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Assessing Alternative Methods of Estimating the Present Value of Future Earnings: A Fifteen-Year Update

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I. Introduction

In the inaugural issue of this *Journal*, Dulaney (1987) offered an assessment of the forecast accuracy of four "conventional" methods of estimating the present value of future earnings. He tested the four methods over 15 rolling 20-year future periods, with the first period covering 1953-1972 and the last covering 1967-1986. For each method and for each period, he first calculated the *estimated* present value of the future loss. He then compared this estimated present value to the *actual* present value,[1] the amount of money that actually would have been needed to replace the lost future earnings as determined with the benefit of hindsight. These comparisons between the estimated and actual present values formed the basis for an assessment of the forecast accuracy of each method.

In this update, these same four conventional methods are evaluated again over the next 15 rolling 20-year periods, with the first covering 1968-1987 and the last covering 1982-2001. Meaningful comparisons of Dulaney's and some new results for the earlier periods with the results for the more recent periods are possible for three of the four methods. These comparisons indicate that the forecast accuracy of all three methods was much worse for the more recent periods. Furthermore, results for the fourth method indicate that it is no more accurate than the other three for the more recent periods. These findings are placed in the context of other recent efforts that have been made to assess the forecast accuracy of various estimation methods. Considering this entire body of work, it seems fair to say that there remains considerable room for improvement in the methods used by forensic economists to estimate the present value of lost future earnings.

II. Assessing the Various Methods

In Dulaney's paper, he described four conventional methods of obtaining the "growth-discount rate" to be used to estimate present value in cases involving lost future earnings.[2] If W is the projected nominal rate of compensa-

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[1]Dulaney used the term "*simulated* present value" for what is here called *actual* present value.

[2]Earnings were interpreted to mean compensation, including fringe benefits. Given the increasing importance of fringe benefits in the post-World War II period, a labor earnings series that includes

tion growth and R is the projected nominal rate of interest, then the growth-discount rate, G, is defined as:

$$G = [(1 + W)/(1 + R)] - 1.$$

As defined, the growth-discount rate is a "net growth rate," a variation of the now more commonly used "net discount rate."[3] The data set used for measuring W was the Bureau of Labor Statistics series on compensation per hour in the U.S. business sector, while the measure of R used was the average yield on three-year U.S. Treasury notes. The four conventional methods assessed by Dulaney were:[4]

(1) The *single base year* method, in which W and R are assigned the values of the compensation growth rate and interest rate, respectively, in the base year of the loss period;
(2) The *three-year base period* method, in which W and R are assigned the values of the average compensation growth rate and the average interest rate, respectively, for the three-year period ending in the base year of the loss period;
(3) The *total offset* method, in which it is assumed that the future compensation growth rate will equal the future interest rate (W = R);
(4) The *historical averages* method, in which W and R are assigned the values of the average compensation growth rate and the average interest rate, respectively, for some meaningfully long historical period.

According to a recent survey, the historical averages method is the most common method in current use by forensic economists. (Brookshire and Slesnick 1999, 74) It should be noted, however, that there is a serious problem with Dulaney's test of this method. For this method, W and R should be assigned values equal to the average rates over some specified historical period. In other words, one should look *backward* at some appropriate historical period to choose values for W and R to be projected *forward* over the future loss period. But as Dulaney stated, "...meaningfully long series of earnings and interest rate data did not precede any of the test periods under consideration...." (Dulaney, 1987, p. 41) Therefore, he used the average compensation growth rate and the average interest rate for the entire period 1953-86 for the measures of W and R that he used to estimate present value for each of the 15 rolling 20-year periods, 1953-1972 through 1967-1986. In all cases, the historical period completely overlapped the future period for which the estimates were being made. This is not a method that any forensic economist can use in practice, since it requires already knowing the future data on compensation and interest rates in order to translate future losses to present value. Therefore, it

fringe benefits does seem clearly preferable to a wage-only series for calculating growth-discount rates.

[3]The net discount rate, D, may be defined as [(1 + R)/(1 + W)] -1, where R and W are again the projected interest and compensation growth rates.

