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Net Discount Rates: Does Duration Matter?

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Abstract *Some economists employ averages of net discount rates over historical periods as proxies for future net discount rates. This raises the question of the time period, or duration, over which to calculate the average net discount rate. Two testing procedures are used to examine this question. The first uses moving average net discount rates over a number of years. A more refined procedure tests the impacts of duration by disaggregating the moving averages. Although the study does offer some insight, results are not conclusive and suggest a need for further research.*

Introduction

One issue in the field of forensic economics is how to estimate an appropriate net discount rate for calculating the present value of future cash flows. Some economists use an average net discount rate calculated over a historical period as an estimate.[1] This raises the question of the time period, or duration, over which to calculate the average net discount rate. One practice is to use a standard duration, for example twenty years. Another practice is to match the duration to the projected period of expected losses. In

[1] Brookshire, Luthy, and Slesnick (2006) surveyed economists about predicting discount rates. A plurality of respondents (41 percent) indicated that they used some historical average of interest rates, rather than current or forecasted rates. The Brookshire, et al. (2006) article does not contain enough information to address the independent forecasting of the components of the NDR. Additionally, there is no reported favored duration. The survey does set up two hypotheticals with different durations for a loss and asked the duration of historical data that an FE might use. In those hypotheticals, the historical duration varies with the duration of loss. In words of the Brookshire et al. article "there is no one-to-one correspondence between the number of future years and the number of past years examined" (p. 47).

this paper, we explore the issue of durations, how net discount rates vary over time, and whether picking one duration versus another is really a critical matter. In particular, the research asks whether the average net discount rate estimated over one duration is statistically different from the average net discount rate estimated over another duration. If the net discount rates are different, then duration may matter. On the other hand, if there is no statistical difference between the net discount rates of the two periods, then it may be sufficient to utilize a duration that lies in a span of durations that produce statistically similar results.

Two testing procedures are used to examine the consequences of duration. The first calculates net discount rates using moving averages. The second procedure tests the impacts of duration by disaggregating the moving averages.

We start by computing moving average 10-year net discount rates over a three-decade series of data. Each 10-year sample has an associated mean and standard deviation. Next, moving average 11-year net discount rates are calculated over the same series. The sample mean and standard deviation are computed for that 11-year sample. A *t*-statistic is used to compare the two means. If the null hypothesis of equal means cannot be rejected, there may be little statistical difference between using a 10-year and 11-year duration. If the null hypothesis of equal means is rejected, this suggests that duration may matter.

To obtain a more comprehensive view on durations, the process is repeated for 12-year through 25-year durations. Then, *t*-statistics are calculated to compare sample net discount rates from each of these durations. In effect, this creates a 15x15 matrix of *t*-statistics. The *i*,*j*th element of the matrix tests whether the net discount rate over a duration of *i* years is statistically different from the net discount rate over a duration of *j* years. Using this matrix, it is possible to determine the spans of durations for which the null hypothesis of similar means can not be rejected and other spans for which the null hypothesis can be rejected.

The process initially examines net discount rates calculated using 10-year U.S. government treasury notes and annual changes in the average weekly earnings of private sector non-farm production workers. The results show that average net discount rates calculated over 10 years are not statistically different than net discount rates calculated over 11-year through 25-year durations. The results from these "aggregate" tests suggest that duration may not be that important when using averages of historical data to calculate discount rates.

The second procedure tests the impacts of duration by disaggregating the moving averages. For each starting year, 10-year through 25-year average net discount rates are calculated, along with their associated standard deviations. For example, if 2006 is used as the starting year, a 10-year average net discount rate is calculated using data from the years 2006 through 1997. An 11-year average net discount rate is calculated using data from 2006 through 1996 up to a 25-year average for data from 2006 through 1982. A series of *t*-statistics is calculated comparing the net discount rate for each duration. The *t*-statistics test the null hypothesis of similar means. The process is then repeated using 2005 as a starting year and so on back to a starting year of 1989.

Results of this second procedure show that in 75 percent of the sample years, net discount rates calculated over 15-year through 18-year durations produce results that are not statistically different from results calculated using durations ranging between10 and 25 years. Net discount rates calculated with durations in this range are "encompassing" in that they are statistically similar to net discount rates calculated using durations from 10 years through 25 years. However, the 15-year through 18-year range is somewhat broad and observations tend to cluster at either one end or the other. As the range is narrowed, fewer observations have durations that encompass net discount rates calculated with durations between10 years and 25 years. A range of 16 years or 17 years produces encompassing net discount rates in only 45 percent of the sample. Based on these research findings, calculating historical net discount rates out 15 years through 18 years may produce results that encompass the broadest array of possible results. However, further research is certainly in order.

The following section describes the literature related to estimating net discount rates and the validity of historical estimates. The moving average process and results are presented in the moving average section, followed by the non-moving average analysis section. The last section states a conclusion.

