3 THE BASICS OF ESTIMATING WAGE OR SALARY LOSS

3.1 Introduction

This chapter provides the basics for projecting wage or salary loss in a "standard" case involving either death or permanent and total disability. Using an illustrative case, it covers such issues as wage growth rates, discounting to present value, work-life expectancy, personal consumption deductions, and income taxes. A foundation is therefore provided for discussions of fringe benefit losses, household service losses, medical costs, partial disability losses and hedonic damages in chapters to follow. The basics in this chapter also provide a starting point for the evaluation of special cases involving different types of occupations and major differences in loss estimates because of age, race, and sex.

3.2 Illustrative Case

The basics of projecting lost earnings can best be discussed with reference to a sample case. Admittedly, this is an "easy" case in the sense that we are provided with complete historical data on a person who is established in the work force.

Assume the case of Mr. Jack Doe, a carpenter who was killed (or permanently and totally disabled) when a crane cable operated by a large construction company struck him. The incident occurred on February 14, 1989. Mr. Doe's date of birth was September 11, 1953, so he was age 35 at the time of his death. He was married, and the date of birth of his wife was August 13, 1955. He had two children: Kristi, with an April 6, 1975 date of birth; and Nikki, with a January 26, 1977 date of birth.

Mr. Doe had worked steadily as a journeyman carpenter in the Carpenter's Union (CU). His hourly wage earnings on the union scale had increased from $7.21/hour in 1977 to $15.81/hour in 1988. His actual annual earnings had increased from $12,387 in 1977 to $29,406 in 1988. (Note that earning power in fringe benefits is to be discussed in the next chapter.)

3.3 Projecting Lost Wage or Salary Earnings

A. *Establishing Base–Level Earnings*

Illustrative Case

The case of Jack Doe encompasses a major problem in establishing base–level earnings. As a construction worker, Jack will not be paid for the standard 2080 hours per year (40 hours per week times 52 weeks). His annual hours of work may significantly vary from the 2080-hour standard, depending upon weather, economic conditions, and other factors. Extensive overtime wages may also be paid in certain periods of any year. Jack's situation is typical of construction and railroad workers, and it may also be an issue for certain manufacturing and service sector workers.

In Table 1, the likely annual earnings for Mr. Doe are established for the base (present) year of 1989, using Mr. Doe's actual work history from 1977-1988. His annual wage earnings are divided by his hourly wage rate at the beginning of the year to establish the average hours per year for which he was *paid*. Thus, overtime hours or changes in leave practices will not harm the estimate. For 12 years, Jack was paid for an average of 1,810 hours per year at an established hourly rate, and these average hours paid do not appear to be trending up or down over these years.

TABLE 1

ESTABLISHING 1989 WAGE EARNINGS BASE
FOR MR. JACK DOE

Year	Wage Earnings	Hourly Rate as of January 1	Average Hours Paid
1977	12,387	7.21	1718
1978	15,307	7.57	2022
1979	15,665	8.65	1811
1980	20,834	10.05	2073
1981	17,034	10.70	1592
1982	17,470	11.60	1506
1983	20,778	12.28	1692
1984	23,727	12.98	1828
1985	26,342	13.67	1927
1986	27,561	14.46	1906
1987	26,721	14.97	1785
1988	29,406	15.81	1860
		AVERAGE	1810

1989 PROJECTED WAGE EARNINGS = 1810 AVG. HOURS PAID x $16.60/HR
1989 RATE = $30,046

In the year after death, the hourly rate was $16.60, which is multiplied by the 12-year average of 1,810 hours per year to establish a 1989 base level of $30,046 per year.

This technique is especially defensible when annual earnings in the last year of work are unusually high or low. A "quirky" year should not be the basis for projecting wage losses. Rather, a multi-year average of hours paid multiplied by an hourly rate establishes a fair basis for a projection, and, as will be seen, the percentage trend rate of future wage increases can then be based upon historical increases in hourly wage earnings.

Another advantage of this technique surfaces when, for example, death occurs in 1986 but the estimate is being made, and the trial will occur, in 1989. The average hours from the work history are set, and hourly wage earnings are known through the current year of 1989. Thus, annual wage earnings can be established for each year through 1989, and projections with wage trends and discounting will only begin after 1989.

Other Issues

When the deceased or injured person is an established 2,080-hours-per-year wage earner or a salaried worker with a full-time salary history, establishing base level earnings may be more straightforward. Usually, annual earnings have steadily progressed upward. The base is the last full year of wage or salary earnings.

Considerable judgment by the forensic economist may nevertheless be involved. Even for these types of workers, job changes, temporary layoffs, illness, promotions, bonuses, and other variables may cause annual earnings to fluctuate. Assume that annual earnings for a deceased worker had steadily progressed upward through the last full year of work but that the individual had worked through July 15 of the following calendar year, when he or she died. Further assume that the annualized earnings in that partial year of work would be a wage base significantly higher or lower than a wage base from the last full year of work. Should the economist use the last full year of work; the last, partial year of work annualized to a full year; or some average of the two years?

Our only general rule is that the use of a last, partial year of (annualized) earnings becomes more credible when more than one-half of the last year was worked before injury or death. Beyond this general guideline, the choice depends upon the facts of the specific case and the reason(s) for a significant change in the annual progression of earnings. The forensic economist should have reasons, appropriate to the particular case, for his decision on a wage base. Both plaintiff and defense attorneys should explore these choices and their logic through discovery and at trial.

If the current (trial) year is several years beyond the year of death or injury, the base earnings can be adjusted to the current year by the individual's average rate of annual earnings increase in the past or by a post-1970 average annual increase in earnings of American workers. Other issues such as cycling earnings of entrepreneurs, commissions, and bonuses will be discussed among the special cases of Chapter 7.

B. *Growth Rates of Wage/Salary Earnings*

Two Factors in Wage Growth

It is critical to note the two factors which comprise the trend rate of annual growth in wages and salaries for individual American workers and for U.S. workers as a whole. The first, and largest, component is the annual rate of price inflation (change in the Consumer Price Index [CPI]). The wages of workers must stay even with CPI growth if purchasing power, or "real" income, is to merely remain the same.

The second component of wage and salary growth is productivity, or the ability of workers to increase goods and services production in real units. The annual rate of productivity growth, of real income growth, and of purchasing power growth are, in effect, the same for purposes of loss projections. Two simple equations to be remembered are the following:[1]

1. Actual (Nominal) Wage Growth = Inflation Rate (CPI) + Real Wage Growth (Productivity)

or

2. Real Wage Growth (Productivity) = Actual Wage Growth − Inflation Rate (CPI)

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[1] The treatment of a "mathematical bias" involving inflation rates is the subject of a more technical Appendix 3 to this chapter, which is primarily written for forensic economists.

Issues in Predicting Wage Growth

Whether projecting actual or real wage growth, the growth trend should be based upon the specific individual's past record of wage growth. In our opinion, no better predictor for wage growth of the injured or deceased person exists than the "track record" of *that* person.

This basis for a growth projection requires that sufficient years of a documented wage history be available. As a general guideline, 10 or more years of wage history are enough to form the basis for a projection; data on wage growth trends for statistical classes of workers may be a needed back-up with 5-10 years of individual wage history; and less than five years of individual data are usually not enough for a wage projection. The exercise of judgment is still required in specific cases; we have used trends of statistical classes for alternative estimates when wage growth rates based upon 10 or 20 years of specific history on the individual are unusually high.

In the case of minor children without earnings histories, or when sufficient years of individual earnings history are not available before trial, the forensic economist must turn to growth trends for statistical classes of workers. Since these data are available for long time periods, the issue of an appropriate historical time period for future wage projections comes into sharper focus.

Some forensic economists have argued for using very long historical periods for projecting into the future. If data from the end of World War II to the present were available, they would use them for calculating a growth rate, versus 10-year or 20-year historical periods. We see little logic for the arbitrary use of very long versus medium-length time periods, unless, in the judgment of the economist, the characteristics of the longer period render it the best basis for the future projection. Neither is there support in the literature nor in the post-World War II data on real wage growth to support the post-World War II period as the basis for projections.

Other economists have argued that a shorter and more current period, such as the 1980's, is more relevant to the future and should either be used as the historical period or weighted more heavily. As will be seen, this favors the defense. In the eighties, real wage growth has been lower and real interest (discount) rates higher than in longer historical periods.

Another group of economists seems to prefer using the same number of years in the historical period as the projection of wages will cover in the future. This has sometimes been called a "mirror image" method of projection. We see no particular merit to this method, either, and it results in the same economist arguing for different trend rates in similar cases. Practical problems also exist when the treatment of work-life expectancy is varied in the same case, so that different future periods are involved.

Some economists, favoring this technique, would even blend actual data on a deceased person with generalized data on a statistical class to make the technique work. Thus, if the projection were to be for 20 years and only 10 years of wage history existed for the person under study, this 10 years of actual history would somehow be combined with 10 prior years of generalized wage growth data for a large statistical class.[2] This can significantly add to the complexity of testimony, and evidence does not exist that it adds to the accuracy of wage loss estimates.

We have, for many years, preferred to use the medium-length period beginning in 1970 and extending through a current date as the historical period—either when specific data on the deceased can be gathered back to 1970 or when more generalized wage data are necessary. We feel that relationships between wage growth rates and interest rates, especially in this period, are good predictors of the future. This approximately 20-year period is also a compromise between longer periods that tend to favor plaintiffs and shorter periods that tend to favor the defense. Use of this period has also provided us with consistency in projection methods over time, versus use of a "mirror image" time period, and, in testimony, consistency of technique can be an advantage *per se*. Finally, this time period does not require an unnecessarily complex explanation.

The historical time period chosen does make a difference in the calculations. Appendix I shows that actual wage growth for U.S. workers in the 1970-1988 historical period was 7.12 percent annually. Since the average annual rate of price inflation was 6.29 percent in this period, the trend rate of real wage increases was 0.84 percent (rounded). During the longer 1952-1988 period, contrasted in Appendix II, actual wage growth was 6.18 percent, price inflation averaged 4.19 percent, and the trend rate of real wage increases was 1.99 percent.

Given the historical period used for the projection, how are the wage change data in this period "averaged" to produce a trend rate of wage growth for the future? While several methods are available, let us contrast three alternative methods.

The simplest method to apply and explain may be the arithmetic mean method. With twenty years of historical data, nineteen years of wage changes would exist, and the arithmetic mean trend would be the simple average of these nineteen percentage changes. The trend rate would be less accurate than trends produced under other methods, however. This is especially true when wide swings exist from year to year in percentage wage increases and decreases.

Generally, the most accurate method is the Least Squares (either linear or logarithmic) Regression method. This involves the statistical fitting of a trend curve to the scatter of points representing past wage changes. This method is relatively complex and difficult to explain.

Our preference is the Geometric Mean method. The geometric mean trend can be explained as the percentage rate which exactly moves the annual progression (of wage or other variables) from the starting number in the series to the ending number. It makes common sense that the trend for the future should have exactly moved the historical wage series from the starting to the ending wage of the series, but an arithmetic trend rate does not do so.

The geometric mean is almost as precise as Least Squares Regression trends, and it can be explained to a jury. It is receiving widespread discussion and use.[3]

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[2] *See* Gerald Martin. DETERMINING ECONOMIC DAMAGES (Santa Ana, California: James Publishing Group, 1988), section 1010.

[3] *See*, for example, Don Schilling, *Estimating Loss: A 1900-1982 Simulation,* JOURNAL OF RISK AND INSURANCE, March, 1985, p. 105; and W. G. Baker and M. K. Seck, DETERMINING ECONOMIC LOSS IN INJURY AND DEATH CASES (New York: McGraw-Hill, 1987), pp. 55-56.

Yet, forensic economists differ in the method used, so both plaintiff and defense attorneys may wish to scrutinize the ramifications of this choice by the economic expert.