[4]The names of these methods have been slightly altered from those used by Dulaney to make them more descriptive.

is reasonable to conclude that, due to the limitations of his data set, Dulaney was not able to properly test the historical averages method.[5]

Among the three methods that were properly tested, Dulaney found the three-year base period method to be superior because it exhibited the lowest average estimation error and the lowest average degree of bias. For the three-year based period method, the average difference between the estimated and actual present values was 8.5%, with a slight average tendency for the estimated present value to exceed the actual present value. For the single base year method, the average difference between the estimated and actual present values was somewhat higher, 11.9%, with a similar average tendency towards overestimation. The total offset method resulted in an average difference between the estimated and actual present values of 8.8%, so it was almost as accurate as the three-year base period method. However, the total offset method exhibited a greater degree of bias, but in the direction of *under*-estimating the actual present value.

III. Other Similar Studies

Since the time Dulaney's paper was published, there have been relatively few similar studies in which one or more methods of estimating present value have been tested by comparing the estimated and actual present values and determining the relative size of the forecast errors. In an important paper that slightly preceded Dulaney's, Schilling (1985) used economy-wide data on wages along with interest rates on high-grade corporate bonds to test both the total offset method and the historical averages method for numerous rolling loss periods of 30, 12 and 5 years in length extending over the period 1900-1982. He found a "clear if modest superiority" (p. 114) for the total offset method, although perhaps the best that could be said for it was that it was "less inaccurate" (p. 114) than other methods.[6] The total offset method produced mean deviations of the estimated from actual present values of 27% for 30-year loss periods, 16% for 12-year loss periods and 8% for 5-year loss periods. The comparable figures for the historical averages method (with the historical period always equal in length to the forecast period) were 32% for 30-year periods, 26% for 12-year periods and 11% for 5-year periods.

Further results for the total offset method were presented by Pelaez (1989). He used interest rates on one-year Treasury bills and wage data for three sectors and 15 two-digit industries to examine five alternative loss periods of 12, 17, 22, 27 and 32 years in length, with all loss periods ending in 1986. He found that "...for a large number of industries and for diverse worklives, total offset awards are not significantly different from fair awards." (p. 59) The de-

[5]The same problem is *intrinsic* to a fifth method, devised by Dulaney, which he referred to as the *historical simulation approach*. Consequently, it is not discussed in this paper.

[6]Schilling referred to the total offset method as the "Alaska" method, reflecting the fact that it was mandated in the state of Alaska at the time he was writing. He referred to the historical averages method as the "simplified compound discount" method, and he also tested a third method he called the "compound and discount" method. For descriptions of all three methods, see Schilling 1985, pp. 105-106.

viations of the estimated present values from the actual present values were in most cases less than 10%, a much better outcome than found by Schilling.

In a later paper, Pelaez (1991) provided additional findings for both the total offset method and the historical averages method, again using one-year Treasury interest rates and wage data for 21 two-digit industries. He considered two loss periods, 1955-1972 and 1972-1989. For the total offset method, the mean deviation of the estimated from the actual present values for the 21 industries was 3.4% for the 1955-1972 period and 8.8% for the 1972-1989 period. Again, these were far better results than found by Schilling, although it should be noted that this study covered just two loss periods whereas the Schilling study covered a total of 205 periods. Pelaez's results for the historical averages method were actually somewhat better than for the total offset method, with mean deviations of 2.6% for the 1955-1972 period and 6.5% for the 1972-1989 period. However, Pelaez used the entire 1955-1989 period as the "historical" period on which to base the net growth rate used to estimate present values for the 1955-1972 and 1972-1989 "future" periods. So these results suffer from the same problem as Dulaney's, the overlap between the historical period and the future periods for which the forecasts were made. And again, only two loss periods were considered.

In another article, Pelaez (1995) again examined the accuracy of the total offset method, this time for 20 two-digit industries over the period 1955-1993, again using interest rates on one-year Treasury securities and industry wage data. He found that the total offset method resulted in single-digit percentage deviations of estimated from actual present value in 13 of the 20 industries for the full 1955-1993 period. However, when the full period was broken in two parts, the method tended to result in under-compensation for the 1955-1979 period and over-compensation for the 1980-1993 period. He interpreted his results as generally supporting the use of the total offset method.

Haydon and Webb (1992) used economy-wide wage data and interest rates on three-month Treasury bills for the 40-year period 1948-1987 to study the accuracy of the historical averages method. Using 1962 as the base year, they tried to find the best length of the past period (5, 10, 15 or 20 years) on which to base the net discount rate for estimating the present values for various future loss periods (10, 15 and 20 years). While Haydon and Webb avoided the problem of overlapping past and future periods, their 40-year data set limited them to consideration of very few cases of longer-term losses. They could consider just one case of a 20-year historical period used to estimate for a 20-year future loss, two cases of using a past 20-year period to estimate for a 15-year future period, two cases of using a past 15-year period to estimate for a future 20-year period, etc. Overall, their results were inconclusive. Noting an upward trend in the net discount rate over the time period covered in their study, they suggested use of a net discount rate that was the average of rates based on longer and shorter historical periods.