Literature Review

A variety of studies has examined the nature of net discount rates. A dominant theme has been whether historical averages are appropriate at all for predicting future rates. Early studies such as Albrecht and Moorhouse (1989), Havrilesky (1989), Nowak (1991), Lewis (1991), and Johnson and Gelles (1996) used rhetorical and

statistical analyses to examine the question. More recent works such as Pelaez (1991), Bonham and La Croix (1992), Haslag, Nieswiadomy, and Slottje (1991, 1994), Gamber and Sorensen (1993, 1994), Hays, et al. (2000), Horvath and Sattler (1997), Payne, Ewing, and Piette (1999a, 1999b), Sen, Gelles, and Johnson (2000, 2002), and Braun, Lee, and Strazicich (2005) looked at the stationarity of the underlying interest rates, wage growth rates and net discount rates to determine if the use of historical rates is appropriate.

Recalling the theory, if a process exhibits a unit root, then a shock to the process is permanent and the best predictor of the next period's rate is the current rate. Alternatively, if the process is stationary, historical averages are appropriate estimators.

The results of studies examining stationarity of net discount rates have been mixed. Many studies found net discount rates to be stationary, typically with a mean and/or trend shift around 1980; see, for example, Haslag, Nieswiadomy, and Slottje (1991, 1994), Gamber and Sorensen (1993, 1994), Hays, et al. (2000), Horvath and Sattler (1997), Payne, Ewing, and Piette (1999a, 2001), and Sen, Gelles, and Johnson (2000, 2002). Other papers such as Payne, Ewing, and Piette (1998) and Braun, Lee, and Strazicich (2005) found the process to exhibit a unit root. Based on the compendium of this research, it is not possible to reject using historical data to estimate future net discount rates.[2]

In this paper we extend that literature by searching for the appropriate duration to use when employing historical data. To a limited extent, this question has been addressed in the literature as well. Brush (2004) examined whether historical estimates accurately project future rates. He developed estimates based on *ex post* data and compared those to *ex ante* results. As for duration of the *ex post* data, he selected a "meaningfully long historical period" of 15 years (Brush 2004, p. 2). He gave no support for why a 15-year period was used. In two companion pieces, Brush (2003a, 2003b) looked more exhaustively at whether historically-based wage growth and interest rates reflected actual experience. Brush looked at data from 10-year, 20-year and 30-year historical periods. However, he gave no rationale for using those time spans.

Haydon and Webb (1992) also compared *ex post* to *ex ante* results. They used historical averages of 5-year, 10-year, 15-year

[2] Another question asked in the literature is whether age-earnings considerations make the use of a net discount rate appropriate at all. See, for example, Lewis (1989). While this question is interesting, it is outside the bounds of the current analysis.

and 20-year periods and compared those values to averages calculated out over 5-year, 10-year, 15-year and 20-year periods into the future. They found that "[n]o one time period consistently determined a net discount rate that most accurately predicted the actual rates" (Haydon and Webb 1992, p. 143). They suggested that one approach to this problem would be to average a rate calculated over a long period (20 or more years) with a rate calculated over a shorter period (5 years or 10 years), but gave no solid statistical support for this recommendation.

Ireland (2002), in an update of his previous work, looked at historical interest rates, inflation rates, and employment cost rates to determine historical net and real discount rates. Rates were calculated for the 50-year period from 1953 through 2003 up to the one-year period of 2002 and 2003. However, he made no attempt to justify any particular time period. His net discount rate was the mathematical consequence of the components.

Moving Averages

Before discussing the moving averages (i.e., mean) procedure, consider how the net discount rate in each year is defined. It is calculated as:

$$NDR_t = (1 + r_t)/(1 + g_t) - 1 \qquad (1)$$

Where

NDR_t is the net discount rate in year t

r_t is the nominal interest rate

g_t is the wage growth rate.

The nominal interest rate is the market yield on U.S. Treasury securities at 10-year constant maturity, quoted on investment basis and was obtained from the Federal Reserve website. The wage growth rate is the 12-month percent change in the average weekly earnings of private sector non-farm production workers and was obtained from the U.S. Department of Labor, Bureau of Labor Statistics website.

Averages of net discount rates are calculated over periods of various durations. These means are calculated as:

$$\overline{NDR}_D = \frac{1}{D}\sum_{t=1}^{D} NDR_t \qquad (2)$$

where $\overline{NDR}_D$ is the average net discount rate calculated over the period of duration *D*.

To begin with, moving average net discount rates are calculated with 10-year durations using 33 observations over a four decade span. Next, we determine the mean of the moving averages for the 10-year durations. As shown in Table 1, using a 10-year duration, the mean of the average net discount rates is 3.35 percent and the associated standard deviation is 1.85 percent.

Table 1. Sample Statistics for a Variety of Durations of Moving Average Net Discount Rates

Duration (in years)	Number of Observations	Average Net Discount Rate	Standard Deviation	95% Confidence Interval	
				Lower Bound	Upper Bound
10	33	3.35	1.85	2.71	3.98
11	32	3.41	1.77	2.80	4.02
12	31	3.47	1.69	2.88	4.06
13	30	3.53	1.60	2.96	4.10
14	29	3.59	1.49	3.05	4.14
15	28	3.66	1.37	3.15	4.17
16	27	3.73	1.24	3.26	4.19
17	26	3.78	1.11	3.36	4.21
18	25	3.83	0.97	3.45	4.21
19	24	3.87	0.85	3.53	4.21
20	23	3.90	0.74	3.60	4.20
21	22	3.91	0.63	3.65	4.17
22	21	3.91	0.55	3.68	4.14
23	20	3.90	0.47	3.69	4.10
24	19	3.87	0.41	3.69	4.05
25	18	3.83	0.35	3.67	4.00