Projecting Actual Wage Growth in Illustrative Case

Assume that a wage loss projection for Mr. Jack Doe is to be based upon actual wage growth, so that both price inflation and productivity growth will be considered. In Table 2, a 12-year wage history for Mr. Doe is shown, and these data, specific to Mr. Doe, will be used for a projection. Since the hourly wages steadily moved upward, the arithmetic mean trend is very close to the geometric mean trend. The 7.40 percent geometric trend will be used in the projection; this annual rate exactly moves the wage progression from $7.21/hour in 1977 to $15.81/hour in 1988.

Table 3 shows an actual wage loss estimate for Mr. Doe of $6,499,564. The $30,046 wage base from Table 1 is used for the partial year of loss in 1989, and this annual wage base is then increased by the 7.40 percent geometric trend rate of actual wage growth through life expectancy. This is *not* an appropriate loss estimate, but it lays the initial foundation for developing an appropriate estimate as this chapter moves through successive issues and refinements.

Projecting Real Wage Growth in Illustrative Case

The primary difficulty of projections based upon actual wage growth trends can be readily seen in Table 3. It is difficult for juries to understand annual wages growing from a $30,046 annualized base at age 36 to $81,628 at age 50 to $452,830 at age 74. Jurors can much more easily understand a small rate of annual growth in the productivity, or purchasing power, of wage income, after the effects of inflation have been removed.

In Table 4, the actual wage history and 7.40 percent trend are repeated from Table 2. The comparable trend in the CPI (price inflation) is then shown as 6.11 percent. The 1977-1988 trend rate of growth of *real* wages of Mr. Doe is therefore the 1.24 percent difference in these two numbers.

In Table 5, the real wage loss of Mr. Doe is calculated as $1,541,207. The 1989 wage base of $30,046 is used, as before, but the wage growth trend is now 1.29 percent per year versus 7.40 percent. The effects of price inflation have been removed, and no number in the annual wage loss column should look unreasonable to a juror. The first and last year of lost wages are partial years, based upon the date of death and life expectancy.

We recommend projections based upon these real wage growth rate trends. The plaintiff attorney might ask at this point, "Why should I support moving from a technique in Table 3 producing a $6,499,564 estimate to the techniques behind Table 5, which produce a $1,541,207 estimate?" Remember that discounting to present value has not been discussed, and it will also be recommended that inflation be removed from actual interest rates in discounting to present values.

3.4 Discounting to Present Values

A. *Time Value of Money*

Wage or any other earnings trends, projected into the future as shown in the last section, must be discounted to a present value. This is because of the time value

TABLE 2

WAGE EARNINGS GROWTH FOR MR. JACK DOE 1977-1988

Year	Hourly Wages	Percent Increase
1977	7.21	—
1978	7.57	4.99
1979	8.65	14.27
1980	10.05	16.18
1981	10.70	6.47
1982	11.60	8.41
1983	12.28	5.86
1984	12.98	5.70
1985	13.67	5.32
1986	14.46	5.78
1987	14.97	3.53
1988	15.81	5.61

(ARITHMETIC) MEAN RATE OF GROWTH = 7.47 PERCENT
GEOMETRIC MEAN RATE OF GROWTH = 7.40 PERCENT

TABLE 3

CUMULATIVE WAGE EARNING CAPACITY LOSS
OF MR. JACK DOE THROUGH LIFE EXPECTANCY
1989-2028

Year	Age	Wages	Cumulative
1989	36	$ 26,342	$ 26,342
1990	37	32,269	58,611
1991	38	34,657	93,268
1992	39	37,222	130,490
1993	40	39,976	170,466
1994	41	42,934	213,400
1995	42	46,111	259,511
1996	43	49,523	309,034
1997	44	53,188	362,222
1998	45	57,124	419,346
1999	46	61,351	480,697
2000	47	65,891	546,588
2001	48	70,767	617,355
2002	49	76,004	693,359
2003	50	81,628	774,987
2004	51	87,668	862,655
2005	52	94,155	956,810
2006	53	101,122	1,057,932
2007	54	108,605	1,166,537
2008	55	116,642	1,283,179
2009	56	125,274	1,408,453
2010	57	134,544	1,542,997
2011	58	144,500	1,687,497
2012	59	155,193	1,842,690
2013	60	166,677	2,009,367
2014	61	179,011	2,188,378
2015	62	192,258	2,380,636
2016	63	206,485	2,587,121
2017	64	221,765	2,808,886
2018	65	238,176	3,047,062
2019	66	255,801	3,302,863
2020	67	274,730	3,577,593
2021	68	295,060	3,872,653
2022	69	316,894	4,189,547
2023	70	340,344	4,529,891
2024	71	365,529	4,895,420
2025	72	392,578	5,287,998
2026	73	421,629	5,709,627
2027	74	452,830	6,162,457
2028	75	337,107	6,499,564

J. DOE $6,499,564

TABLE 4

GEOMETRIC MEAN
REAL WAGE GROWTH TREND OF MR. JACK DOE
1977-1988

	Actual Wage		CPI		Real Wage
Year	Amount	Percent Change	Index	Percent Change	Percent Change
1977	7.21	—	181.50	—	—
1978	7.57	4.99	195.30	7.60	−2.61
1979	8.65	14.27	217.70	11.47	2.80
1980	10.05	16.18	247.00	13.46	2.73
1981	10.70	6.47	272.30	10.24	−3.78
1982	11.60	8.41	288.60	5.99	2.43
1983	12.28	5.86	297.40	3.05	2.81
1984	12.98	5.70	307.60	3.43	2.27
1985	13.67	5.32	318.50	3.54	1.77
1986	14.46	5.78	323.40	1.54	4.24
1987	14.97	3.53	335.00	3.59	−0.06
1988	15.81	5.61	348.40	4.00	1.61
GEOMETRIC AVERAGE		7.40		6.11	1.29

TREND RATE OF REAL WAGE GROWTH = 1.29 PERCENT

SOURCE: For Consumer Price Index, monthly publication of Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Table 30.

TABLE 5

CUMULATIVE "REAL" WAGE EARNING CAPACITY
LOSS OF MR. JACK DOE THROUGH LIFE EXPECTANCY,
AGES 36-75

YEAR	AGE	WAGES	CUMULATIVE
1989	36	$26,342	$ 26,342
1990	37	30,434	56,776
1991	38	30,827	87,603
1992	39	31,225	118,828
1993	40	31,628	150,456
1994	41	32,036	182,492
1995	42	32,449	214,941
1996	43	32,868	247,809
1997	44	33,292	281,101
1998	45	33,721	314,822
1999	46	34,156	348,978
2000	47	34,597	383,575
2001	48	35,043	418,618
2002	49	35,495	454,113
2003	50	35,953	490,066
2004	51	36,417	526,483
2005	52	36,887	563,370
2006	53	37,363	600,733
2007	54	37,845	638,578
2008	55	38,333	676,911
2009	56	38,827	715,738
2010	57	39,328	755,066
2011	58	39,835	794,901
2012	59	40,349	835,250
2013	60	40,870	876,120
2014	61	41,397	917,517
2015	62	41,931	959,448
2016	63	42,472	1,001,920
2017	64	43,020	1,044,940
2018	65	43,575	1,088,515
2019	66	44,137	1,132,652
2020	67	44,706	1,177,358
2021	68	45,283	1,222,641
2022	69	45,867	1,268,508
2023	70	46,459	1,314,967
2024	71	47,058	1,362,025
2025	72	47,665	1,409,690
2026	73	48,280	1,457,970
2027	74	48,903	1,506,873
2028	75	34,334	$1,541,207

J. DOE $1,541,207

of money. Stated simply, a dollar received today is more valuable to us than that same dollar received sometime in the future. Why?

If we have the dollar today, it is a certainty. However, we run some risk on any promise or guarantee of the dollar received later. Secondly, if we have the dollar today versus one year hence, we can take advantage of any investment or other opportunities which reveal themselves during the year. The most important reason for wanting the dollar *today* is that we can invest the dollar, earn compound interest in safe U.S. Treasury investments, and have more than the one dollar (after subtracting inflation) at some future date; the real rate of riskless return has generally been positive.

In cases of economic damages, we have a stream of annual losses in future dollars which must be converted to a lump sum of loss in today's dollars. This is called a *present value*. The process of discounting future values to a present value is the exact reverse of the process of taking a present value (principal), computing compound interest, and arriving at a future value of principal plus interest. The following equations make this clear:

1. Future Value = Present Value $(1 + i)^n$,
where
i = interest rate
n = number of years in future

2. Present Value = Future Value × $\left[\frac{1}{(1 + i)^n}\right]$
where
i = interest (discount) rate
n = number of years in future

The second equation is obtained by algebraically rearranging terms in the first equation. The bracketed expression in Equation #2 is referred to as the "discount factor." A column of discount factors will be seen in the examples to follow. Yet, the key variable is the interest, or discount, *rate*. This is the "i" in the equations and is the rate of interest at which an economist believes a lump sum can be safely invested. The higher the assumed interest (discount) rate, the lower will be the present value lump sum of economic loss. (If earned interest can be greater, less is needed in the lump sum principal.)

The purpose of discounting future earnings to a present value lump sum, it should be remembered, is to exactly restore the purchasing power which the deceased or injured worker would have produced. Thus, an interest rate must be chosen for investment of the lump sum principal, so that the lump sum plus all earned interest will exactly restore the stream of purchasing power during work life expectancy and be exactly used up in the process. Zero dollars should remain after the projected end of working life for the deceased/injured worker.

One other issue relating to the time value of money should be discussed. Assume a wrongful death in 1985, with a 1989 trial date and twenty years of projected earning capacity after 1989. The present year, when a lump sum jury award will be received, and presumably invested, is 1989. Lost earnings are estimated, however, for the past years of 1985-1988, the present year of 1989, and for twenty future years. The estimates for the twenty future years are discounted to a 1989 present value because of the time value of money. Logic, and sound economics, would likewise dictate that the 1985-1988 estimates be compounded upward by prevailing interest rates. When this is done, the term for the interest addition on past year amounts is "Pre-Judgement Interest." Many jurisdictions do not allow pre-judgement interest calculations, even though future values must be discounted to a present value.

B. *Choosing the Interest (Discount) Rate*

The Two Risks

Investment in a bond or other fixed-return financial instrument involves two risks. The first is the risk of default—that the issuer of the bond will fail and the investor will lose the principal and interest. The second is the risk of unanticipated price inflation. Assume an investor locks into a fixed interest return of 7 percent per year for 20 years when inflation is 5 percent annually. If in the second or third year, inflation climbs to 12 percent annually, then the goods and services which can actually be bought with the fixed 7 percent return decline dramatically. Inflation has badly damaged the purchasing power of the fixed income stream over the 20 years.

As will be seen, higher interest rates must be, and are, paid to investors who are willing to bear either or both risks. Interest rates rise on investments where there is greater risk of default and, generally, on investments with longer maturities.

Alternative Interest (Discount) Rates

The investment alternative closest to the "ideal" of a risk-free investment is a 3-month U.S. government bill. No risk of default exists (unless the government collapses and ceases printing money to repay its debts). Virtually no risk of unanticipated price inflation exists, as the principal and earned interest will be paid within 3 months. Choosing a point-in-time example, the early-April 1989 annualized interest rate (yield) on a 3-month U.S. government bill was approximately 9.4 percent. If price inflation is expected to increase, interest rates will be higher. Anticipated price inflation is the major component of interest rates. Therefore, if inflation increases over time, the principal can be re-invested at the higher interest rates which will exist every 3 months as interest rates rise.