Falero (1996) set out to assess four alternative methods of estimating present value. Using both short-term and long-term Treasury interest rates and U.S. manufacturing wages for all possible rolling 20-year loss periods from 1920 through 1994, he tested (1) a method similar to Dulaney's single base year method, (2) a method similar to Dulaney's three-year base period method, (3) the total offset method, and (4) the simple use of a net growth rate of +1.5.[7] Unfortunately, Falero's test of the single base year method was flawed by his substitution of the inflation rate for the wage growth rate in the calculation of his net growth rates, thus ignoring the possibility of any real wage growth. For his test of the base period method, he used a five-year base period instead of three years, a reasonable alternative, but in this case he used an erroneous measure of the five-year wage growth rate that resulted in a systematic understatement of the net growth rates.[8] In any case, both of these methods, as well as the total offset method, failed to meet his statistical tests of acceptable performance. Only the fourth "method," the simple use of a net growth rate of +1.5%, produced acceptable forecasting performance, and Falero offered no explanation for how this particular value was chosen.

To sum up, the few studies of the kind discussed in this section have produced mixed results, and they have not led to any consensus concerning what is the most accurate method of estimating the present value of a future earnings loss. Taken altogether, they do not foster much confidence in the accuracy of any of these methods of estimating present value.

IV. Comparisons of 1953-1967 and 1968-1982 Results

The main focus of this section is on the comparison of results for the earlier 15 rolling 20-year periods covered in Dulaney's study, extending from 1953-1972 through 1967-1986, with the new results for the 15 rolling 20-year periods extending from 1968-1987 through 1982-2001. Direct comparisons can be made for the single base year method, the three-year base period method, and the total offset method. In addition, new results of a reasonable test of the historical averages method are presented for the later 15 periods.

The data series used to generate the new results are the same as those used by Dulaney. Compensation growth is measured using the BLS series on compensation per hour in the U.S. business sector (see Jacobs 2001 and *Economic Report of the* President 2003), and the interest rate series used is based on three-year U.S. Treasury notes (see *Economic Report of the President* 2003).

An attempt was made to calculate the estimated and actual present values in a manner consistent with the methods described in Dulaney's paper. The Appendix contains a detailed description of the computational methods used in the present paper. These methods, when applied to the earlier 1953-67 periods, do not in fact replicate Dulaney's results, for reasons that are not entirely clear. However, for purposes of the comparisons to be made, Dulaney's results and the results of the attempted replication are close, and the conclusions that can be drawn with either set of results are the same.

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[7]Falero called these four methods, respectively, the "current rate method," the "modified current method," the "full offset method," and the "net below market method." Comparing Schilling (1985), Dulaney (1987), Falero (1996) and the present paper, it is evident that the lack of a consistent nomenclature is a problem in this area of forensic economics research.

[8]Rather than use a five-year compound average growth rate, Falero used a simple average growth rate that included just four years of growth for each five-year period. It was calculated for year t as $((wage_t - wage_{t-4})/wage_{t-4})/5$.

For various estimation methods (single base year, three-year base period, total offset), Table 1 presents: (1) results from Dulaney's study of the 15 20-year rolling periods from 1953-1972 through 1967-1986; (2) new results for the same periods covered by Dulaney using the computational methods described in the Appendix; and (3) new results for the later 15 20-year rolling periods from 1968-1987 through 1982-2001 using these same computational methods. The comparative data include the breakdown of deviations of estimated from actual present values between over- and under-estimation (column 3), the mean percentage deviation (without regard to sign) of the estimated from the actual present values (column 4), and the mean ratio of the estimated to actual present values (column 5). The mean percentage deviation is the average of the absolute values of the percentage differences between the estimated and actual present values, and serves as a measure of relative *accuracy*. In general, the lower the mean percentage deviation, the more accurate is the estimation method. The mean ratio of estimated to actual present values is a measure of *bias*. If the mean ratio in column 5 exceeds 1.00, this indicates an average tendency towards over-estimation, a bias in favor of the plaintiff. If the mean ratio is less than 1.00, this indicates an average tendency towards under-estimation, a bias in favor of the defendant.