With these figures determined, the next step in the analysis is to repeat the process by calculating sample statistics for other durations and comparing the statistics. Table 1 shows sample statistics for the 10-year through 25-year means. Column one shows the duration and column two shows the number of observations in the sample. Note that as the duration increases, the sample size decreases. This occurs because the moving averages are calculated over the same period of 1965 through 2006

regardless of the duration. Hence, one observation is lost for each increase in duration. The third column depicts the average net discount rate for each sample. The average net discount rates range from a low of 3.35 percent for the 10-year duration moving averages to a high of 3.91 percent for the 21-year and 22-year duration moving averages. The last three columns show the standard deviation and the lower and upper bounds of 95 percent confidence intervals, respectively, ranging from a low of 2.71 percent and a high of 4.21 percent.

The focus of this analysis is to see if net discount rates vary significantly for different durations. This translates to testing a null hypothesis that the mean for a sample with duration *i* is not statistically different from the mean of a sample with duration *j*. Conversely, the alternative hypothesis dictates that the means are different.

With these two hypotheses defined, a *t*-statistic can be used to test the null hypothesis for any pair of durations. The *t*-statistic formula is shown in equation:

$$t = \frac{\overline{NDR}_i - \overline{NDR}_j}{\sqrt{\left(\frac{s_i^2}{n_i} + \frac{s_j^2}{n_j}\right)}}. \qquad (3)$$

In equation (3), the variables $\overline{NDR}_i$, s_i^2, and n_i are the mean, variance, and number of observations associated with the samples for durations *i* and *j*, respectively.

Table 2 shows the bottom quadrant of a matrix of *t*-statistics that test the equality of means for durations from 10 years through 25 years. For example, the upper left-hand value is the *t*-statistic for the test of equality between the 10-year and 11-year durations. The results indicate that none of the means are statistically different.

As indicated by Table 2, the results suggest that average net discount rates do not vary in a statistically significant way over different durations when using averages of historical data as proxies for net discount rates. However, this result may be an artifact related to using the 10-year Treasuries. To test this, the process for testing equality of means for varying durations can be applied to securities with a variety of maturities, including a 1-year T-Bill and 2-year through 7-year T-Notes. In each case, statistics would not

Table 2. *t*-Statistics for Tests of Equality of Means for a Variety of Duration Samples

Time Duration (in years)	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
11	0.14														
12	0.28	0.14													
13	0.42	0.28	0.14												
14	0.58	0.44	0.30	0.16											
15	0.76	0.62	0.48	0.33	0.18										
16	0.94	0.80	0.66	0.52	0.36	0.19									
17	1.12	0.98	0.84	0.69	0.54	0.36	0.18								
18	1.29	1.15	1.01	0.86	0.71	0.53	0.35	0.17							
19	1.43	1.28	1.14	1.00	0.84	0.67	0.49	0.31	0.14						
20	1.54	1.39	1.25	1.11	0.96	0.78	0.60	0.43	0.26	0.12					
21	1.61	1.47	1.33	1.18	1.03	0.85	0.67	0.50	0.32	0.18	0.07				
22	1.64	1.49	1.35	1.20	1.05	0.87	0.69	0.51	0.34	0.19	0.07	0.00			
23	1.62	1.47	1.33	1.18	1.02	0.84	0.65	0.47	0.29	0.13	0.00	-0.08	-0.08		
24	1.56	1.41	1.26	1.11	0.94	0.76	0.56	0.36	0.17	0.00	-0.15	-0.25	-0.27	-0.19	
25	1.46	1.31	1.15	1.00	0.83	0.63	0.42	0.21	0.00	-0.19	-0.36	-0.48	-0.53	-0.47	-0.29

allow rejecting the null hypothesis of $\bar{r}_i = \bar{r}_j$ for any note or bond, or any duration pairing. Another explanation may be that averaging over averages washes out any meaningful variation in the data. The next section explores this explanation more fully.

Non-Moving Average Analysis

In this section, the duration question is approached from a different angle. The net discount rate data are disaggregated to individual durations.

Table 3, spanning over two pages and the years 2006 through 1974, shows the mean of the net discount rate for each duration and each starting year. The first column of Table 3 on its first page, for example, shows the average net discount rate for a 10-year duration. The first element in that column calculates the 10-year average net discount rate moving backwards from the year 2006. It yields an average net discount rate of 1.7 percent. The last element in the first column appears on the second page and calculates the 10-year average net discount rate moving backward from 1974 and reaching 1965. It yields an average net discount rate of 0.9 percent.

The last column in Table 3 shows the average net discount rates using a 25-year duration. The first element in that column calculates the average net discount rate moving backward in 25-year increments starting in 2006. That average net discount rate is 3.9 percent. The last element in the last column calculates the average net discount rate moving backwards 25 years from 1989. That average net discount rate is 3.0 percent. Throughout the entire table, the average net discount rates range from a low of 0.8 percent and a high of 6.3 percent, both of which are 10-year durations.