It should be noted that investors are better off with a fixed interest rate on a longer-term U.S. government bond when price inflation and market interest rates fall after a lump sum is invested. This fall in rates cannot be anticipated with any certainty, and the risk of an increase in rates, reducing the investment value, always exists. With falling short-term rates and the principal re-invested every 3 months under our "safe" scenario, the lump-sum is re-invested at lower and lower interest rates, versus the constant, higher rate on a longer-term bond.

However, the rate of earnings increase for the deceased worker would also have been falling. The purchasing power of the lump sum earnings to the survivors or estate is not really harmed *vis-a-vis* the purchasing power of earnings which the deceased would have produced. Our goal in opting for 90-day rates is to protect against a serious erosion (due to rising price inflation) in the ability of those who receive a lump sum to invest and exactly match the purchasing power which would have been earned. Our goal is not to increase a return on investment if this means speculating or, in general, running risks that survivors will fall far behind in the purchasing power that would have existed absent the death or injury. There are many types of possible investments, ranging in risk from a short term U.S. Treasury bill to the equity markets in Singapore. An investment in the U.S. Treasury bill is most likely to compensate for inflation in a risk-free environment.

Investments and re-investments in 90-day bills also may imply slightly higher transaction costs than less frequent investments in longer-term securities. If an adjustment is not made for these transaction costs, the net investment earnings to survivors or an estate are very slightly lower. This may be a small sacrifice in view of the risk of rapidly rising price inflation and a significant decline in the purchasing power of returns on long-term bonds.

Forensic economists do differ in their choice of discount rates. Some prefer higher returns on non-U.S.-government securities, despite the increased risk of default. Others opt for interest rates on long-term U.S. government bonds, despite the great risk of rising price inflation. It does appear that the prevailing mood of forensic economists is to use interest rates on "relatively short term" U.S. government securities.[4] If logic dictates that purchasing power must be protected, however, then the use of 90-day U.S. Treasury bill rates extends this logic to its conclusion. "Sensitivity analyses" can always be made to test the effects upon lump sum estimates of the use of maturities slightly greater than 3 months.

Bond markets constantly change, as do relationships among alternative investments. In the mid-1980's, yields on 3-month U.S. government securities were 6.05 percent, almost 8 percent on 3-year maturities and 8.5 percent on 20-30 year maturities. Forensic economists supporting interest rates on longer-term securities were producing lower present value estimates because of the selection of investment instruments, alone. In Spring 1989, the unusual situation existed that interest rates on 3-month U.S. government bills were actually greater than the annual yield on 30-year U.S. government bonds; the so-called "yield curve" was inverted. Thus, the choice of shorter-term securities would not have resulted in lower present value estimates than under the longer-maturity alternatives.

Applying Discount Rates in Illustrative Case

Returning to the case of Mr. Jack Doe, wage projections have been based upon the twelve-year (1977-1988) real wage earnings history of Mr. Doe. The twelve-year history of average interest (discount) rates on 3-month U.S. government bills must also be determined. This is accomplished in Table 6. Average interest rates on 3-month U.S. government bills are shown for each year, and a geometric mean of 9.24 percent is calculated for the 1977-1988 period. This means that if $100 had been invested in 1977 and earned a compound and uniform 9.24 interest rate, then the value of principal plus interest would be $264.27 in 1988, or the exact value of the $100 investment multiplied by the 1988 interest rate index.

This 9.24 average rate of interest (discount) includes price inflation. Since the actual wage growth rate of 7.40 percent in Table 4 was reduced by the 6.11 percent

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4 See William Harris, *Inflation Risk as Determinant of the Discount Rate in Tort Settlements*, JOURNAL OF RISK AND INSURANCE (June 1983), pp. 265-280; Ronald Dulaney, *An Historical Simulation Approach to the Present Valuation of Future Earnings*, JOURNAL OF FORENSIC ECONOMICS (September 1987), pp. 37-48; and James W. Martin, Jr., *Estimating Monetary Loss Due to Personal Injury*, JOURNAL OF FORENSIC ECONOMICS (May 1988), pp. 1-18.

TABLE 6

REAL WAGE GROWTH VERSUS REAL INTEREST (DISCOUNT) RATES FOR EARNINGS HISTORY OF MR. JACK DOE 1977-1988

	Actual Wages		Interest (Discount)		CPI			Real Interest
Year	Amount	Percent Change	3-Month Rate	Index	Index	Percent Change	Real Wage Change	(Discount) Rate Change
1977	7.21	—	—	1.0000	181.50	—		
1978	7.57	4.99	7.46	1.0746	195.30	7.60	−2.61	−0.14
1979	8.65	14.27	10.45	1.1869	217.70	11.47	2.80	−1.02
1980	10.05	16.18	12.05	1.3299	247.00	13.46	2.73	−1.41
1981	10.70	6.47	14.75	1.5261	272.30	10.24	−3.78	4.51
1982	11.60	8.41	11.14	1.6961	288.60	5.99	2.43	5.15
1983	12.28	5.86	8.94	1.8477	297.40	3.05	2.81	5.89
1984	12.98	5.70	9.98	2.0321	307.60	3.43	2.27	6.55
1985	13.67	5.32	7.73	2.1892	318.50	3.54	1.77	4.19
1986	14.46	5.78	6.16	2.3241	323.40	1.54	4.24	4.62
1987	14.97	3.53	6.27	2.4698	335.00	3.59	−0.06	2.68
1988	15.81	5.61	7.00	2.6427	348.40	4.00	1.61	3.00
AVG.		7.40	9.24			6.11	1.29	3.13

REAL WAGE GROWTH = 1.29 PERCENT
REAL INTEREST (DISCOUNT) RATE = 3.13 PERCENT
NET "GAP" = 1.29 GROWTH − 3.13 DISCOUNT = −1.84 PERCENT

SOURCE: For Consumer Price Index, monthly publication of Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Table 30.

average inflation rate to a 1.29 percent "real" rate, inflation must also be subtracted from the average of actual interest rates. This is accomplished in Table 6. The 9.24 percent actual interest rate average is lowered by the 6.11 percent average inflation rate to derive an average "real" interest rate of 3.13 percent for the 1977-1988 period. Thus, wages are to be increased by a compounding real wage growth rate of 1.29 percent and, at the same time, decreased by a real interest (discount) rate of 3.13 percent per year.

This is accomplished in Table 7, which builds upon Table 5 by introducing discounting to present values. The 3.13 percent real rate is used and inserted into the previously shown equation to derive the discount factor. The future wage estimate multiplied by the discount factor for each year results in the present value estimate for each year. The sum of the present values is an $856,281 lump sum estimate of lost earning capacity in wages. This sum, if invested in risk-free U.S. government bills, would exactly restore the stream of lost wages, using up all the principal and all earned interest in the process.

It should be noted that the forensic economist may have a standard historical

TABLE 7

PRESENT VALUE OF LOST EARNING CAPACITY
IN WAGES FOR MR. JACK DOE,
AGES 36-75

Year	Age	Wages	Discount Factor	Present Value	Cumulative
1989	36	$26,342	1.00000	$26,342	$ 26,342
1990	37	30,434	0.96965	29,510	55,852
1991	38	30,827	0.94022	28,984	84,836
1992	39	31,225	0.91169	28,468	113,304
1993	40	31,628	0.88402	27,960	141,264
1994	41	32,036	0.85719	27,461	168,725
1995	42	32,449	0.83117	26,971	195,696
1996	43	32,868	0.80594	26,490	222,186
1997	44	33,292	0.78148	26,017	248,203
1998	45	33,721	0.75777	25,553	273,756
1999	46	34,156	0.73477	25,097	298,853
2000	47	34,597	0.71247	24,649	323,502
2001	48	35,043	0.69084	24,209	347,711
2002	49	35,495	0.66988	23,777	371,488
2003	50	35,953	0.64955	23,353	394,841
2004	51	36,417	0.62983	22,937	417,778
2005	52	36,887	0.61072	22,528	440,306
2006	53	37,363	0.59218	22,126	462,432
2007	54	37,845	0.57421	21,731	484,163
2008	55	38,333	0.55678	21,343	505,506
2009	56	38,827	0.53988	20,962	526,468
2010	57	39,328	0.52350	20,588	547,056
2011	58	39,835	0.50761	20,221	567,277
2012	59	40,349	0.49220	19,860	587,137
2013	60	40,870	0.47726	19,506	606,643
2014	61	41,397	0.46278	19,158	625,801
2015	62	41,931	0.44873	18,816	644,617
2016	63	42,472	0.43512	18,480	663,097
2017	64	43,020	0.42191	18,151	681,248
2018	65	43,575	0.40910	17,827	699,075
2019	66	44,137	0.39669	17,509	716,584
2020	67	44,706	0.38465	17,196	733,780
2021	68	45,283	0.37297	16,889	750,669
2022	69	45,867	0.36165	16,588	767,257
2023	70	46,459	0.35068	16,292	783,549
2024	71	47,058	0.34004	16,002	799,551
2025	72	47,665	0.32972	15,716	815,267
2026	73	48,280	0.31971	15,436	830,703
2027	74	48,903	0.31001	15,160	845,863
2028	75	34,334	0.30342	10,418	$856,281

J. DOE $856,281

period for use in deriving a real discount rate. This might be the 1970-1988 period shown in Appendix 1, which provides a 1.59 percent real discount rate compared to the 3.13 percent rate from the shorter 1977-1988 period. The plaintiff's economist may choose the 3.13 percent rate to be conservative and to avoid criticism that a longer period was chosen to produce a lower real discount rate. This can be an issue of technical perfection versus effectiveness in testimony. For the Jack Doe sample case, this higher 3.13 percent rate was chosen to match the historical period for which wage data were available.

The critical role of the chosen interest (discount) rate should again be emphasized. Assume that an interest rate 1 percent higher was chosen—4.13 percent versus 3.13 percent—because longer-term or other, more risky investments were allowed. The present value loss from this single change would drop from $856,281 to $730,446.

3.5 The Teeter-Totter: Alternative Approaches in Selecting Wage Growth Rates Versus Discount Rates

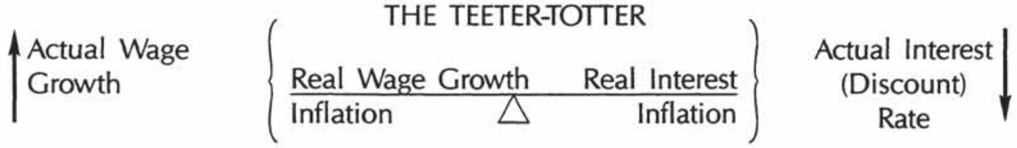
A. The Concept

A key assumption in lost earning capacity estimates concerns the relationship between wage growth rates and interest (discount) rates. Once a wage base is established in the trial year, for example, the economist must make an assumption on the rate of wage growth into the future and on the appropriate rate of interest to use in discounting future losses to present values. At trial, we have discussed this relationship in terms of a child's see-saw, or teeter-totter.

A generalized Teeter-Totter is shown in Figure 1 to illustrate key concepts in the Sections 3.3 and 3.4, above. Note that the actual wage growth rate is subdivided into its two components of price inflation and real wage growth. The actual discount rate is divided into its sub-components of inflation and the real interest rate. Examined below are five alternative methods for dealing with the Teeter-Totter in the Jack Doe example.[5]

FIGURE 1

THE TEETER-TOTTER



B. Inflation Added Method: Teeter-Totter

Many forensic economists have consistently used this method over the years. As shown in Figure 2, the 1977-1988 average inflation rate of 6.11 percent appears on both sides of the equation. Actual wage growth is 7.40 percent, or the 6.11 percent inflation rate plus 1.29 in real wage growth. The actual interest rate is 9.24 percent, or the 6.11 percent inflation rate plus the 3.13 percent real interest rate. The critical net difference between 7.40 percent moving upward and 9.24 percent moving

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[5] In Chapter 12, legal parameters which mandate or affect the choice of alternative methods are detailed by jurisdiction. Also, see the technical note in Appendix 3 to this chapter.

downward is a negative (compounding downward) rate of 1.84 percent annually. The present value of lost wages is $871,451 under this technique.