Table 1
Summary of Results—Four Estimation Methods

(1)	(2)	(3)	(4)	(5)
Method	Beginning Years of 20-Year Periods	Direction of Deviations from Actual P.V.	Mean Deviation of Estimated from Actual P.V.	Mean Ratio Estimated to Actual P.V.
Single Base Year	1953-1967 (Dulaney)	7 over, 8 under	11.9%	1.05
	1953-1967 (New)	9 over, 6 under	11.2%	1.05
	1968-1982 (New)	13 over, 2 under	24.7%	1.23
Three-Year Base	1955-1967 (Dulaney)	7 over, 6 under	8.5%	1.04
	1955-1967 (New)	8 over, 5 under	5.9%	1.03
	1968-1982 (New)	14 over, 1 under	26.6%	1.27
Total Offset	1953-1967 (Dulaney)	0 over, 15 under	8.8%	0.91
	1953-1967 (New)	0 over, 15 under	8.1%	0.92
	1968-1982 (New)	14 over, 1 under	18.3%	1.18
Historical Averages	1968-1982 (New)	15 over, 0 under	27.4%	1.27

The differences in results between the earlier periods covered by Dulaney and the more recent periods are rather large. Since there are small differences between Dulaney's results and the new results for the same earlier periods, the focus here will be on comparing the new results for both the earlier and later periods that were produced using a consistent set of methods.

Referring to Table 1, consider first the single base year method. For the earlier 15 periods, this method resulted in over-estimation of the actual present value in nine cases, and under-estimation in the remaining six cases, a relatively balanced outcome. For these 15 periods, the mean percentage deviation was 11.2% and there was a small average bias in favor of plaintiffs, with a mean ratio of estimated to actual present values of 1.05. For the later 15 periods, the single base year method resulted in over-estimation in 13 of the 15 cases. The mean deviation was 24.7%, more than twice as large as for the earlier periods, and the mean ratio of estimated to actual present value was 1.23, indicating a much stronger average bias in favor of the plaintiff.

With the three-year base period method, the differences are even greater. For the earlier 15 periods, there was over-estimation in eight cases and under-estimation in five cases.[9] The mean deviation was 5.9%, and again there was a relatively small average bias for the plaintiff, with a mean ratio of estimated to actual present values of 1.03. For the later 15 periods, the three-year base period method produced over-estimation in 14 of 15 cases. The mean deviation was 26.6%, more than *quadruple* the mean deviation of the earlier periods. The mean ratio of estimated to actual present values was 1.27, again indicating a much stronger bias in favor of the plaintiff in the later periods.

Next, consider the forecast performance of the total offset method. This method resulted in *under*-estimation in all 15 cases for the earlier periods, but *over*-estimation in 14 out of 15 cases for the later periods, a dramatic turnaround. The mean deviation more than doubled from 8.1% in the earlier periods to 18.3% in the later periods, while the mean ratio of estimated to actual present values swung from 0.92 (bias for the defendant) for the earlier periods to 1.18 for the later periods (bias towards the plaintiff).

To sum up, these three conventional methods all produced much better forecast results for the 20-year periods beginning in 1953 through 1967 than for the 20-year periods beginning in 1968 through 1982. For the earlier periods, both the single base year method and the three-year base period method produced mixed results between over-estimation and under-estimation, while the total offset method always under-estimated the actual present values. The three-year base period method yielded the best overall results, with a mean deviation of 5.9% and a mean ratio of estimated to actual present values of 1.03. In sharp contrast, for the later periods, all three methods performed much worse. All three methods almost always over-estimated the actual present value. Compared to the earlier periods, mean estimation errors doubled for the single base year method and the total offset method and quadrupled for the three-year base period method, while the mean ratios of estimated to ac-

[9]For this method there were only 13 rolling 20-year periods in Dulaney's study, beginning with 1955, since three years of data were needed to compute the average compensation growth and interest rates, and the interest rate series dates back only to 1953.

tual present values shifted heavily towards bias in favor of the plaintiff with all three methods. For the later periods with beginning years 1968 through 1982, the total offset method produced the best overall performance, but the mean percent deviation was a relatively large 18.3% and the mean ratio of estimated to actual present value was 1.18.