Table 3. Average Net Discount Rates for Various Starting Years and Durations

	Duration															
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
2006	1.7	1.9	2.0	2.2	2.2	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.4	3.6	3.7	3.9
2005	2.0	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.1	3.2	3.4	3.6	3.8	3.9	4.1	4.1
2004	2.3	2.4	2.4	2.6	2.8	2.9	3.0	3.2	3.3	3.5	3.7	3.9	4.0	4.2	4.2	4.2
2003	2.4	2.5	2.6	2.8	3.0	3.1	3.3	3.4	3.5	3.8	4.0	4.1	4.3	4.3	4.3	4.2
2002	2.5	2.7	2.9	3.1	3.2	3.4	3.5	3.7	3.9	4.1	4.2	4.4	4.4	4.4	4.3	4.2
2001	2.8	3.0	3.2	3.3	3.5	3.6	3.8	4.0	4.2	4.3	4.5	4.5	4.5	4.4	4.3	4.1
2000	3.1	3.2	3.4	3.5	3.7	3.9	4.1	4.4	4.4	4.6	4.7	4.6	4.5	4.4	4.2	4.0
1999	3.4	3.5	3.7	3.8	4.0	4.3	4.5	4.6	4.8	4.8	4.8	4.6	4.5	4.3	4.1	4.0
1998	3.6	3.8	4.0	4.1	4.4	4.6	4.7	4.9	4.9	4.9	4.8	4.6	4.4	4.2	4.1	4.0
1997	4.0	4.2	4.4	4.6	4.9	5.0	5.2	5.2	5.1	4.9	4.7	4.5	4.3	4.2	4.1	4.0
1996	4.5	4.6	4.9	5.1	5.2	5.4	5.4	5.3	5.1	4.9	4.7	4.5	4.4	4.2	4.1	3.9
1995	4.7	5.0	5.3	5.3	5.6	5.5	5.4	5.2	5.0	4.7	4.5	4.4	4.3	4.1	3.9	3.8
1994	5.1	5.4	5.4	5.7	5.6	5.5	5.3	5.0	4.8	4.5	4.4	4.3	4.1	3.9	3.7	3.7
1993	5.6	5.6	5.8	5.8	5.7	5.4	5.1	4.8	4.6	4.5	4.3	4.2	3.9	3.7	3.7	3.6
1992	5.9	6.1	6.0	5.9	5.6	5.3	5.0	4.7	4.6	4.4	4.2	4.0	3.8	3.7	3.6	3.5
1991	6.3	6.2	6.0	5.7	5.3	5.0	4.7	4.6	4.4	4.2	3.9	3.8	3.7	3.6	3.4	3.4
1990	6.3	6.1	5.8	5.4	5.0	4.7	4.5	4.4	4.2	3.9	3.7	3.7	3.5	3.4	3.3	3.2
1989	6.2	5.8	5.4	5.0	4.7	4.5	4.3	4.1	3.8	3.6	3.6	3.4	3.3	3.2	3.2	3.0
1988	5.9	5.4	5.0	4.7	4.5	4.3	4.1	3.8	3.5	3.5	3.4	3.2	3.2	3.1	3.0	
1987	5.4	5.0	4.6	4.4	4.2	4.0	3.6	3.4	3.4	3.3	3.1	3.1	3.0	2.9		

Table 3. Average Net Discount Rates for Various Starting Years and Durations, continued

	Duration															
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1986	4.9	4.5	4.3	4.1	3.8	3.5	3.3	3.3	3.1	3.0	2.9	2.8	2.7			
1985	4.3	4.1	3.9	3.7	3.3	3.1	3.1	2.9	2.8	2.8	2.7	2.6				
1984	3.7	3.6	3.3	3.0	2.7	2.8	2.6	2.5	2.5	2.4	2.3					
1983	3.1	2.9	2.5	2.3	2.4	2.3	2.1	2.1	2.1	2.0						
1982	2.6	2.2	2.0	2.1	2.0	1.9	1.9	1.9	1.8							
1981	1.6	1.5	1.6	1.5	1.4	1.5	1.5	1.4								
1980	1.1	1.3	1.2	1.1	1.2	1.2	1.2									
1979	1.0	0.9	0.9	1.0	1.0	0.9										
1978	0.8	0.8	0.9	0.9	0.9											
1977	0.8	0.9	1.0	0.9												
1976	1.0	1.0	0.9													
1975	1.1	1.0														
1974	0.9															

