap standard errors. CU-R^2 denotes the pseudo R^2 measure of Cragg and Uhler. KS denotes the Kolmogorov-Smirnov test of the null hypothesis that duration has the stated distribution.

Table 2: Parameter Estimates for Hybrid REITs						
Expansions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00047	0.00124	0.35687	0.00147	0.00326	0.33289
β	0.64202	0.49949	0.11732	0.38026	0.50762	0.23911
λ	0	--	--	0.51220	0.36078	0.09933
CU-R^2	0.2282	--	--	0.5887	--	--
KS	0.1113	--	0.9992	0.1798	--	0.8690
Contractions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00191	0.00246	0.23000	0.00015	0.00053	0.39137
β	0.53546	0.31236	0.06241	1.26636	0.71300	0.05949
λ	0	--	--	0.07560	0.05304	0.09856
CU-R^2	0.2359	--	--	0.8801	--	--
KS	0.1873	--	0.8351	0.2072	--	0.7321

Note: SE denotes bootstrap standard errors. P-value denotes the marginal significance level of a one-sided test using the bootstrap standard errors. CU-R^2 denotes the pseudo R^2 measure of Cragg and Uhler. KS denotes the Kolmogorov-Smirnov test of the null hypothesis that duration has the stated distribution.

Table 3: Parameter Estimates for Mortgage REITs						
Expansions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00530	0.00594	0.19909	0.00314	0.00478	0.26628
β	0.09323	0.20539	0.33098	0.26908	0.32957	0.22057
λ	0	--	--	0.17970	0.14586	0.12886
CU-R^2	0.0117	--	--	0.5961	--	--
KS	0.1438	--	0.9768	0.1636	--	0.9301
Contractions						
	Weibull			Mudholkar		
	Estimate	SE	P-value	Estimate	SE	P-value
α	0.00254	0.00233	0.15414	0.00007	0.00014	0.31411
β	0.60009	0.28420	0.03386	1.72326	0.50211	0.00548
λ	0	--	--	0.04070	0.02066	0.04474
CU-R^2	0.2860	--	--	0.9029	--	--
KS	0.1881	--	0.8311	0.2071	--	0.7330

Note: SE denotes bootstrap standard errors. P-value denotes the marginal significance level of a one-sided test using the bootstrap standard errors. CU-R^2 denotes the pseudo R^2 measure of Cragg and Uhler. KS denotes the Kolmogorov-Smirnov test of the null hypothesis that duration has the stated distribution.

Appendix A: Index Chronology

Date	Equity REITs Turning Point	Equity REITs Duration	Hybrid REITs Turning Point	Hybrid REITs Duration	Mortgage REITs Turning Point	Mortgage REITs Duration
5-Jan-99			Peak			
6-Jan-99	Peak					
8-Jan-99					Peak	
16-Mar-99	Trough	47			Trough	45
29-Mar-99			Trough	57		
26-May-99			Peak	41		
28-May-99	Peak	52				
1-Jun-99					Peak	53
23-Jun-99					Trough	16
8-Jul-99					Peak	10
2-Dec-99	Trough	130				
9-Dec-99					Trough	108
14-Dec-99						
30-Dec-99			Trough	151		
14-Jan-00			Peak	11		
20-Jan-00					Peak	28
26-Jan-00	Peak	37				
28-Feb-00	Trough	22				
10-Mar-00					Trough	35
21-Mar-00			Trough	45		
8-Aug-00			Peak	97		
14-Aug-00	Peak	117				
30-Oct-00	Trough	54				
22-Nov-00			Trough	75		
30-Jan-01	Peak	62				
16-Mar-01						
22-Mar-01	Trough	36				
16-Aug-01			Peak	183		
17-Aug-01					Peak	363
22-Aug-01	Peak	106				
10-Sep-01					Trough	15
19-Oct-01			Trough	41		
24-Oct-01	Trough	40				
3-May-02			Peak	134		
4-Jun-02	Peak	152				
21-Jun-02					Peak	193
23-Jul-02			Trough	55	Trough	21
5-Aug-02	Trough	43				
28-Aug-02	Peak	17				

Continued on the next page.