As already noted, Dulaney was unable to undertake a suitable test of the historical averages method. Given the passage of time, however, it is now possible to use the same data series to perform a meaningful test of the historical averages method for the rolling 15 20-year periods with beginning years from 1968 through 1982. Since few such studies have been done (see section III), and since it is a method in common use, it seems worthwhile to do so.

Given the limitations of the interest rate series, one can use a maximum *past* historical period of 16 years ending in the base year to derive the net growth rate for the 20-year forecast period beginning in 1968.[10] Therefore, for each of the 15 rolling 20-year periods beginning in 1968 through 1982, the immediately preceding 16-year period was used to calculate the historical average earnings growth and interest rates used to estimate present value.[11] As shown in Table 1, the results are very close to those obtained for both the single base year and three-year base period methods for the same periods. The mean deviation of the estimated present values from the actual present values was 27.4%, and the method was highly biased, as it produced an overestimate in all 15 cases with a mean ratio of estimated to actual present values of 1.27. Clearly, the historical averages method does not represent an improvement over the other three methods for the more recent periods.

V. Explanation of Comparative Results

No one familiar with the relative movement of interest rates and earnings growth rates in the U.S. economy in recent decades should be surprised by the comparative results just described. Interest rates jumped sharply in the late 1970s and early 1980s, and the relationship between interest rates and compensation growth rates changed abruptly at about the same time. This is illustrated in Figure 1, which shows the yield on three-year Treasury notes as well as the annual net growth rate for each year from 1953 through 2001. The annual net growth rate was usually positive prior to 1980, but then fell sharply, reaching a low of -6.7% in 1984. It remained negative until 1998, when it became slightly positive again. Several scholars have identified a "break" or "regime shift" in the relationship between earnings growth and interest rates

[10]There is no consensus on whether short-term, intermediate-term, or long-term interest rates should be used for the purpose of discounting a long-term future loss. (See Brookshire and Slesnick 1993, pp. 35-36.) In evaluating the accuracy of the historical averages method, the choice among interest rates should make little difference, as long as the same interest rate is used to calculate both the estimated and actual present values. Therefore, the three-year Treasury note is again used here.

[11]According to a recent survey, forensic economists who used the historical averages method used an average of 28 years of interest rate data for discounting a 30-year future loss. (Brookshire and Slesnick 1999) Therefore, for the present case of a 20-year future loss, 16 years of data would seem to provide a reasonable, if not ideal, test of common practice.

around 1980, with much lower net growth rates (higher net discount rates) prevailing after the break than before.[12] (Havrilesky, 1989; Johnson and Gelles, 1996; Horvath and Sattler, 1997; Sen, Gelles and Johnson, 2000). Havrilesky (1989) attributed this break to structural changes in the economy arising from a slowdown in productivity growth, soaring federal budget deficits, an increase in the overall public and private debt burden, deregulation of the financial sector, and a change in monetary policy away from an emphasis on moderating interest rates.