Table 4 Variances for Various Starting Years and Durations

Starting Year	Duration															
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
2006	0.3	0.4	0.8	1.0	0.9	1.1	1.6	1.8	2.0	2.3	2.6	2.9	3.8	4.5	4.6	5.2
2005	0.2	0.7	0.8	0.7	0.9	1.4	1.6	1.7	2.1	2.3	2.6	3.5	4.2	4.3	4.9	4.7
2004	0.6	0.8	0.7	0.9	1.3	1.6	1.7	2.0	2.3	2.5	3.4	4.1	4.1	4.8	4.6	4.4
2003	0.8	0.8	0.9	1.4	1.6	1.7	2.0	2.3	2.5	3.5	4.2	4.2	4.8	4.6	4.4	4.4
2002	0.8	1.0	1.4	1.6	1.7	2.0	2.3	2.5	3.4	4.1	4.1	4.7	4.5	4.3	4.3	4.7
2001	1.0	1.5	1.7	1.7	2.0	2.3	2.4	3.4	4.1	4.0	4.6	4.4	4.2	4.2	4.7	5.1
2000	1.6	1.7	1.8	2.1	2.3	2.5	3.4	4.1	4.0	4.6	4.3	4.1	4.2	4.7	5.1	5.5
1999	1.8	1.8	2.0	2.2	2.4	3.3	4.0	3.8	4.4	4.2	4.0	4.1	4.7	5.1	5.6	5.5
1998	1.8	2.0	2.2	2.3	3.2	3.9	3.7	4.3	4.0	3.8	4.0	4.6	5.2	5.7	5.6	5.6
1997	1.5	1.6	1.7	2.6	3.2	3.1	3.6	3.4	3.2	3.5	4.3	4.9	5.5	5.5	5.5	5.7
1996	1.1	1.2	2.1	2.6	2.5	3.0	2.8	2.7	3.1	4.0	4.8	5.5	5.4	5.4	5.8	6.7
1995	1.0	1.9	2.5	2.3	2.8	2.6	2.5	3.0	4.1	4.9	5.6	5.6	5.6	6.0	7.0	7.3
1994	2.0	2.6	2.4	2.8	2.6	2.6	3.1	4.3	5.2	5.9	5.9	5.9	6.3	7.3	7.6	7.3
1993	2.5	2.3	2.7	2.5	2.5	3.2	4.4	5.4	6.2	6.2	6.2	6.6	7.6	8.0	7.6	7.7
1992	1.6	2.0	1.9	2.0	2.9	4.4	5.5	6.4	6.4	6.4	6.8	8.0	8.3	8.0	8.0	8.2
1991	1.8	1.8	1.9	2.9	4.6	5.8	6.9	6.8	6.8	7.2	8.4	8.7	8.3	8.4	8.5	8.2
1990	1.9	2.0	3.2	5.0	6.3	7.3	7.2	7.2	7.5	8.8	9.1	8.6	8.7	8.7	8.4	8.2
1989	2.1	3.4	5.4	6.8	7.9	7.7	7.6	8.0	9.2	9.5	9.0	9.0	9.0	8.7	8.4	8.5
1988	3.7	5.9	7.4	8.5	8.3	8.2	8.5	9.7	9.9	9.4	9.3	9.3	8.9	8.7	8.7	
1987	6.6	8.1	9.2	8.9	8.6	8.9	10.1	10.3	9.7	9.6	9.5	9.1	8.8	8.7		

Table 4 Variances for Various Starting Years and Durations, continued

Starting Year	Duration															
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1986	8.9	10.0	9.5	9.1	9.3	10.4	10.5	9.9	9.7	9.6	9.1	8.8	8.7			
1985	10.8	10.1	9.6	9.6	10.7	10.7	10.0	9.8	9.6	9.1	8.7	8.6				
1984	9.3	8.7	8.7	9.6	9.5	8.9	8.6	8.4	7.9	7.5	7.4					
1983	7.3	7.1	8.0	7.8	7.2	7.0	6.7	6.3	6.0	5.9						
1982	6.7	7.4	7.2	6.7	6.3	6.1	5.7	5.3	5.2							
1981	3.7	3.5	3.4	3.2	3.1	2.9	2.7	2.7								
1980	2.5	2.6	2.4	2.3	2.2	2.0	2.0									
1979	1.7	1.6	1.5	1.5	1.4	1.3										
1978	1.6	1.5	1.5	1.4	1.3											
1977	1.6	1.6	1.5	1.4												
1976	1.8	1.6	1.5													
1975	1.7	1.7														
1974	1.6															

Table 4, also spanning two pages, shows the variances associated with each mean net discount rate. The variances range from a low of 0.2 and a high of 10.8.

Table 5, also spanning two pages, shows the *t*-statistics at the 95 percent confidence interval that test the null hypothesis of identical means over varying durations calculated using the same starting year. In particular, Table 5 tests whether using a duration of 10 years results in an average net discount rate that is statistically different from net discount rates calculated using durations of between 11 and 25 years. The first column in Table 5 is a test for similarity of means when comparing 10-year and 11-year durations. Note that the first column heading is a duration of 11 years rather than 10 years because the cells in Table 5 compare two durations, the shortest of which is 10 years. The first element in the first column, the 11-year duration column, shows the *t*-statistic when the average net discount rate over the 10-year period of 2006 through 1997 is compared to the average net discount rate over the 11-year period of 2006 through 1996. The *t*-statistic suggests that these two particular averages are not statistically different.

The last element in the first column of Table 5 shows the *t*-statistic when the average net discount rate over the 10-year period of 1975 through 1966 is compared to the average net discount rate over the 11-year period of 1975 through 1965. Again, the *t*-statistic suggests that these two particular averages are not statistically different.

The last column in Table 5 is a test for similarity of means when comparing net discount rates calculated over a 10-year period with those calculated over a 25-year duration. The first element in the last column tests for comparability of net discount rates when both net discount rates are calculated looking backward from 2006. The *t*-statistic when the average net discount rate over the 10-year period of 2006 through 1997 is compared to the average net discount rate over the 25-year period of 2006 through 1982 suggests that these two averages are statistically different. The last element in the last column compares the net discount rate calculated over the 10-year period 1989 through 1980 with the net discount rate calculated over the 25-year period of 1989 through 1965. The *t*-statistic suggests that these two averages are statistically different as well.