FIGURE 2

INFLATION ADDED METHOD: TEETER-TOTTER

$$\uparrow \quad 7.40 \left\{ \frac{1.29}{6.11} \quad \triangle \quad \frac{3.13}{6.11} \right\} 9.24 \quad \downarrow$$

Net Difference = −1.84%

C. *Inflation Removed Method*

This is the method which we have used over the years, except in unusual circumstances. As shown in Figure 3, price inflation of 6.11 percent is the major component on *both* sides of the Teeter-Totter. Therefore, the effects of price inflation are canceled out and removed. The wage base is increased by Jack Doe's real wage growth trend of 1.29 percent annually and then decreased to present value at the real interest (discount) rate of 3.13 percent, calculated over the same 1977-1988 period. The ability of the invested lump sum to cover lost purchasing power of wages is ensured, whatever the rate of price inflation, if the historical relationship between the Teeter side and the Totter side remains basically the same.

The net difference of 1.84 percent, compounding downward each year, remains the same. Because of a slight mathematical bias when price inflation is removed (see the technical discussion in Appendix 3), the present value of lost wages is lowered slightly to $856,281. The economist has not needed to predict future rates of price inflation, and the very high wage numbers shown in such inflation-added tables as Table 3 are never calculated or shown. Rather, inflation-removed tables such as Table 7 are shown, annual wage loss numbers look intuitively reasonable, and the emphasis is on the preservation of purchasing power.

FIGURE 3

INFLATION REMOVED METHOD: TEETER-TOTTER

$$\uparrow \quad 1.29 \left\{ \frac{1.29}{\cancel{6.11}} \quad \triangle \quad \frac{3.13}{\cancel{6.11}} \right\} 3.13 \quad \downarrow$$

Net Difference = −1.84%

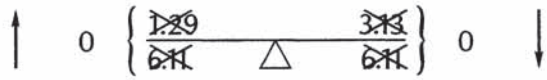
D. *Total Offset Method*

Some have argued that since the net difference may be small in many cases, both components on the Teeter (wage) side should be totally offset by both components on the Totter (discount rate) side. The advantage of the total offset method is simplicity, in that precise relationships between the Teeter and the Totter are not explained to a jury, and, perhaps, the use of an economist can be avoided.

In fact, many other issues must be addressed by an economic expert, so that use of a total offset seldom eliminates the need for a careful examination of economic losses. When a state statute or court decision mandates use of a total offset, loss estimates rise. The net difference is now 0 percent instead of −1.84 percent annually compounding downward (see Figure 4). In our Jack Doe example, the present value of wage loss becomes $1,188,916, which is $332,635 (or 38.8 percent) higher than the $856,281 inflation-removed estimate.

FIGURE 4

TOTAL OFFSET METHOD: TEETER-TOTTER



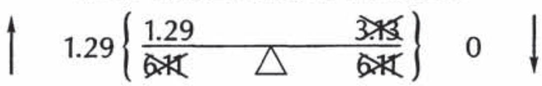
Net Difference = 0%

E. *Real Wage Offset Method*

A handful of jurisdictions have mandated that inflation on the Teeter side be offset against both components—inflation and real interest—on the Totter side. This has an even greater upward effect upon economic loss estimates, as the net difference is the 1.29 percent real wage growth rate (see Figure 5). This is the only value which has not been canceled out. The present value of wage loss becomes $1,541,207 in the Jack Doe case, or 80 percent higher than the $856,281 estimate in the inflation-removed method.

FIGURE 5

REAL WAGE OFFSET METHOD



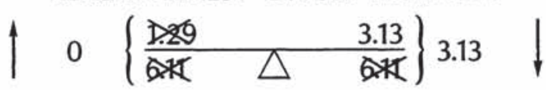
Net Difference = +1.29%

F. *Real Interest Offset Method*

Finally, a real interest offset might be employed. This is at the other extreme end of the spectrum from a real wage offset. Both components of wage growth are offset against only inflation on the interest rate side. Only the 3.13 percent real interest rate average would remain, so that the wage base would compound downward by the negative net difference of 3.13 percent (see Figure 6). This method also makes little economic sense. In the Jack Doe case, the present value of wage loss is $695,015, or 18.8 percent lower than the $856,281 inflation-removed estimate.

FIGURE 6

REAL INTEREST OFFSET METHOD



Net Difference = −3.13%

In summary, assumptions regarding the Teeter-Totter may make a significant difference in final results. Let us now turn to other important concepts.

3.6 Work-Life Expectancy

A. *The Concept*

The $856,115 loss estimate in Table 7 is still not the appropriate loss estimate in most circumstances. It assumes a 100 percent probability that Mr. Doe would have been alive, participating in the work force, and employed in each and every year through his life expectancy of age 75. While this is possible, it is not probable.

The estimate of lost earning capacity in wages must be adjusted for work-life expectancy if the measure of economic damages is what we *expect* that Jack Doe would have actually earned. Somehow, the loss figures must be lowered to reflect the major probabilities that might have kept Jack from continuous, full-time work over his life. Before turning to issues relating to how work-life reductions should be made, a more fundamental issue should at least be mentioned.

Wrongful death statutes and appellate court opinions often directly refer to lost earning "capacity." Forensic economists have assumed this to mean that likely earnings are a stream of earnings through *work-life* expectancy, rather than through the longer period of *life* expectancy. Yet, a dictionary definition of "capacity" is, "the maximum amount that can be contained; the maximum or optimum amount of production. . . ."[6] When we speak of plant capacity, we mean the maximum production of a manufacturing plant, without regard to the expected utilization of the plant as a percentage of its maximum production.

Unless statutes or appellate court opinions specifically refer to the need for consideration of work-life expectancy as they discuss lost earning capacity, then the legal parameters within which the forensic economist must work are unclear. It can be argued that the term "earning capacity," or the term "earning power," implies that work-life expectancy reductions should not be made. Indeed, work-life probabilities address the likelihood that full earning capacity will not be achieved by a person at a specified age.

B. *Traditional Approaches*

Until recent years, work-life expectancy tables, developed and published by the U.S. Department of Labor, were based upon census data. These tables might tell us that a Jack Doe, dead at age 33, had a work-life expectancy through age 62. An economist would then refer to the cumulative column of Table 7 above, look up the total through age 62, and estimate that the expected value of loss for Jack Doe would be $644,617.

Such work-life tables were seriously flawed. They assumed that once Jack Doe began participating in the work force, he would continuously do so through age 62. This was a particularly serious error for women, who frequently exit and enter the work force. These work life tables also assumed a 0 percent chance of unemployment. Finally, they did not differentiate work-life expectancy by such important variables as race and educational level.[7] In a 1982 article, the leading U.S. Department of Labor expert on work-life expectancy stated that these tables were obsolete.[8]

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[6] THE AMERICAN HERITAGE DICTIONARY (Boston: Houghton Mifflin Company, 1982), p. 236.

[7] *See* Michael L. Brookshire and William E. Cobb, *The Life-Participation-Employment Approach to Worklife Expectancy in Personal Injury and Wrongful Death Cases,* FOR THE DEFENSE (July 1983), pp. 20-25.

[8] Shirley J. Smith, *New Worklife Estimates Reflect Changing Profile of Labor Force,* MONTHLY LABOR REVIEW (March 1982), pp. 15-20.

The Bureau of Labor Statistics of the Department of Labor replaced these tables in 1982 with so-called "increment-decrement" tables of work-life expectancy.[9] These tables corrected one major problem in the existing tables. They allowed for the fact that persons enter and exit from active participation in the work force before they finally retire, die, or become permanently disabled. Work-life expectancy is also broken down by such relevant variables as race, sex, and whether the person was active (participating) or inactive in the work force at the time of injury or death.

Mr. Jack Doe was a 35-year-old white male, active in the work force, at the time of death. The most recent increment-decrement tables give Jack another 25.3 years of working life, or through age 60.3. Referring again to Table 7, the expected loss through age 60 is a present value of $606,643. Yet, even these new increment-decrement tables retain significant shortcomings when applied to projections of expected earnings loss. They assume a zero percent chance of unemployment for a typical person over the entire period of his life in which he desires to have a job. In other words, these tables assume that anytime one wants a job, one will obtain a job and keep it. This assumption is not consistent with reality.

Secondly, these U.S. work-life tables give a number of years—25.3 for Jack Doe—beyond an injury/death date for which earnings should be projected. Actually, chances of less-than-perfect work-life exist at each age and vary importantly by age. Those who use increment-decrement tables delay the impact of work-life reductions until the end of a working life. When the net difference of the Teeter-Totter is negative, as has been true for years, this understates the work-life reductions, and overstates economic damages, compared to a technique which assigns work-life reductions to each successive age of the injured or deceased worker. This problem in the application of U.S. work-life tables can be substantial, especially for female workers.[10]

C. *The Life-Participation-Employment Technique*

The Concept in Illustrative Case

Discontent with the flaws of traditional work-life tables led to the development of the Life-Participation-Employment (LPE) technique for adjusting loss estimates by work-life expectancy. It was recognized that existing U.S. Department of Commerce and U.S. Department of Labor data, disaggregated by age, race, and sex and updated annually, would allow an economist to adjust loss estimates by the three major variables affecting the duration of a working life:

1. **Probability of Life (L)**—Mr. Jack Doe would not have earned the wage figures in Table 7 had he died in any future year. We know from U.S. Department of Commerce statistics the probability that Jack, as an average white male, would live to and through each future age. This "L" statistic of life expectancy becomes the first adjustment in the overall LPE technique.

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9 *Ibid.*

10 For more background on these issues, *see* David M. Nelson, *The Use of Worklife Tables in Estimates of Lost Earning Capacity,* MONTHLY LABOR REVIEW (April 1983), pp. 30-31; George Alter and William Becker, *Estimating Lost Future Earnings Using the New Worklife Tables,* MONTHLY LABOR REVIEW (February 1985), pp. 39-42; and Shirley Smith, *A Comment,* MONTHLY LABOR REVIEW (February 1985), p. 42.

2. **Probability of Labor Force Participation (P)**—Even had he lived, Mr. Doe would not have earned the wage figures in Table 7 if he had retired, become disabled, or for some other reason not participated in the work force at any age. We know from U.S. Department of Labor data the probability that an average white male will participate in the work force (either have a job or be attempting to find one) at each age. This "P" statistic is the second adjustment for work-life expectancy.
3. **Probability of Employment (E)**—Mr. Doe would not have earned the wage figures in Table 7 if he had been unemployed for any part of any year through his life expectancy. We know from the U.S. Department of Labor the probability that an average white male may be employed at each age. This "E" statistic is the third adjustment for work-life expectancy. It should also be noted that historical periods of 10 years or more may be averaged for the "P" and "E" statistics, so that a "quirky" year in the economy will not bias the expected value estimate.[11]

One must be alive (L) to participate (P) in the economy, and one must be participating to have a chance of being employed (E). Therefore, the *product* of the three distinct probabilities at each age—the joint probability LPE—is the chance that an average person would actually have been alive, trying to find a job, and, in fact, employed. In Table 8, the previous loss estimates for Mr. Jack Doe are lowered by these LPE probabilities at each age. By multiplying the previous present value estimates by these probabilities, we are further reducing the loss estimate by all of the major life risks to which Mr. Doe would have been exposed—the risk of death, of disability, of ill health, of unemployment, and the chance of early retirement.