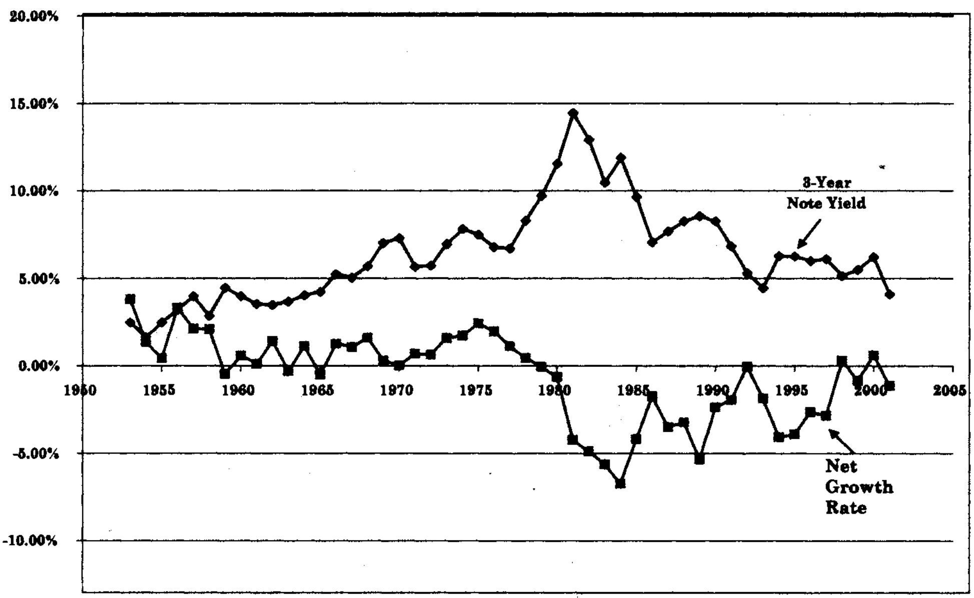

Figure 1
Three-Year Treasury Note Yield and Annual Net Growth Rate, 1953-2000

In general, when the net growth rate used to estimate the present value of a 20-year future loss proves to be significantly higher than the net growth rates that actually prevail over the future period, the estimated present value will be too high and the plaintiff will be significantly over-compensated. On the other hand, if the net growth rate used for estimation proves to be lower than those that prevail in the future period, the estimated present value will be too low and the plaintiff will be under-compensated. The results for the earlier periods were mixed, but for the 15 rolling 20-year periods from 1968-1987

[12]Sen, Gelles and Johnson (2000) have pin-pointed the break as having occurred in the third quarter of 1978.

through 1982-2001, over-compensation predominated because of the time pattern of the net growth rates shown in Figure 1.

With respect to use of the total offset method, the net growth rate used for estimation is always zero. When this method was used for the earlier periods for which net growth rates were generally positive, it underestimated the actual present values. When it was used for the later periods in which net growth rates were generally negative, it overestimated present values.

VI. Time Series Studies

The behavior over time of the net growth rate suggests another approach to evaluating various methods of estimating the present value of future lost earnings. This approach involves the examination of the time series properties of interest rates, earnings growth rates and net discount rates using the statistical tools of modern time series analysis, including stationarity tests and cointegration analysis. (See, for example, Lewis, 1991; Haslag, Nieswiadomy and Slottje, 1991 and 1994; Bonham and La Croix, 1992; Gamber and Sorensen, 1993 and 1994; Gilbert, 1996; Pelaez, 1996; Payne, Ewing and Piette, 1998 and 1999; Piette, Payne and Ewing, 1999). These time series studies are potentially useful in determining the appropriateness of various methods of estimating present value, although, unlike the studies described in section III, they do not generally provide information on the degree of accuracy or inaccuracy that may arise from their use. While a thorough review of this literature is beyond the scope of this study, a brief discussion is in order.[13]

The time series of the net discount rate, derived from the interest rate and the earnings growth rate, may be relatively stable and predictable even if the interest rate and earnings growth rate are not, provided that the latter two variables share a common stochastic trend. The net discount rate series will be stationary (i.e., be mean-reverting) if, and only if, the interest rate and earnings growth rate are cointegrated. If the time series of the net discount rate is stationary about its mean, then this provides justification for the use of the historical averages method to determine the interest rate and the earnings growth rate (or the net discount rate derived from them) to be used in discounting future lost earnings to present value. Furthermore, if the historical net discount rate is stationary and also has a value of approximately zero, this provides justification for the use of the total offset method. If the net discount rate is *not* a stationary series but is a pure random walk without drift or deterministic trend, there is no justification for the use of historical averages, and the use of the most recent value (the single base year method) would be preferable. If the net discount rate exhibits drift or deterministic trend, then the simple historical averages method is again inappropriate, although in these cases historical data may still be useful in selecting an appropriate net discount rate. In light of all this, a great deal of effort has gone into analyzing the time series properties of the net discount rate.

Results of the time series studies have been mixed, depending in part on the specific span of time covered and on the specific statistical methods used.

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[13]For a concise review, see Payne, Ewing and Piette (1999), pp. 215-217.

The works of Haslag, Nieswiadomy and Slottje (1991, 1994), Pelaez (1996) and Gilbert (1996) have lent support to the use of the historical averages method, but most other studies have not (Lewis, 1991; Bonham and La Croix, 1992; Gamber and Sorenson, 1993 and 1994; Payne, Ewing and Piette, 1998). The time series studies generally have been confounded by the sharp downward movement in net growth rates (upward movement in net discount rates) that occurred in the late 1970s and early 1980s. In rejecting use of the historical averages method, Bonham and La Croix (1992) and Payne, Ewing and Piette (1998) both have suggested using the most recent value of the net discount rate for discounting purposes. Others have found the net discount rate to be trend stationary with mean reversion properties (Pelaez, 1996; Piette, Payne and Ewing, 1999), indicating that historical data are useful for forecasting purposes as long as the trend component is taken into account. But Gamber and Sorenson (1993, 1994) concluded that the net discount rate is stationary around a shifting mean, and suggested use of the mean since the last shift. Payne, Ewing and Piette (1999) have more recently offered a similar suggestion, supporting the use of historical averages for discounting purposes as long as one recognizes structural breaks and avoids using an average that encompasses both pre- and post-break periods.