Both Table 5 and Table 6 use shading of elements to identify their most interesting results.

The overall results in Table 5 are interesting. Starting in any year, the net discount rate calculated by looking back 10 years is not statistically different than the net discount rate calculated looking backwards as many as 14 years. The null hypothesis of similar means

Table 5 *t*-statistics for Identical Means between Durations of 10 and *t* Years

Starting															
							t = Duration								
Year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
2006	0.45	0.98	1.34	1.56	1.90	2.23	2.54	2.83	3.11	3.39	3.66	3.81	4.01	4.28	4.49
2005	0.68	1.07	1.28	1.65	2.00	2.33	2.64	2.93	3.22	3.50	3.65	3.86	4.14	4.35	4.58
2004	0.35	0.48	0.83	1.23	1.56	1.84	2.15	2.44	2.71	2.95	3.20	3.44	3.68	3.86	3.99
2003	0.11	0.46	0.89	1.21	1.49	1.80	2.09	2.37	2.64	2.91	3.14	3.39	3.55	3.66	3.53
2002	0.37	0.82	1.15	1.44	1.76	2.06	2.35	2.62	2.90	3.14	3.39	3.55	3.66	3.51	3.17
2001	0.46	0.80	1.07	1.40	1.70	1.98	2.28	2.58	2.80	3.07	3.21	3.29	3.12	2.77	2.46
2000	0.31	0.56	0.87	1.15	1.42	1.75	2.05	2.25	2.53	2.63	2.68	2.49	2.16	1.87	1.60
1999	0.23	0.54	0.82	1.08	1.44	1.75	1.94	2.22	2.30	2.33	2.12	1.78	1.48	1.20	1.11
1998	0.31	0.60	0.86	1.24	1.57	1.74	2.03	2.10	2.11	1.88	1.51	1.20	0.91	0.80	0.67
1997	0.30	0.58	1.00	1.36	1.53	1.84	1.88	1.86	1.56	1.14	0.78	0.46	0.32	0.16	0.07
1996	0.30	0.80	1.20	1.37	1.70	1.71	1.65	1.27	0.76	0.36	0.01	0.16	0.35	0.60	0.94
1995	0.57	0.99	1.14	1.49	1.47	1.37	0.95	0.42	0.01	0.35	0.54	0.74	1.01	1.33	1.58
1994	0.40	0.50	0.83	0.77	0.65	0.29	0.14	0.50	0.82	0.99	1.18	1.42	1.71	1.94	2.03
1993	0.06	0.39	0.30	0.14	0.21	0.62	0.96	1.26	1.45	1.64	1.87	2.14	2.37	2.47	2.66
1992	0.38	0.22	0.01	0.46	0.91	1.28	1.61	1.84	2.07	2.33	2.61	2.86	3.00	3.22	3.44
1991	0.22	0.48	0.92	1.33	1.69	2.02	2.26	2.50	2.77	3.04	3.29	3.45	3.68	3.91	4.07
1990	0.29	0.76	1.20	1.57	1.91	2.16	2.41	2.68	2.96	3.22	3.37	3.61	3.84	4.01	4.21
1989	0.52	1.00	1.39	1.74	1.98	2.24	2.52	2.80	3.07	3.22	3.45	3.69	3.85	4.04	4.26
1988	0.51	0.91	1.25	1.46	1.69	1.94	2.23	2.48	2.59	2.79	2.99	3.12	3.27	3.45	
1987	0.38	0.70	0.88	1.06	1.29	1.56	1.77	1.84	2.01	2.17	2.26	2.37	2.51		

Note: Shaded cells indicate statistical significance at the 95% level of confidence.

Table 5 *t*-statistics for Identical Means between Durations of 10 and *t* Years, continued

Starting															
							***t* = Duration**								
Year	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1986	0.31	0.46	0.62	0.83	1.10	1.29	1.33	1.48	1.62	1.69	1.77	1.90			
1985	0.13	0.27	0.47	0.73	0.91	0.93	1.07	1.20	1.24	1.32	1.43				
1984	0.13	0.32	0.60	0.78	0.79	0.92	1.05	1.08	1.15	1.26					
1983	0.19	0.49	0.68	0.66	0.78	0.92	0.93	0.99	1.11						
1982	0.31	0.49	0.43	0.55	0.68	0.67	0.72	0.83							
1981	0.18	0.02	0.13	0.25	0.18	0.19	0.31								
1980	0.25	0.17	0.06	0.18	0.20	0.08									
1979	0.07	0.18	0.01	0.06	0.06										
1978	0.10	0.12	0.20	0.09											
1977	0.23	0.31	0.19												
1976	0.07	0.07													
1975	0.16														

Note: Shaded cells indicate statistical significance at the 95% level of confidence.

can not be rejected. In almost all years, once duration extends beyond 20 years, the net discount rates often are statistically different from those calculated with a 10-year duration and the null hypothesis of identical means can be rejected. However, depending on the years, net discount rates calculated with durations within the range between 15 years and 20 years may or may not be statistically different from net discount rates calculated over a 10-year duration.

Exceptions to this result occur for the years 1998 through 1993. In those years, a 10-year average net discount rate is not statistically different from a net discount rate calculated over 20 years. Over this time span, duration does not seem to matter.