It is clear from Table 8 that these work-life expectancy reductions using the LPE technique are significant. By his late 50's, Mr. Doe's present value numbers are multiplied by approximately 60 percent and therefore lowered by approximately 40 percent. After age 65, the present value estimates are lowered by 85 percent or more. The *expected* (present) value of lump sum loss is the $568,512 lump sum in Table 8, versus the $644,617 or $606,643 alternatives using existing U.S. work-life tables. The LPE technique may lower loss estimates even more, in percentage terms, depending upon the race and sex of the plaintiff. Many of these "special cases" will be further explored in Chapter 7. On the other hand, an application of the LPE technique can greatly raise the value of loss estimates in partial disability cases, and this will be explored in Chapter 8.

Other Work-Life Issues

The $568,512 loss estimate is conservative. Remembering Table 1, we have already established an earnings base of 1,810 hours per year times applicable hourly rates. This is below the standard work hours of 2,080 per year (40 hours per week times 52 weeks per year). In effect, a chance of less-than-full employment in each year has already been considered. A good argument can be made that only an "LP"

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[11] As will be seen in Chapter 7 on *Special Cases,* historical averages are not used to project participation rates for average females.

TABLE 8

PRESENT VALUE OF EXPECTED LOST EARNING CAPACITY IN WAGES FOR MR. JACK DOE, AGES 36-75

Year	Age	Wages	Discount Factor	Present Value	Work Life Probability	Expected Value	Cumulative
1989	36	$26,342	1.00000	$26,342	0.9170	$24,156	$ 24,156
1990	37	30,434	0.96965	29,510	0.9153	27,011	51,167
1991	38	30,827	0.94022	28,984	0.9134	26,474	77,641
1992	39	31,225	0.91169	28,468	0.9114	25,946	103,587
1993	40	31,628	0.88402	27,960	0.9093	25,424	129,011
1994	41	32,036	0.85719	27,461	0.9070	24,907	153,918
1995	42	32,449	0.83117	26,971	0.9045	24,395	178,313
1996	43	32,868	0.80594	26,490	0.9018	23,889	202,202
1997	44	33,292	0.78148	26,017	0.8989	23,387	225,589
1998	45	33,721	0.75777	25,553	0.8854	22,625	248,214
1999	46	34,156	0.73477	25,097	0.8587	21,551	269,765
2000	47	34,597	0.71247	24,649	0.8550	21,075	290,840
2001	48	35,043	0.69084	24,209	0.8511	20,604	311,444
2002	49	35,495	0.66988	23,777	0.8467	20,132	331,576
2003	50	35,953	0.64955	23,353	0.8418	19,659	351,235
2004	51	36,417	0.62983	22,937	0.8365	19,187	370,422
2005	52	36,887	0.61072	22,528	0.8306	18,712	389,134
2006	53	37,363	0.59218	22,126	0.8241	18,234	407,368
2007	54	37,845	0.57421	21,731	0.8169	17,752	425,120
2008	55	38,333	0.55678	21,343	0.7518	16,046	441,166
2009	56	38,827	0.53988	20,962	0.6158	12,908	454,074
2010	57	39,328	0.52350	20,588	0.6086	12,530	466,604
2011	58	39,835	0.50761	20,221	0.6007	12,147	478,751
2012	59	40,349	0.49220	19,860	0.5922	11,761	490,512
2013	60	40,870	0.47726	19,506	0.5830	11,372	501,884
2014	61	41,397	0.46278	19,158	0.5731	10,979	512,863
2015	62	41,931	0.44873	18,816	0.5625	10,584	523,447
2016	63	42,472	0.43512	18,480	0.5512	10,186	533,633
2017	64	43,020	0.42191	18,151	0.5392	9,787	543,420
2018	65	43,575	0.40910	17,827	0.4070	7,256	550,676
2019	66	44,137	0.39669	17,509	0.1311	2,295	552,971
2020	67	44,706	0.38465	17,196	0.1275	2,192	555,163
2021	68	45,283	0.37297	16,889	0.1236	2,087	557,250
2022	69	45,867	0.36165	16,588	0.1196	1,984	559,234
2023	70	46,459	0.35068	16,292	0.1152	1,877	561,111
2024	71	47,058	0.34004	16,002	0.1107	1,771	562,882
2025	72	47,665	0.32972	15,716	0.1059	1,664	564,546
2026	73	48,280	0.31971	15,436	0.1009	1,557	566,103
2027	74	48,903	0.31001	15,160	0.0957	1,451	567,554
2028	75	34,334	0.30342	10,418	0.0920	958	$568,512

J. DOE $568,512

reduction should be made in Table 8, as the "E" reduction has already been accomplished. The "LP" loss estimate may therefore be higher than under an increment-decrement technique, which ignores "E" reductions anyway. This is an illustration of the flexibility of the LPE approach.

The LPE approach is superior to the use of existing work-life expectancy tables, even the newest increment-decrement tables. The chance of unemployment *is* considered. The basic data on all three probabilities are up-dated and published annually. Appropriate work-life reductions are correctly assigned to each successive age and year. Finally, the economist can adjust any or all of the three distinct probabilities based upon the specifics of each case. If life expectancy is better than average, or participation different from average, or employment rates 100 percent over the past 20 years, for example, appropriate adjustments can be attempted or ranges of loss established.

The basic LPE technique is still to be refined. An LPEH approach will soon be established to consider the possibility that an average employed person may be working less than full-time hours (H). Another issue is that LPE-type data are now available either by age, race, and sex, or by age, educational level, and sex. We need a Bureau of Labor Statistics series based upon all four major variables—age, race, educational level, and sex.

As a final comment, increment-decrement tables may be useful in specific cases, and some economists construct both increment-decrement and LPE versions of reports. One shortcoming of increment-decrement tables can be addressed by coupling an unemployment probability with an increment-decrement number that incorporates life and participation probabilities. The increment-decrement tables are also useful for older workers, who are near retirement age. These tables allow the economist to calculate the additional years of working life depending upon whether the person was active (participating) or inactive in the work force at the time of death or injury. This is a key variable in determining likely work-life for such persons, and it is not directly considered in an LPE approach.

3.7 Personal Consumption Reductions

A. *The Concept in Illustrative Case*

Personal consumption deductions from expected earnings are only relevant to wrongful death cases. Had he not died, Jack Doe would have spent some amount of total family income exclusively on himself. This amount would not have been available to the rest of Jack's family. Since the family would not have enjoyed this part of income anyway, now that Jack is dead, they have not *lost* this portion of projected income. We therefore reduce the wage loss estimate by some amount that reflects Jack's personal consumption. In most jurisdictions, this must be the actual dollars which we would have expected Jack to spend exclusively on himself, rather than a maintenance consumption level that is usually much lower.

Consistent with a theme already introduced in wage projections, we would prefer to base a personal consumption deduction on the spending patterns established by Jack himself, rather than to use average spending data for large statistical groups. One page of the Information Guide Sheet shown in Chapter 2 is devoted to this task. The spending data could be the best estimate of the surviving wife, based upon checkbook and other information. Jack's personal spending in a typical year would be divided by earnings in the same year to derive a percentage for use as the personal consumption deduction.

When this percentage-of-earnings deduction for the specific person cannot be developed, or as a check on the percentage figure provided by survivors, most forensic economists have turned to the classic study of personal consumption in two-adult households by Professor Earl Cheit.[12] Relevant data from Professor Cheit's study are reproduced in Table 9. The percentage of total income spent by either adult exclusively on himself or herself is shown, and it is shown that this percentage declines below 30 percent when minor children are present in the household.

With only two adults in the household, why would the spending of each be only 30 percent of total income? What about the remaining 40 percent? The answer is that a portion of total income is spent on common expenses. Jack Doe's surviving widow must continue to spend on items which she, Jack, and the children used in common. She must still spend money on the family home and its maintenance, a car, etc. This is the remaining 40 percent of the 100 percent total. Jack would have spent only 30 percent of total income *exclusively* on himself, for his own necessities and enjoyments. Therefore, the reduction is 30 percent of the expected value of wage loss for most years shown in Table 8 (after the children have left home); the reduction is 22 percent when two minor children are in the home and 26 percent in the years when the youngest minor child remains in the home.[13]

The amounts of these annual reductions for personal consumption are shown in Table 10, assuming for simplicity that Jack's spending is consistent with the Cheit conclusions. As with wages, future personal consumption is discounted to present value and adjusted by LPE factors to expected (present) values. In summary Table 11, the final reductions are shown, and the lost earning capacity estimate, less personal consumption, is now $410,249.

B. *Alternative Approaches and Related Issues*

A few other studies of personal consumption, along the lines of the Cheit study, have appeared since the original work by Professor Cheit. These studies have produced slightly different conclusions about percentage-of-earnings consumption by adults in a household, so that some variations in the Cheit conclusions may have empirical support. However, one attempt to contrast the various studies shows that the consensus of conclusions from these studies is very close to the original Cheit conclusions.[14]

An entirely separate approach to determining the personal consumption of adults is the use of Revised Equivalency Scales (RES's) from the U.S. government. In effect, the spending of a "typical" family of two adults and two children is set at 100 percent. Other combinations of family size are then set at percentages above

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12 Earl F. Cheit, INJURY AND RECOVERY IN THE COURSE OF EMPLOYMENT (New York: John Wiley & Sons, Inc., 1961).

13 When a consumption percentage is developed for the specific deceased person for the number of children in the home at his or her death, it can still be scaled upward based upon the Cheit study as the children reach adulthood.

14 Martin, *op. cit.*, section 500.

TABLE 9

CONSUMPTION EXPENDITURES OF ANY ADULT IN FAMILY, BY SIZE OF FAMILY

Family Size at Death of Adult	One Adult's Consumption Expenditures as Percentage of Family Income
Two adults	30%
Two adults, 1 minor dependent child	26%
Two adults, 2 minor dependent children	22%
Two adults, 3 minor dependent children	20%
Two adults, 4 minor dependent children	18%

SOURCE: Earl F. Cheit, INJURY AND RECOVERY IN THE COURSE OF EMPLOYMENT (New York: John Wiley & Sons, Inc., 1961), p. 78.

TABLE 10

PRESENT VALUE OF EXPECTED PERSONAL CONSUMPTION EXPENDITURES FOR MR. JACK DOE, AGES 36-75

Year	Age	Personal Consumption	Discount Factor	Present Value	Work Life Probability	Expected Value	Cumulative
1989	36	-$5,795	1.00000	-$5,795	0.9170	-$5,314	-$ 5,314
1990	37	-6,695	0.96965	-6,492	0.9153	-5,942	-11,256
1991	38	-6,782	0.94022	-6,377	0.9134	-5,825	-17,081
1992	39	-6,870	0.91169	-6,263	0.9114	-5,708	-22,789
1993	40	-6,958	0.88402	-6,151	0.9093	-5,593	-28,382
1994	41	-8,329	0.85719	-7,140	0.9070	-6,476	-34,858
1995	42	-8,437	0.83117	-7,013	0.9045	-6,343	-41,201
1996	43	-9,860	0.80594	-7,947	0.9018	-7,167	-48,368
1997	44	-9,988	0.78148	-7,805	0.8989	-7,016	-55,384
1998	45	-10,116	0.75777	-7,666	0.8854	-6,787	-62,171
1999	46	-10,247	0.73477	-7,529	0.8587	-6,465	-68,636
2000	47	-10,379	0.71247	-7,395	0.8550	-6,323	-74,959
2001	48	-10,513	0.69084	-7,263	0.8511	-6,182	-81,141
2002	49	-10,649	0.66988	-7,134	0.8467	-6,040	-87,181
2003	50	-10,786	0.64955	-7,006	0.8418	-5,898	-93,079
2004	51	-10,925	0.62983	-6,881	0.8365	-5,756	-98,835
2005	52	-11,066	0.61072	-6,758	0.8306	-5,613	-104,448
2006	53	-11,209	0.59218	-6,638	0.8241	-5,470	-109,918
2007	54	-11,354	0.57421	-6,520	0.8169	-5,326	-115,244
2008	55	-11,500	0.55678	-6,403	0.7518	-4,814	-120,058
2009	56	-11,648	0.53988	-6,289	0.6158	-3,873	-123,931
2010	57	-11,798	0.52350	-6,176	0.6086	-3,759	-127,690
2011	58	-11,951	0.50761	-6,066	0.6007	-3,644	-131,334
2012	59	-12,105	0.49220	-5,958	0.5922	-3,528	-134,862
2013	60	-12,261	0.47726	-5,852	0.5830	-3,412	-138,274
2014	61	-12,419	0.46278	-5,747	0.5731	-3,294	-141,568
2015	62	-12,579	0.44873	-5,645	0.5625	-3,175	-144,743
2016	63	-12,742	0.43512	-5,544	0.5512	-3,056	-147,799
2017	64	-12,906	0.42191	-5,445	0.5392	-2,936	-150,735
2018	65	-13,073	0.40910	-5,348	0.4070	-2,177	-152,912
2019	66	-13,241	0.39669	-5,253	0.1311	-689	-153,601
2020	67	-13,412	0.38465	-5,159	0.1275	-658	-154,259
2021	68	-13,585	0.37297	-5,067	0.1236	-626	-154,885
2022	69	-13,760	0.36165	-4,976	0.1196	-595	-155,480
2023	70	-13,938	0.35068	-4,888	0.1152	-563	-156,043
2024	71	-14,117	0.34004	-4,800	0.1107	-531	-156,574
2025	72	-14,300	0.32972	-4,715	0.1059	-499	-157,073
2026	73	-14,484	0.31971	-4,631	0.1009	-467	-157,540
2027	74	-14,671	0.31001	-4,548	0.0957	-435	-157,975
2028	75	-10,300	0.30342	-3,125	0.0920	-288	-$158,263