While the appropriateness of the historical averages method may be considered to be an unsettled issue, numerous recent research studies have led to a near-consensus against use of the total offset method. While the method has had its defenders (Pelaez, 1989 and 1995; Lawlis and Male, 1994; Schwartz, 1997), critics of the total offset method are numerous (Nowak, 1991; Gelles and Johnson, 1996; Horvath and Sattler, 1997; Haydon and Webb, 1997; Ireland, 1999; Sen, Gelles and Johnson, 2000; Payne, Ewing and Piette, 2001). Using the interest rate most favorable to acceptance of the total offset method (the three-month Treasury bill rate), Sen, Gelles and Johnson (2000) found that the net discount rate averaged 3.21% over the "post-break" period from 1978 through 1999. Looking at just the last 10 years of that period, the net discount rate still averaged 1.76%, far from zero. And another recent empirical study has concluded that, for the period 1980-2000, the assumptions of the total offset method are not supported by the data and the use of the method is not valid (Payne, Ewing and Piette, 2001, p. 11). Findings such as these may explain why, as Ireland has stated (1999, p. 21), only a small number of forensic economists now use this approach. Be that as it may, the results of the present study show that the total offset method actually worked somewhat better than the other three methods tested for the 15 20-year periods from 1968-1987 through 1982-2001.

VII. Summary and Conclusions

Forensic economists use a variety of methods to determine the appropriate net discount rate (or its component parts, the interest rate and earnings growth rate) to be used to estimate the present value of a future earnings loss. Studies by Dulaney and a few other researchers have attempted to directly assess the relative forecast accuracy of several of these methods. For each method and for various time periods, they have compared the estimated present value of the future loss to the actual present value as determined with hindsight.

Dulaney's study covered four methods (single base year, three-year base period, total offset, historical averages) of estimating present value for 15 rolling 20-year loss periods with beginning years 1953 through 1967. The present study has updated his work to cover the next 15 rolling 20-year loss periods with beginning years 1968 through 1982. For the three methods for which direct comparisons are possible, each method performed much worse in the later periods than in the earlier periods, and the fourth method (historical averages) did not represent an improvement over the other three for the later periods.

A review of other similar studies indicates that they have produced mixed results, and the results of time series studies are also ambiguous. At this time there is no single method for which clear superiority can be claimed or which exhibits a high degree of accuracy over long periods of time. The development and use of better methods of estimating the present value of future lost earnings should remain a priority for forensic economists.

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Appendix

In the calculation of both the actual present values and the estimated present values, it has been assumed that interest payments are credited and wage payments are made at the end of each year. The calculations are made for a worker whose compensation would have tracked the economy-wide compensation index. As with all other studies of this type, complications that might arise due to taxes, consumption allowances or the use of age-earnings profiles have been ignored.

Table A-1 illustrates the calculation of the "actual" present value at the beginning of 1982 for the future losses over the 20-year period 1982-2001, assuming a base annual loss of $10,000. The earnings growth rate for each year is the percentage change in the index of hourly compensation for the U.S. business sector between the previous year and that year (see Jacobs 2001 and *Economic Report of the* President 2003), whereas the interest rate is the average yield on the three-year Treasury note during that year (see *Economic Report of the President* 2003). Starting with the beginning balance in Year 1 (1982), interest is added and earnings subtracted, resulting in the ending balance for Year 1. This becomes the beginning balance for Year 2 (1983), and again interest is added and earnings subtracted, resulting in the ending balance for Year 2, which becomes the beginning balance for Year 3, etc. The problem is to find the correct beginning balance in Year 1 so that the ending balance in Year 20 = 0. This problem is easily solved using the "Goal Seek" function in the Microsoft Excel spreadsheet program. (Other spreadsheet programs have similar functions.) As shown, the correct answer is $138,044. It should be noted that the "actual" present value calculated in this manner depends on the exact year-to-year movement of both the compensation growth rate and the interest rate, and not just their average values over the period.