Tables such as Table 5 can be produced that compare average net discount rates over all other durations. The next table in the sequence, for example, would compare an 11-year duration to longer durations. A table after that would compare 12-year durations to 13-year through 25-year durations. The last table in the sequence would compare average net discount rates over 24 years to average net discount rates over 25 years. Although the tables are not shown here, their results are summarized in this article's Table 6.

The columns in Table 6 show the starting duration for which larger durations are compared. For example, the first column compares the net discount rate for a 10-year duration to net discount rates calculated over longer durations. The second column compares the net discount rate for an 11-year duration to net discount rates calculated over longer durations, and so forth. Accordingly, like Table 5 not having a 10-year duration column so too Table 6 does not have a 25-year column.

The rows in Table 6 show the starting year for the calculation of the net discount rate. In the first row, for example, all net discount rates were calculated when the duration looks backward from 2006. The elements in Table 6 are the number of years beyond the starting duration until the first statistically different mean net discount rate is found.

In Table 6, the upper left-hand element of 6 indicates that when net discount rates are calculated moving backward from 2006, it takes an increase in duration of six years beyond a 10-year duration before the resulting net discount rate is statistically different from the 10-year average net discount rate (i.e., from Table 5 the first shaded element in the year 2006 row is the 16-year duration column). The rest of the elements in that row show similar

Table 6. Years Between Durations for Means to be Statistically Different

Starting	Duration														
Year	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
2006	6	6	7	7	6	7	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*
2005	5	7	7	6	6	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*
2004	7	7	6	6	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
2003	7	6	6	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
2002	6	6	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
2001	6	7	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
2000	7	7	6	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1999	8	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1998	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1997	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1996	*N*	*N*	*N*	*N*	*N*	10	8	8	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1995	*N*	*N*	12	11	9	8	7	8	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1994	15	12	11	9	8	7	7	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1993	12	10	8	7	7	7	9	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1992	9	7	6	6	7	9	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1991	6	6	6	7	9	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1990	6	6	7	9	11	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
1989	5	7	9	11	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*

Note: Table 6 contains three forms of notation. The three notations are a number, the letter "*N*", and a cell containing an *N* being shaded. The number indicates the number of years that must be added to that column's duration before a statistical difference exists. The *N* indicates that no longer duration obtains a statistically significant difference. A shaded cell *N* indicates that no statistically significant difference is obtained by comparing with either shorter durations or longer durations than that column's durations. Shaded cell *N*'s are "encompassing" durations.

test statistics when the base net discount rate is calculated over longer periods. The second element in the 2006 row, for example, shows that it takes 6 years beyond an 11-year duration before the mean net discount rate is different from the 11-year average net discount rate (as discussed above, this type of table is not included in this article).

An *N* in Table 6 indicates that the net discount rate for the duration starting in that column is not statistically different from the net discount rate using any duration as large as 25 years. Looking at the first row of the table, for example, the average net discount rates over durations of 19 through 24 years are not statistically different than the average net discount rate over a 25-year duration.

Consider the results in Table 6 and the year 2003. The net discount rate using a 10-year duration is not statistically different from the net discount rate until durations starting at 17 years. However, the net discount rate using a 16-year duration is not statistically different from net discount rates associated with using durations out through 25 years. Therefore, selecting a duration of 16 years effectively produces an average net discount rate that is not statistically different from net discount rates generated using durations ranging between 10 and 15 years or between 17 and 25 years. A 16-year duration encompasses results using 10-year through 25-year durations. The duration that encompasses both ends of the spectrum is the region shown in gray in Table 6.

In the Table 6 row of 2006, there are no shaded elements because there are no "encompassing" durations that span the averages calculated using durations within the range of between 10 years and 25 years.

In the 2001 row, columns of 14-years and 15-years are the encompassing durations and thus are shaded elements. The net discount rate calculated in either year is not statistically different than discount rates calculated using durations of 10 years through 13 years or of 16 years through 25 years. In the 1997 row all columns are encompassing durations.

The general conclusion from Table 6 is that over the time period of 2006 through 1989 there is no duration of 10-years or longer than never is an encompassing value. Over that 18-year range on Table 6 of 2006 through 1989, more often than not durations of 16-years or longer do obtain statistically significant difference from longer durations. Never does a duration of 19-years or longer obtain a statistically significant difference from longer durations. However, the duration of 10-years performs best

with only the rows 1997, 1996, and 1995 failing to obtain at least one statistically significant difference from some other duration.

Conclusion

Economists have examined the proper duration to use when employing historical net discount rates as proxies for future net discount rates. Two tests were developed to investigate this issue. The first uses moving average net discount rates to examine the implications of duration. The results show that average net discount rates calculated over 10 years usually are, but sometimes are not, statistically different than net discount rates calculated over 11 through 25 years. These results indicate that duration may not be that important when using averages of historical net discount rates to calculate discount rates.

In the 2001 row, columns 14-years and 15-years are the encompassing durations and thus are shaded elements. The net discount rate calculated in either year is not statistically different than discount rates calculated using durations of 10 through 13 years or of 16 through 25 years. In the 2002 row, 15 years is the only encompassing duration. In the rows for 1997 through 1992, 18 years is always in the encompassing range. From row 1991 back to row 1989, the encompassing range is only 14 or 15 years.