J. DOE -$158,263

and below this 100 percent index. By comparing the percentages for the before-death and after-death family composition, the percentage-of-income consumption of the deceased adult is estimated.

The RES percentages are usually very similar to the Cheit percentages, but their deviation is more difficult to explain. Furthermore, these tables may need to be manipulated in some cases to avoid the conclusion of negative consumption by a deceased adult. The preference of most economists for the Cheit study is not difficult to understand.

Both Cheit-type and RES conclusions share some potential drawbacks if not properly applied to calculations of net economic losses. Both deal with percentages of income, rather than percentages of earnings. If a deceased household head had significant unearned income each year, and was spending 30 percent of family income, then his spending could be much higher than 30 percent of his own earned income. An upward adjustment in the consumption percentage can and should be madè, if the true legal standard is net economic loss to survivors.

Similarly, standard approaches don't directly deal with two-income households with both adults working. Thirty-percent-of-income consumption by the male, for example, must be converted to a (higher) percentage of his own income when net economic losses are projected. Thirdly, the percentage-of-income guidelines do not vary by the income level of the relevant household. An array of economic data suggest that a male household head with a very high income would spend less than the 30 percent average. The percentage would probably be above the 30 percent average for very low income families. The forensic economist may wish to consider this issue, explicitly or implicitly, when dealing with extremes of income.

The Cheit and other traditional studies also were aimed at two-adult households. For minor children and single persons, consumer expenditure data collected by the U.S. government for single persons must be used when a credible spending sheet on the deceased cannot be developed. The 40 percent "common spending" issue, discussed before, does not apply, and the problem becomes isolating those categories of income use, beyond clear savings, which generate or preserve assets of value after a death. This will be further highlighted in the "special cases" of Chapter 7, but the percentage-of-income reduction usually exceeds 80 percent.

C. *Maintenance Versus Actual Consumption Deductions*

As will be seen in the jurisdiction-by-jurisdiction survey of Chapter 12, a few states do not allow any reduction in the loss estimate for the likely consumption of the deceased. A few other states prescribe a reduction for only that level of consumption which would have been necessary to maintain the worker in a healthy condition, instead of the actual level of consumption which we would have expected from him or her.

Under such a standard, single person poverty level income may be divided by base year earnings to determine a percentage-of-earnings reduction for future years. Or, the economist may adjust U.S. data on actual spending to reflect spending by one person on necessities. The maintenance standard almost always results in a lower reduction than an actual consumption standard, and the difference is especially important in the death of single persons. The maintenance standard may result in reductions in a 30-50 percent range, depending upon the projected earnings level, versus a reduction exceeding 80 percent under an actual consumption standard.

Thornton and Schwartz suggest that the various state laws actually confront the forensic economist with a range of guidelines on consumption reductions that may impact his techniques. For example, Pennsylvania appears to be a "maintenance" state but maintenance is to be deducted only during the work-life expectancy of the deceased.[15] Usually, deductions for consumption would extend beyond the end of work-life, or fringe benefit projections would be adjusted to achieve the same result. These same authors also suggest that the more liberal (from the plaintiff's perspective) maintenance standard may make more sense as public policy in those jurisdictions which don't allow (hedonic) testimony on the lost pleasure of living *per se*. Why lower the loss estimate for spending that brings enjoyment beyond the maintenance level when, on the other hand, a separate estimate of the lost enjoyment of life *per se* is not allowed?[16]

All of these issues concerning the proper treatment of consumption or maintenance deductions lead to one generalized conclusion. This is a fertile and necessary area for further research in the emerging field of forensic economics.

3.8 The Impact of Income Taxes

A. *The Two Effects*

Since the 1980 U.S. Supreme Court decision in *Norfolk & Western Railway v. Liepelt*, economists have been required in most railroad and other federal cases to consider the impact of income taxes on lump sum loss estimates.[17] A few states also provided for the consideration of income-tax effects, and the status of state laws on this subject will be reviewed in Chapter 12. Defense attorneys initially favored this development, as it was assumed that the consideration of income taxes could only lower lump sum loss estimates. It was discovered, however, that when all effects of income taxes are considered, the lump sum estimate of lost earning capacity might well increase.[18] This may be the reason that momentum to expand the jurisdictions considering income tax effects was significantly eroded after the early eighties.

Indeed, *two* effects of income taxes exist in those jurisdictions where income tax effects must be considered. The first effect is obvious. The economist must project a stream of after-tax earnings losses, which must be lower than a before-tax earnings stream. This is a downward effect; it lowers the lump sum estimate of lost earning capacity.

Yet, there is a second, upward effect of income taxes, which is often sufficiently powerful to overcome the downward effect. It has sometimes been labeled the

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15 Robert Thornton and Eli Schwartz, *An Uneasy Case for the Personal Maintenance Reduction*, JOURNAL OF FORENSIC ECONOMICS (September 1987), p. 17.

16 *Ibid.*

17 *Norfolk & Western Railway Co. v. Kandythe J. Liepelt, Administratix*, 444 U.S. 490, 100 S.Ct. 755, 62 L.Ed.2d 689, (1980).

18 *See* Dennis Brady, Michael Brookshire, and William Cobb, *Calculating the Effects of Income Taxes on Lost Earnings*, TRIAL (September 1982), pp. 65-68 and 84. *Also see* Randall Goodwin and Chris Paul, *The Consideration of Progressive Taxes in Present Value Calculations for Personal Injuries and Wrongful Death Cases*, JOURNAL OF FORENSIC ECONOMICS (May 1988), pp. 83-92.

"reverse tax effect." A lump sum (present value) will presumably be received by the plaintiffs. This lump sum is tax free,[19] but plaintiff survivors must pay income taxes on the interest earnings. Therefore, a complicated mathematical process must be used to adjust the present value lump sum upward. Interest will be earned on this increased lump sum, income tax will be paid on these interest earnings, and the lump sum plus after-tax interest will exactly restore the projected stream of after-tax earnings.[20]

The necessity of considering both impacts of income taxes on loss estimates significantly increases the complexity of the economic analysis. Because of the Tax Reform Act of 1986, which was not completely implemented until 1990, historical experience does not exist for use in predicting average taxes paid for all income classes. Even the average taxes paid or average itemized deductions for the specific injured or deceased person before 1990 cannot be used for projections beyond 1990. Some economists have chosen to apply the standard deduction and the two tax rates of 15 percent and 28 percent for future year projections.

Another problem exists when both marriage partners worked before the injury or death. Assume that each adult earned $30,000, for a total family income of $60,000, before the husband died. Should the lost $30,000 of earned income from the deceased husband be taxed at an average tax rate applicable to the first $30,000 of annual income, or at a rate applicable to his added (marginal) $30,000 of income, or at some weighted tax rate which is a compromise between these lower and higher rates? The effects of the death on filing status and the number of exemptions must also be considered.

Beyond these complications in the calculation of damages, tax-considered loss estimates can be very difficult to explain. The economist may need to explain how both income tax effects are considered by simultaneously solving a system of equations through a computer simulation. The economist, in order to derive a tax-considered estimate, has begun his analysis at the $0 which survivors will have at the end of a projected working life for the deceased. By this point, the survivors must have used the lump sum award and all earned interest to exactly restore the lost (after tax) earning capacity. The economist has then worked backwards from the last year to the first year of the loss period, considered all income tax effects, and derived a present value estimate of lost earning capacity.

Because of this complexity, some economists use, and some courts seem to favor, an alternative approach to handling the reverse tax effect: discounting to present values at interest rates on tax-exempt (state and local government) bonds. Or, a historical, percentage relationship is established between yields on tax-exempt bonds and the higher yields on taxable U.S. government securities. When adjustments are considered for the risk of default, tax-exempt yields have recently been 28-30 percent less than yields on taxable U.S. government securities. The marginal federal tax rate was 28 percent by 1989. Thus, the lower discount rate results in a higher

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[19] *See* Mark Cochran, *Should Personal Injury Damage Awards Be Taxed,* CASE WESTERN RESERVE LAW REVIEW, Vol. 38:4, pp. 43-65, but note that the reverse tax effect is not covered in this article.

[20] *See* Dennis Brady, Michael Brookshire, and William Cobb, *The Development and Solution of a Tax Adjusted Model for Personal Injury Awards,* JOURNAL OF RISK AND INSURANCE (March 1984), pp. 138-142.

economic loss estimate, when considered alone. This is the expected direction of the "reverse tax effect." Income tax effects on both lost wages and interest earnings have been considered, and complicated mathematical explanations have been avoided.

The 1986 Tax Reform Act "flattened" the tax rate structure, with the highest tax rate set at 28 percent. This change, taken alone, has somewhat lessened the power of the reverse tax effect. Given this, two major factors determine whether the net of the downward versus the upward (reverse) effects will lower or raise the lump sum loss estimate. The first factor is the age of the person at time of injury or death. If he or she is younger, interest on a lump sum must compound over a longer period, the upward effect becomes more powerful, and the consideration of income taxes will raise the present value estimate of loss. When the death or injury occurs in the age 50's or later, the consideration of income taxes will likely lower the estimate.

While the loss element of employer contributions to fringe benefits will be discussed in the next chapter, the tax effects on both wage and fringe benefit loss must now be briefly considered. As the ratio of fringe benefit loss to wage loss rises, the chance that the net effect will be a higher loss estimate increases. Fringe benefits, at least traditionally, are not taxed, so that no downward effect exists. The upward (reverse) effect still exists. Therefore, the proportionate impact of fringe benefits to wages as a loss element is the second factor.

B. *Illustrative Case*

To see the impact of income taxes on our Jack Doe example, let us temporarily assume employer contributions to fringe benefits of 30 percent of wages.[21] The before-tax loss of $410,249 in Table 11 would therefore increase to a $533,324 present value estimate of overall loss in earnings. (This will be discussed in the following chapter.) When all effects of income taxes are considered, this loss estimate rises to $683,661. The consideration of income taxes increases the present value loss estimate by 28.2 percent in our illustrative case of a relatively young worker with high fringe benefits.