Table A-1
Calculation of Actual Present Value
(Base Loss = $10,000; Period Starts 1982)

Year Number	Calendar Year	Earnings Growth	Interest Rate	Beginning Balance	Plus Interest	Minus Wages	Ending Balance
1	1982	7.41%	12.92%	**$138,044.44**	$17,835.34	$10,741.00	$145,138.78
2	1983	4.23%	10.45%	$145,138.78	$15,167.00	$11,195.34	$149,110.44
3	1984	4.36%	11.89%	$149,110.44	$17,729.23	$11,683.46	$155,156.20
4	1985	5.04%	9.64%	$155,156.20	$14,957.06	$12,272.31	$157,840.95
5	1986	5.21%	7.06%	$157,840.95	$11,143.57	$12,911.69	$156,072.83
6	1987	3.91%	7.68%	$156,072.83	$11,986.39	$13,416.54	$154,642.68
7	1988	4.77%	8.26%	$154,642.68	$12,773.49	$14,056.51	$153,359.66
8	1989	2.75%	8.55%	$153,359.66	$13,112.25	$14,443.07	$152,028.84
9	1990	5.71%	8.26%	$152,028.84	$12,557.58	$15,267.76	$149,318.66
10	1991	4.74%	6.82%	$149,318.66	$10,183.53	$15,991.46	$143,510.74
11	1992	5.26%	5.30%	$143,510.74	$7,606.07	$16,832.61	$134,284.20
12	1993	2.50%	4.44%	$134,284.20	$5,962.22	$17,253.42	$122,992.99
13	1994	1.95%	6.27%	$122,992.99	$7,711.66	$17,589.86	$113,114.79
14	1995	2.11%	6.25%	$113,114.79	$7,069.67	$17,961.01	$102,223.46
15	1996	3.19%	5.99%	$102,223.46	$6,123.18	$18,533.97	$89,812.67
16	1997	3.09%	6.10%	$89,812.67	$5,478.57	$19,106.67	$76,184.58
17	1998	5.46%	5.14%	$76,184.58	$3,915.89	$20,149.89	$59,950.58
18	1999	4.59%	5.49%	$59,950.58	$3,291.29	$21,074.77	$42,167.10
19	2000	6.87%	6.22%	$42,167.10	$2,622.79	$22,522.61	$22,267.28
20	2001	2.91%	4.09%	$22,267.28	$910.73	$23,178.01	$0.00

Table A-2 illustrates the calculation of the "estimated" present value for the same period using the *single base year* method. The earnings growth rate for 1982 is 7.41% while the interest rate is 12.92%. Therefore, beginning with the first year, 1982, earnings are assumed to grow at the rate of 7.41% every year over the entire period, while each year's earnings are discounted to present value using the discount rate of 12.92%. The result is the estimated total present value of $123.261. For the *three-year base period* method, the earnings growth rate used was the average growth rate in the compensation index between 1979 and 1982, while the interest rate used was the average for the three years 1980 through 1982. For the *total offset* method, the estimated present value was always calculated simply as: $10,000 x 20 = $200,000. Finally, for the *historical averages* method, the earnings growth rate used was the average growth rate between 1966 and 1982, while the interest rate used was the average for the years 1967-1982.

Table A-2
Calculation of Estimated Present Value

Base Loss	Period Starts	Earnings Growth	Interest Rate
$10,000	1982	7.41%	12.92%

Year Number	Calendar Year	Future Earnings	Present Value
1	1982	$10,741.00	$9,512.04
2	1983	$11,536.91	$9,047.90
3	1984	$12,391.79	$8,606.40
4	1985	$13,310.02	$8,186.45
5	1986	$14,296.30	$7,786.98
6	1987	$15,355.65	$7,407.01
7	1988	$16,493.51	$7,045.58
8	1989	$17,715.68	$6,701.79
9	1990	$19,028.41	$6,374.77
10	1991	$20,438.41	$6,063.71
11	1992	$21,952.90	$5,767.83
12	1993	$23,579.61	$5,486.38
13	1994	$25,326.86	$5,218.67
14	1995	$27,203.58	$4,964.02
15	1996	$29,219.36	$4,721.80
16	1997	$31,384.52	$4,491.40
17	1998	$33,710.11	$4,272.24
18	1999	$36,208.03	$4,063.77
19	2000	$38,891.05	$3,865.48
20	2001	$41,772.87	$3,676.86
Estimated Present Value			**$ 123,261.09**