Appendix A (Continued)

Date	Equity REITs Turning Point	Equity REITs Duration	Hybrid REITs Turning Point	Hybrid REITs Duration	Mortgage REITs Turning Point	Mortgage REITs Duration
30-Aug-02			Peak	28	Peak	28
9-Oct-02			Trough	27		
22-Oct-02					Trough	36
23-Oct-02	Trough	39				
24-Dec-02	Peak	43				
6-Jan-03			Peak	60		
14-Jan-03					Peak	57
30-Jan-03			Trough	17		
12-Feb-03	Trough	33				
13-Feb-03					Trough	21
5-Mar-04	Peak	267				
10-May-04	Trough	45				
18-Jul-03			Peak	117	Peak	107
5-Aug-03			Trough	12		
25-Aug-03					Trough	26
5-Mar-04			Peak	147		
9-Mar-04					Peak	135
13-May-04			Trough	48		
17-May-04					Trough	48
15-Sep-04		88+		85+		83+

Note: The + indicates the duration of the incomplete expansion (as of 15-Sep-2004).

Figure 1: Equity REIT Index and Corresponding Hodrick-Prescott Filter

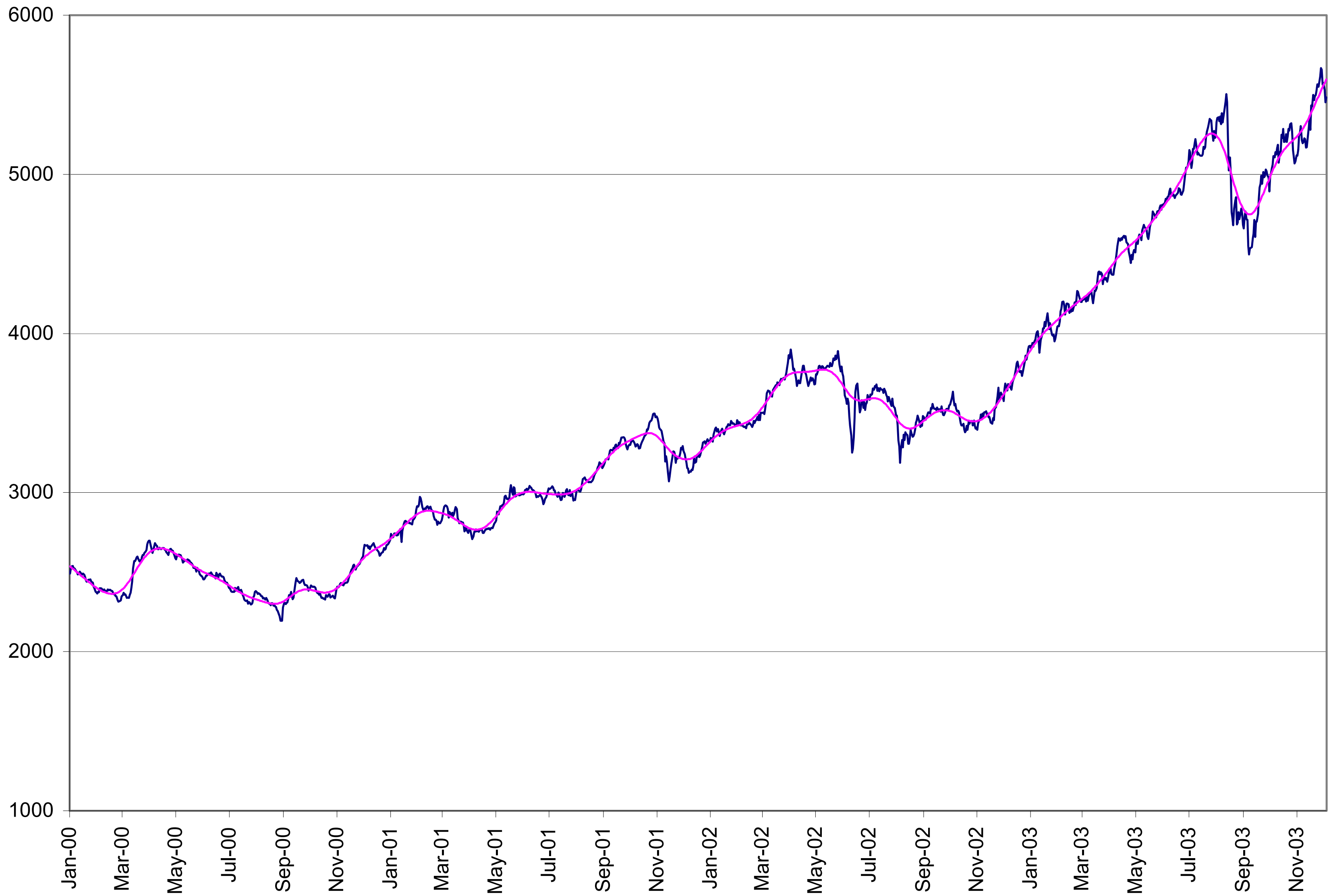

Figure 2: Hybrid REIT Index and Corresponding Hodrick-Prescott Filter

Figure 3: Mortgage REIT Index and Corresponding Hodrick-Prescott Filter

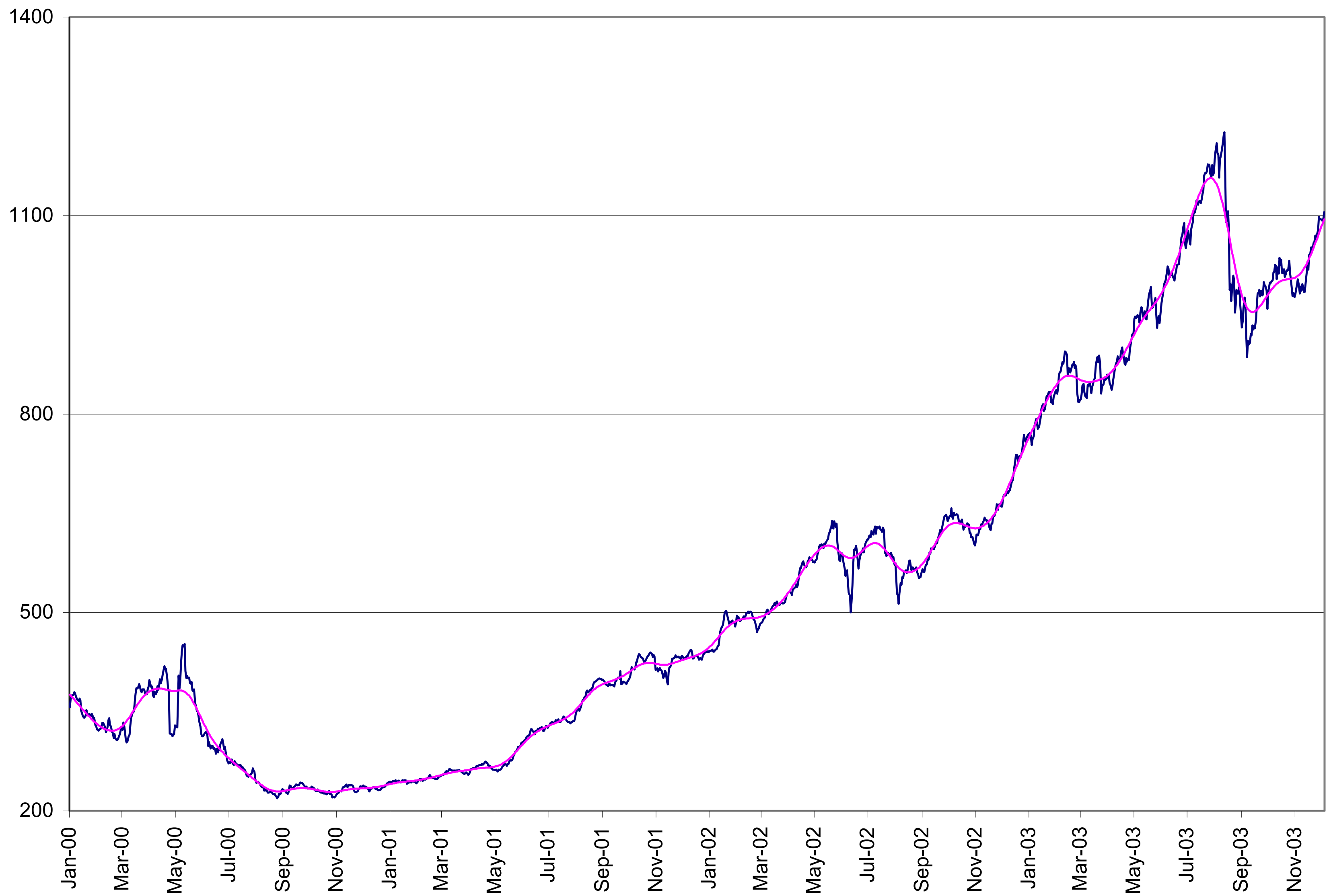

Figure 4: Hazard Plot of Equity REIT Expansions

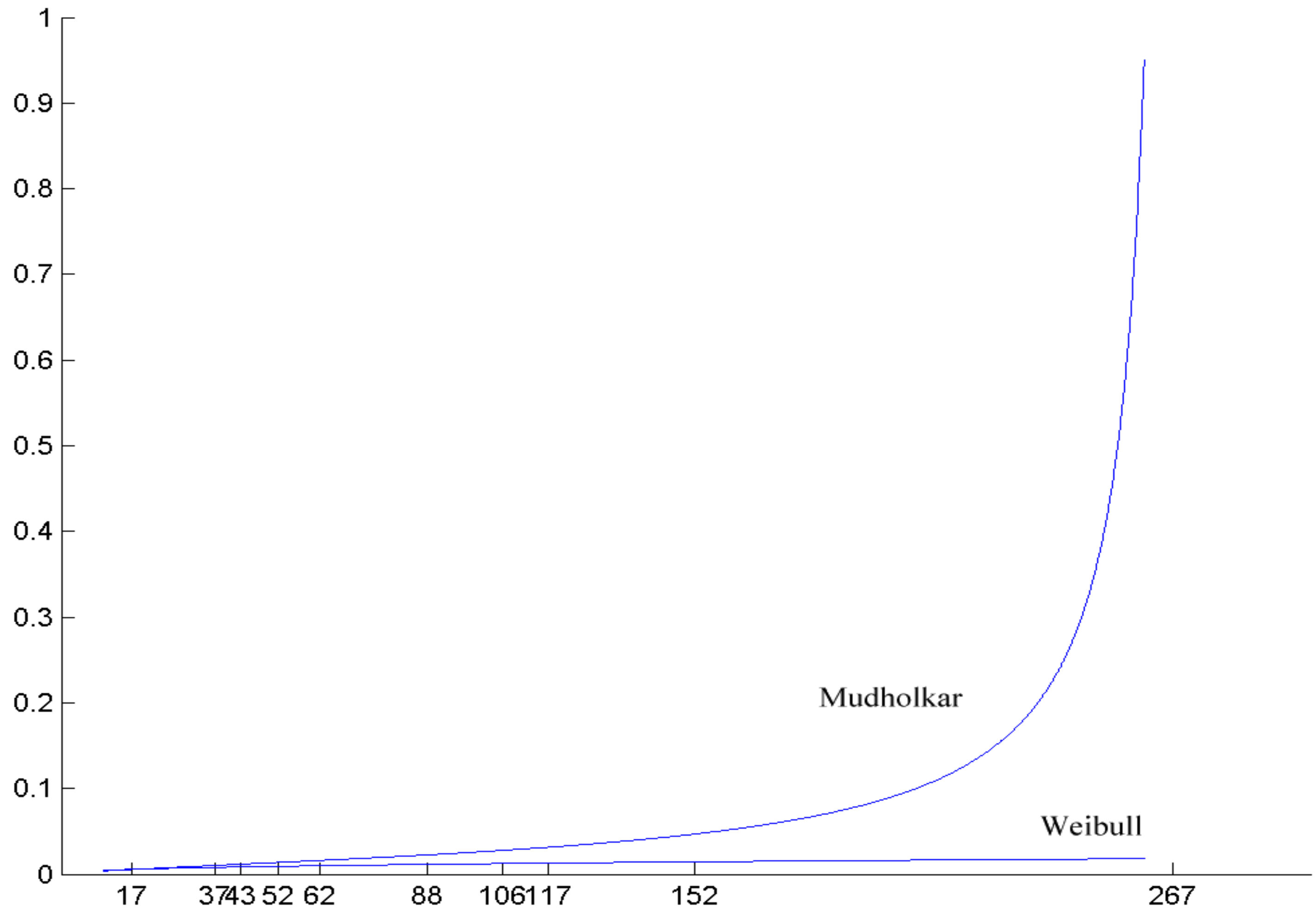

Figure 5: Hazard Plot of Equity REIT Contractions