Only federal income taxes were considered in the illustrative example. Where state or local income taxes are to be considered, the direction of change from the before-tax estimate should be the same, assuming that state and local taxes are progressive and/or based upon the federal tax structure. If considering federal income taxes increases the Jack Doe estimate by 28.2 percent, the consideration of all income taxes should be expected to increase the before-tax estimate by that amount or slightly more.

3.9 Testimony

A. *General*

In Chapter 11, a comprehensive set of guidelines is provided for economic testimony at trial. It is there that major strategies and tactics are outlined for both plaintiff

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[21] This 30.00 percent figure is a national statistic for hourly-paid employees, which is discussed in the following chapter.

TABLE 11

PRESENT VALUE OF EXPECTED LOST EARNING CAPACITY
IN WAGES FOR MR. JACK DOE AFTER DEDUCTING
PERSONAL CONSUMPTION EXPENDITURES
AGES 36-75

Year	Age	Expected Wages	Personal Consumption	Expected Loss	Cumulative
1989	36	$ 24,156	-$5,314	$ 18,842	$ 18,842
1990	37	27,011	-5,942	21,069	39,911
1991	38	26,474	-5,825	20,649	60,560
1992	39	25,946	-5,708	20,238	80,798
1993	40	25,424	-5,593	19,831	100,629
1994	41	24,907	-6,476	18,431	119,060
1995	42	24,395	-6,343	18,052	137,112
1996	43	23,889	-7,167	16,722	153,834
1997	44	23,387	-7,016	16,371	170,205
1998	45	22,625	-6,787	15,838	186,043
1999	46	21,551	-6,465	15,086	201,129
2000	47	21,075	-6,323	14,752	215,881
2001	48	20,604	-6,182	14,422	230,303
2002	49	20,132	-6,040	14,092	244,395
2003	50	19,659	-5,898	13,761	258,156
2004	51	19,187	-5,756	13,431	271,587
2005	52	18,712	-5,613	13,099	284,686
2006	53	18,234	-5,470	12,764	297,450
2007	54	17,752	-5,326	12,426	309,876
2008	55	16,046	-4,814	11,232	321,108
2009	56	12,908	-3,873	9,035	330,143
2010	57	12,530	-3,759	8,771	338,914
2011	58	12,147	-3,644	8,503	347,417
2012	59	11,761	-3,528	8,233	355,650
2013	60	11,372	-3,412	7,960	363,610
2014	61	10,979	-3,294	7,685	371,295
2015	62	10,584	-3,175	7,409	378,704
2016	63	10,186	-3,056	7,130	385,834
2017	64	9,787	-2,936	6,851	392,685
2018	65	7,256	-2,177	5,079	397,764
2019	66	2,295	-689	1,606	399,370
2020	67	2,192	-658	1,534	400,904
2021	68	2,087	-626	1,461	402,365
2022	69	1,984	-595	1,389	403,754
2023	70	1,877	-563	1,314	405,068
2024	71	1,771	-531	1,240	406,308
2025	72	1,664	-499	1,165	407,473
2026	73	1,557	-467	1,090	408,563
2027	74	1,451	-435	1,016	409,579
2028	75	958	-288	670	$410,249
TOTAL		$568,512	-$158,263	$410,249	

and defense attorneys, as these attorneys interact with economic experts. Yet, some treatment of testimony will be provided here, as will occur in the following chapters on other elements of possible economic damages.

B. *Direct Examination*

A basic thrust for the plaintiff economist is to keep his explanation of complicated issues as simple as possible. His techniques should appear fair, as the jury should certainly not believe him to be stretching the estimates.

More specifically, the base level of wage earnings should be shown to be a sound foundation. Real wages and interest rates should be used; these should generally result in the present value of future losses compounding downward each year. This would not be true if the real wage growth rate of the individual was higher than normal. Where data specific to the deceased or injured person have been used, such as his own trend rate of wage growth, this should be emphasized. The jury should understand why "safe" interest (discount) rates should be used.

Tables such as Table 8 and/or Table 11 may be distributed to the jury or enlarged as exhibits. With real wage increases, no wage number on Table 8 looks unreasonable, but the significant reductions under the LPE techniques are also shown. Further reductions for the personal consumption of a deceased are then shown in Table 11. If applicable, it can be explained that income tax adjustments fairly consider all relevant effects.

C. *Cross Examination*

The defense will normally use its economist in preparing for cross examination of the plaintiff economist, but the defense economist may be placed on the stand to counter unusual assumptions, poor techniques, or errors. In every case, the validity of all assumptions and techniques used by the plaintiff economist should be scrutinized, and it should be determined whether he has used different methods in similar cases. The defense economist may re-run an analysis and change only one variable used by the plaintiff economist to spotlight the effects of a particularly weak assumption or method.

Analyses are especially weak and suspect when generalized data for statistical classes have been used and data for the specific deceased or injured person are available. Why was a wage base constructed when we know wages in a base year? Why was an all-U.S.-worker wage trend used when the actual trend for the relevant worker was much lower? What if the person's employment record was poor but only average work-life reductions were made? Why was a national statistic used as a personal consumption deduction, when the actual consumption of the decedent was greater than average?

The defense may re-calculate all of the numbers with actual wage growth rates and actual interest rates. This results in a column of future wage losses such as the third column of Table 3. It is difficult for a jury to understand annual wage earnings moving from $26,342 to over $450,000. The defense may also pursue the argument that interest rates on long-term government bonds, many corporate bonds, and insured annuities are "relatively" safe and present value figures should be lower.

The plaintiff economist can sometimes be caught in outright errors. Assume he made a 30 percent personal consumption deduction for a deceased husband, based upon the Cheit study. If the wife also worked, this 30 percent reduction may be much too low. The 30 percent is a percentage of total family income, which translates into the husband spending *more* than 30 percent of *his* income.

The defense may point out that traditional work-life tables, if these were used, assume no possibility of unemployment. On the other hand, LPE tables should usually not be attacked, as they result in the greatest reductions among alternative techniques. By the same token, income tax considerations probably should not be emphasized, as they often raise before-tax estimates.

3.10 Summary

This chapter has provided the basis for all that follows. The fundamentals of projecting wages, discounting to present values, adjusting for work-life expectancy, deducting for personal consumption, and considering income tax effects were described. This was accomplished with reference to an illustrative case. Finally, some mention was made of issues in testimony.

APPENDIX 1

THE "TEETER-TOTTER"

REAL WAGE GROWTH VERSUS REAL INTEREST (DISCOUNT) RATE FOR ALL U.S. WORKERS, 1970-1988

	All U.S. Wage Index		Interest (Discount Rate)		Consumer Price Index			Real Interest
Year	Index	Percent Change	Rate	Index Change	Index	Percent Change	Real Wage Change	(Discount) Change
1970	57.80	—	—	1.0000	116.30	—	—	—
1971	61.60	6.57	4.46	1.0446	121.30	4.30	2.28	0.16
1972	65.50	6.33	4.18	1.0883	125.30	3.30	3.03	0.88
1973	70.90	8.24	7.27	1.1674	133.10	6.23	2.02	1.04
1974	77.60	9.45	8.16	1.2626	147.70	10.97	−1.52	−2.81
1975	85.20	9.79	6.01	1.3385	161.20	9.14	0.65	−3.13
1976	92.80	8.92	5.14	1.4073	170.50	5.77	3.15	−0.63
1977	100.00	7.76	5.41	1.4835	181.50	6.45	1.31	−1.04
1978	108.50	8.50	7.46	1.5941	195.30	7.60	0.90	−0.14
1979	119.10	9.77	10.45	1.7607	217.70	11.47	−1.70	−1.02
1980	131.50	10.41	12.05	1.9729	247.00	13.46	−3.05	−1.41
1981	143.70	9.28	14.75	2.2639	272.30	10.24	−0.97	4.51
1982	154.90	7.79	11.14	2.5161	288.60	5.99	1.81	5.15
1983	161.40	4.20	8.94	2.7410	297.40	3.05	1.15	5.89
1984	167.90	4.03	9.98	3.0146	307.60	3.43	0.60	6.55
1985	175.50	4.53	7.73	3.2476	318.50	3.54	0.98	4.19
1986	183.10	4.33	6.16	3.4476	323.40	1.54	2.79	4.62
1987	190.40	3.99	6.27	3.6638	335.00	3.59	0.40	2.68
1988	199.50	4.78	6.90	3.9166	348.40	4.00	0.78	2.90
AVG.		.0712		.0788		.0629	.0084	.0159

SOURCES: For average compensation changes of U.S. workers, monthly issues of the U.S. Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Tables 42 and 44; for interest rates, ECONOMIC REPORT OF THE PRESIDENT (Washington, D.C.: U.S. Government Printing Office, January, 1989), Table B-71, p. 390; and for Consumer Price Index, monthly issues of the U.S. Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Tables 30 and 32.

APPENDIX 2

THE "TEETER-TOTTER"

REAL WAGE GROWTH VERSUS REAL INTEREST (DISCOUNT) RATE FOR ALL U.S. WORKERS, 1952-1988

	All U.S. Wage Index		Interest (Discount Rate)		Consumer Price Index			Real Interest (Discount) Change
Year	Index	Percent Change	Rate	Index Change	Index	Percent Change	Real Wage Change	
1952	23.00	—	—	1.0000	79.50	—	—	—
1953	24.60	6.96	1.97	1.0197	80.10	.75	6.20	1.22
1954	25.30	2.85	.97	1.0296	80.50	.50	2.35	.47
1955	26.00	2.77	1.79	1.0480	80.20	−.37	3.14	2.16
1956	27.70	6.54	2.72	1.0765	81.40	1.50	5.04	1.22
1957	29.50	6.50	3.34	1.1125	84.30	3.56	2.94	−.22
1958	30.90	4.75	1.87	1.1333	86.60	2.73	2.02	−.86
1959	32.20	4.21	3.48	1.1727	87.30	.81	3.40	2.67
1960	33.60	4.35	3.00	1.2079	88.70	1.60	2.74	1.40
1961	34.90	3.87	2.43	1.2373	89.60	1.01	2.85	1.42
1962	36.60	4.87	2.84	1.2724	90.60	1.12	3.75	1.72
1963	37.90	3.55	3.23	1.3135	91.70	1.21	2.34	2.02
1964	39.90	5.28	3.64	1.3613	92.90	1.31	3.97	2.33
1965	41.50	4.01	4.05	1.4164	94.50	1.72	2.29	2.33
1966	44.30	6.75	5.01	1.4874	97.20	2.86	3.89	2.15
1967	46.70	5.42	4.43	1.5533	100.00	2.88	2.54	1.55
1968	50.40	7.92	5.50	1.6387	104.20	4.20	3.72	1.30
1969	53.90	6.94	6.89	1.7516	109.80	5.37	1.57	1.52
1970	57.80	7.24	6.66	1.8683	166.30	5.92	1.32	.74
1971	61.60	6.57	4.46	1.9516	121.30	4.30	2.28	.16
1972	65.50	6.33	4.18	2.0332	125.30	3.30	3.03	.88
1973	70.90	8.24	7.27	2.1810	133.10	6.23	2.02	1.04
1974	77.60	9.45	8.16	2.3590	147.70	10.97	−1.52	−2.81
1975	85.20	9.79	6.01	2.5008	161.20	9.14	.65	−3.13
1976	92.80	8.92	5.14	2.6293	170.50	5.77	3.15	−.63
1977	100.00	7.76	5.41	2.7715	181.50	6.45	1.31	−1.04
1978	108.50	8.50	7.46	2.9783	195.30	7.60	.90	−.14
1979	119.10	9.77	10.45	3.2895	217.70	11.47	−1.70	−1.02
1980	131.50	10.41	12.05	3.6859	247.00	13.46	−3.05	−1.41
1981	143.70	9.28	14.75	4.2296	272.30	10.24	−.97	4.51
1982	154.90	7.79	11.14	4.7008	288.60	5.99	1.81	5.15
1983	161.40	4.20	8.94	5.1210	297.40	3.05	1.15	5.89
1984	167.90	4.03	9.98	5.6321	307.60	3.43	.60	6.55
1985	175.50	4.53	7.73	6.0675	318.50	3.54	.97	4.19
1986	183.10	4.33	6.16	6.4412	323.40	1.54	2.79	4.62
1987	190.40	3.99	6.27	6.8451	335.00	3.59	.21	2.68
1988	199.50	4.78	6.90	7.3174	348.40	4.00	.97	2.90
AVG.	.0618		.0568		.0419		.0199	.0149

SOURCES: For average compensation changes of U.S. workers, monthly issues of the U.S. Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Tables 42 and 44; for interest rates, ECONOMIC REPORT OF THE PRESIDENT (Washington, D.C.: U.S. Government Printing Office, January, 1989), Table B-71, p. 390; and for Consumer Price Index, monthly issues of the U.S. Bureau of Labor Statistics, MONTHLY LABOR REVIEW (Washington, D.C.: U.S. Government Printing Office), Tables 30 and 32.