The general conclusion from Table 6 is that over the time period 2006 through 1989, using durations of 14 years through 18 years represents the net discount rate that encompasses the widest range of durations. In 15 of the 18 years over that period, the net discount rate associated with using a 14-year through 18-year duration is not statistically different than the net discount rate associated with using durations of 10 years through 25 years. This range of five years, however, is fairly broad. In only one sample year – 1997 – are all five durations encompassing. Otherwise, observations from 1989 through 1991, as well as 1998 and later tend to cluster at the lower end of the range while observations between 1992 and 1996 tend to cluster at the higher end of the range. If the bands are narrowed from 15-year or 17-year durations, only 12 of the 18 sample years have an encompassing duration. If they are further narrowed from 16-year or 17-year durations, only eight have encompassing durations.

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Forensic economists shall at all times strive to practice within the boundaries of professional and disciplinary honesty and fairness. To this end, they must assume the responsibility of holding their colleagues in the profession accountable to the ethical principles promulgated herein.

Editor's Note

Each issue of a journal presents its own challenges and learning opportunities. Any attentive editor always will be humbled by the generosity of others and the aid they provide to that journal. A host of folks are owed a hearty thank you. Alas, this short space could not accommodate so long a list. Thus, this general "Thank you!" will need to suffice for the authors, the reviewers, the *JLE* Board of Editors, the AAEFE Board of Directors, and the cheerful assistance of the editorial staff.

JLE v14i2 offers up to the reader four distinctive views of universal problems confronting forensic economics; albeit each article is cloaked in the garb of a distinctive branch of forensic economics. First, Rosenbaum and Guthmann gaze into the future, while standing in the past, only to find a dimly defined forecasting horizon. Next, Dawson grapples with how to assess value that springs from access to a resource. Then, Nieberding and Cantor seek to define the boundaries of the market and its participants. Lastly, McCollister and Pflaum challenge an assumption standard to all statistical analysis. The *Journal* hopes you will find each as enjoyable a read as each is an informative read.

I would be remiss if I did not, in some manner, note the trials and tribulations besetting AAEFE and the *JLE* over the last year and a half. As tempting as it might have been to be disheartened by the behavior of some, without fail the courage, steadfastness, and cheerfulness of many more has been a well received balm. Let me just say that lose, draw, or win (however any one of those might be calibrated), my attitude will be about the same. K.D. Lang catches that spirit quite well in the lyrics of her song "Luck in My Eyes" (http://www.lyricsfreak.com/k/k.d.+lang/luck+in+my+eyes_20076951.html visited on September 23, 2007.) Regardless of the outcome, *JLE* has built up an inventory of manuscripts that justify an expectation of a second year that includes three issues of the *JLE*. That is something that has not happened since during Creighton Frampton AAEFE President's term of office. When the AAEFE Members assemble at 6:00 PM on Wednesday, March 26, 2008 in Las Vegas they will assemble with a reinvigorated *JLE*. Hopefully, when they depart around 4:00 PM on that Friday they will have clarity of situation and purpose as well as material diminution of rancor.

Journal of
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Contents

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All reviewers and all authors were required to self identify any conflicts of interest that might apply to the performance of their respective professional tasks. All conflicts of interest identified by the authors and reviewers for each manuscript are listed below:

No declared conflicts of interest.

Mission of the *Journal of Legal Economics*

JLE is the publication of AAEFE; as such the *Journal* focuses upon the proof of monetary damages in a litigation context. Clearly **theory** is welcome; however, theoretical manuscripts need to be focused on the questions related to proof. For example, manuscripts focused on theory often speak to the professional limits on the expert's ability to assist the trier of fact. Manuscripts focused on the **practice** of forensic economics often are the core of the *Journal*. Manuscripts focused on the **pedagogy** of forensic economics are relatively rare because there are so few academic curriculums devoted to the field.

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If you can not use the web site, then contributors must submit *four hard copies* of manuscript *in addition to one diskette copy* with all work saved in Microsoft Word 2000 or higher for Windows 2000 or higher.

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To join AAEFE, or to pay the submission fee via the web, please follow this link: **http://nbdc.unomaha.edu/aaefe/**. Your credit card charge will be by the University of Nebraska at Omaha (or its Nebraska Business Development Center) rather than by AAEFE or the *JLE*. Your surface mail receipt will clearly describe the purpose of your credit card charge.

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13. All matters of style should correspond to those prescribed by the *Chicago Manual of Style*, 14th ed.

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Book

Martin, Gerald D. 2007. *Determining economic damages*. Costa Mesa, CA: James Publishing, Inc.

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Journal Article

Ray, Clarence G. 1991. President's comments: The economic expert and civil litigation. *Journal of Legal Economics* 1(1): 1–4.

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Book Article or Chapter

Hall, Robert E, and Victoria A. Lazear. Reference guide on estimation of economic losses in damages awards. In *Reference manual on scientific evidence.* 2d ed. Federal Judicial Center. St. Paul, MN: West Group.

Website

Ireland, Thomas. 2006. Court decisions of special interest to forensic economists. In *Useful information about forensic economics*. University of Missouri Saint Louis. [Last visited September 22, 2007]. Available: http://www.umsl.edu/divisions/artscience/economics/ForensicEconomics/CasesFE.html

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