APPENDIX 3

OFFSETTING RATES—A TECHNICAL NOTE

This note discusses the issue of precision with regard to offsetting for inflation to determine real rates (for wages, interest or other rates) and with regard to offset of growth and discount rates for present value determination of projected quantities (wages, medical costs, etc.). The task of an economist is to present to a jury accurate estimates explained in a concise and simple way. Within reasonable limits, trade-offs may be involved between precision and the effectiveness of testimony.

Economists are frequently faced with the choice of presenting slightly less precise estimates to a jury in exchange for significantly greater jury understanding. After all, a jury cannot obtain a postgraduate degree in economics, or medicine for that matter, being limited to only a few hours of testimony summarizing complex fields of science. If the direction and dimension of the sacrifice in precision is known and understood, an expert witness may conclude that in many instances the increase in simplicity and thus in jury understanding may be well worth it.

Inflation Offset

Earlier in this chapter, we stated that the equation relating actual (nominal or observed) rates (R), inflation (I) and real rates (r) is:

1. $$r = R - I.$$

This equation applies equally to removing the effects of inflation from wage growth rates or any other type of rate that is affected by inflation. This equation is intuitive and simple. Regarding interest rates, for example, the real rate is that portion of the actual rate that exceeds the inflation rate. So if the observed rate of a one year U.S. Treasury Note is 8 percent and if inflation over the period is 6 percent, then the real rate over the period is 2 percent. This concept is quite easily presented to a jury.

Unfortunately, the actual equation to calculate real rates is slightly more complicated, and not so easily presented to a jury. Here is why. In the above example, if a bond costing $1,000 is bought at the beginning of 1990 and earns $80 in interest paid at the beginning of 1991, or 8 percent interest, and if inflation is measured to be 6 percent during 1990, then the equation would imply that 2 percent (8 percent − 6 percent) is the real interest earned.

But the $80 in interest is paid in 1991, one year later, when the value of an item that originally cost $1.00 in 1990 subsequently costs $1.06 in 1991. Of the $80 in interest paid, $60 exactly compensates for inflation regarding the value of the initial $1,000 investment. The remaining $20 in 1991 dollars is the real interest paid. In 1990 dollars, this $20 is worth $20/$1.06 or $18.87. This is $1.13 less than $20. Alternatively stated, in 1990 dollars the $1,000 in principal plus $18.87 in real interest, equalling $1018.87, is worth 6 percent more in 1991 dollars, or exactly $1,080. The $18.87 in real interest promised is not payable until 1991, at which time it and the principal are paid, in 1991 dollars, thus adding 6 percent inflation to the payment.

So $18.87 was the real interest earned in 1990 dollars, $60 compensated for inflation on the original cost of $1,000, and $1.13 was the inflation component on the real interest earned. After all, the real interest of $18.87 must also be inflated by 6 percent to equal $20.00 in 1991 dollars.

If there had been zero inflation, the real rate of interest paid would be exactly the same as the actual rate. If we assume that the real rate of interest is the same, no matter what the inflation rate is, then this real interest rate would have to be the same, measured in 1990 dollars, as the real rate of interest paid in the instance where we assumed 6 percent inflation. One can determine the real interest rate correctly by using the same year dollar value, either as 18.87/1000 or 20/1060, both of which are 1.887 percent, not 2 percent which results from mixing dollar values, by dividing $20 in 1991 dollars by $1,000 in 1990 dollars. The important concept is to determine the rate using the same year's dollar value. Measured in either 1990 or 1991 dollars, the actual amount of real interest earned must be the same. The actual equation for measuring real interest is not equation (1), but:

2. $$r = (R - I)/(1 + I)$$

So, in the above example, real interest is (8 percent − 6 percent)/1.06 or 1.887 percent. Equation (1) overestimates the real rate by exactly the rate of inflation. If inflation is 6 percent, equation 1 gives a real rate which is 6 percent higher than the actual real rate.

Economists typically present equation (1) to juries when explaining the difference between real and nominal rates, and this is the method we have chosen to present in this chapter. It should be recognized that equation (2) is the more precise and correct equation, however.

Mathematical Bias

Since equation (1) overestimates the discount rate, it produces an underestimate of the present value of future dollars. If equation (1) is chosen as the method for jury presentation, this generally conservative approach may or may not be emphasized in testimony; it is conservative nonetheless.

If equation (1) is also used to determine real wage growth rates (or other growth rates) as well as to determine real interest rates, this will result in an *underestimate* of the present value if wages grow more slowly than interest. In the examples in this chapter and in the past from 1970 through 1988 as shown in Appendix 1, this was the case. However, from 1952 through 1988, wages grew more quickly than interest rates, as shown in Appendix 2. If the wage growth rate used is greater than the interest rate used, then equation (1) will *overestimate* the present value of future wages.

The forensic economist must be aware of the degree and the direction of the bias before choosing whether to present the simpler inflation offset method represented by equation (1). Below is a chart showing the bias in the estimates using equation (1) for differing economic scenarios including deflation, expressed as a percentage above or below the precise estimates obtained using equation (2) for 1, 2, 5, 10, 15 and 30 years in the future, for each $1.00 in wages in 1990. Shown for year 5 for example is the bias in the present value of the estimate for year 5, not for all years 1 through 5. The charts describe inflation, high inflation, and deflation scenarios.

The charts show how the percentage bias (over or underestimate) changes for any future year's present value, where W is the wage growth rate, R is the interest rate and I is the rate of price inflation or deflation. The bias is greater when inflation is higher and when the difference between W and R is greater. When $R = W$, there is no bias. When $I = 0$, there is no bias. Under conditions of inflation, when $W > R$, the bias produces an overestimate; when $W < R$, the bias produces an underestimate. As I gets larger than 0, the bias increases. If there is deflation, when $I < 0$, as we had continuously from 1926 through 1944, the bias described above switches sign; underestimates become overestimates, and vice versa. As N increases (the number of years into the future), the bias increases.

CHART 1

THE MATHEMATICAL BIAS UNDER THREE INFLATION SCENARIOS

INFLATION SCENARIO

INTEREST = 8%; INFLATION = 6%
NOMINAL WAGE GROWTH RATES: 5% TO 9%

YEAR	5.0%	6.0%	7.0%	8.0%	9.0%
1	−0.168	−0.111	−0.055	0.000	0.054
2	−0.336	−0.222	−0.110	0.000	0.108
5	−0.838	−0.554	−0.275	0.000	0.270
10	−1.668	−1.104	−0.548	0.000	0.541
15	−2.492	−1.652	−0.821	0.000	0.813
30	−4.921	−3.277	−1.636	0.000	1.632

HIGH INFLATION SCENARIO

INTEREST = 18%; INFLATION = 16%
NOMINAL WAGE GROWTH RATES: 15% TO 19%

YEAR	15.0%	16.0%	17.0%	18.0%	19.0%
1	−0.409	−0.270	−0.134	0.000	0.132
2	−0.817	−0.540	−0.268	0.000	0.264
5	−2.029	−1.345	−0.669	0.000	0.661
10	−4.018	−2.672	−1.333	0.000	1.326
15	−5.965	−3.981	−1.993	0.000	1.996
30	−11.575	−7.803	−3.945	0.000	4.031

DEFLATION SCENARIO

INTEREST = 1%; INFLATION = −1%
NOMINAL WAGE GROWTH RATES: −3% TO 2%

YEAR	−3.0%	−2.0%	0.0%	1.0%	2.0%
1	0.040	0.030	0.010	0.000	−0.010
2	0.081	0.060	0.020	0.000	−0.019
5	0.202	0.150	0.049	0.000	−0.048
10	0.405	0.301	0.098	0.000	−0.096
15	0.608	0.451	0.147	0.000	−0.144
30	1.220	0.904	0.295	0.000	−0.388

General Offset of Growth and Discount Rates

While determining real rates by merely subtracting inflation produces a bias, more generally, one cannot simply net out the growth and discount rates for determining present value without producing a bias, whether using real or nominal rates. If the growth rate is 5 percent and the discount rate is 8 percent, one cannot simply offset and assume a 0 percent (5 percent − 5 percent) growth rate and a 3 percent (8 percent − 5 percent) discount rate without encountering a bias.

Assume, for example, that a patient requires annual medical treatment (Q) costing $50,000 in 1990. Assume further than medical costs (W) are estimated to grow at 5 percent per year and that the interest rate used to discount (r) is 8 percent per year. Growing the $50,000 each year at 5 percent and discounting at 8 percent does not give the same answer as projecting no growth and discounting at 3 percent. One cannot simply subtract 5 percent from each growth rate, just as one cannot subtract inflation from each actual growth rate as discussed above. The first method of increasing $50,000 by 5 percent and discounting by 8 percent (dividing by 1.08) produces a result of $48,543. As discussed earlier, the simpler method of merely discounting by 3 percent produces an underestimate when the actual discount rate is greater than the actual growth rate. A precise net discount rate using equation (2) would be (8 percent − 5 percent)/(1. + .05) = 2.857 percent.

This can be seen below, more generally, where n is the number of years into the future, and Q is the quantity to be grown (projected) and discounted to determine a present value for the nth year:

3. $$\frac{Q \times (1 + .05)^n}{(1 + .08)^n}$$ This is not the same as:

4. $$\frac{Q \times (1 + .00)^n}{(1 + .03)^n}$$ Or simply $(Q/1.03)^n$. But (3) is the same as:

5. $$\frac{Q}{(1 + .03/1.05)^n}$$ Or Q/(1.02857) for n = 1.

The detail of this concept is shown by starting with a more general form of equation (3):

6. $$\frac{Q \times (1 + W)^n}{(1 + R)^n}$$ Dividing numerator and denominator by $(1 + W)^n$:

7. $$\frac{Q \times (1 + W)^n/(1 + W)^n}{(1 + R)^n/(1 + W)^n}$$ And simplifying:

8. $$\frac{Q}{[(1 + R)/(1 + W)]^n}$$ And adding and subtracting W in the same term:

9. $$\frac{Q}{[(1 + W + R - W)/(1 + W)]^n}$$ Simplifies to:

10. $$\frac{Q}{[(1 + W/1 + W) + (R - W)/(1 + W)]^n}$$ Which further simplifies to:

11. $$\frac{Q}{[1 + (R - W)/(1 + W)]^n}$$ Which is the same as equation (5).

Note that the numerator of (11) is the same, for $n = 1$, as equation (2).

The final implications of this note are quite clear: one can make projections in real terms just as easily as in actual terms, by assuming that the relationship between wages and interest (for example) is independent of the degree of future inflation. One can thereby avoid an explicit inflation forecast. However, depending upon the conversion technique, there may be a bias introduced. This bias, as seen above, may be small, and may lead to more conservative results.