

Calculating Lost Earnings: Algebraic vs. Spreadsheet Method

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Abstract

Since the early 1980s, economic experts have been using computerized spreadsheets to make their calculations of lost earnings in civil tort cases. The power of computerized data, readily amenable for making calculation changes, has dominated the mode of delivering expert opinions. In this paper, an alternative to the spreadsheet method is presented, based on simple algebraic calculations. The paper explores the strengths and weaknesses of both approaches, and argues for the superiority of the algebraic method, especially in its ability to present clear and simple analysis to plaintiffs, their attorneys and, especially, to the trier of fact.

I. Introduction

There is little need to explain the power of spreadsheet programs. Nearly every aspect of business operations relies on manipulation and analysis of data using computer spreadsheets. Today, the worlds of finance, accounting, economics, marketing and so many other fields would come to a screeching halt if they were denied the use of computer spreadsheets.

Since the early 1980s, in the applied area known as forensic economics, economic experts have been using computerized spreadsheets to make their calculations of lost income or financial support in civil tort cases. This has developed organically inasmuch as a series of separate calculations is required to arrive at properly calculated values of economic loss. For example, reduction of projected earnings by the probability of potential future unemployment can be done easily by having unemployment probabilities entered in a column of data that is mathematically tied to a column of projected gross earnings. Then, if the analyst found it necessary to change the

earnings figures, the unemployment figures would automatically apply to the changed earnings figures, leading to instantaneously recalculated values.

However, use of spreadsheets is not the only way of making the needed calculations. The “best” method, if there is such a thing, should be aimed at effective communication with readers of one’s report and, ultimately, if the case should go to trial, with typical jurors. This paper questions whether the standard spreadsheet method is best for this purpose. Can anything be done to supplement, modify or change the spreadsheet method to make it a more effective vehicle for explaining one’s calculations?

Consider that another way is to express the mathematical relationships, such as that of the probability of unemployment related to the rate of annual earnings, in simple algebraic form to arrive at adjustments to gross earnings comparable to those obtained in the spreadsheet format. Since this approach may not be widely used or understood, the purpose of this paper is to present this alternative algebraic methodology and contrast it to the standard spreadsheet methodology.

The next section describes the various calculations that are often made in lost earnings estimations. Section 3 lays out the basic facts and assumptions of a hypothetical death case so that comparisons of methods may be facilitated. Section 4 briefly describes the spreadsheet method of presenting loss calculations. Section 5 presents the algebraic method. The concluding section compares and contrasts the strengths and weaknesses of the two methods.

2. What is involved in calculating lost financial support?

Consider the hypothetical case of Mr. Exposito who wrongfully died at age fifty on September 2, 2009, in the state of New Jersey, and who was survived by his wife but no dependent children. His reported earnings were as follows:

Year	Earnings
2006	\$76,527
2007	83,787
2008	93,628
2009	69,948

Were an economist asked to calculate the financial support losses to Mrs. Exposito, these earnings figures would be the starting point. There are variations, of course. Had the decedent been earning bonuses or overtime pay, which would have been reflected in his annual earnings, further exploration would be needed to determine their regularity, and the likelihood of their continuing in future years as Mr. Exposito would have gotten older. But we keep our example simple: his earnings were straight salary.

Next, the analyst would need to consider a number of other factors.¹ Had Mr. Exposito lived, what sort of annual changes in earnings might have occurred? Would the annual growth rate of earnings have changed over time? Then there is the question of how much, if any, non-cash compensation was being received from his employment. For example, did the employer cover all or some of Mr. Exposito's medical insurance? Did the employer help fund retirement monies?

Application of certain probabilities would also be necessary. The first is the probability that, had Mr. Exposito lived, he would have faced some small future probability of dying. Thus, it is important to incorporate mortality rates into one's calculations. Then there is the probability of being out of the workforce due to a variety of factors. To capture this probability, many economists make use of published worklife expectancy probabilities. Since these already incorporate mortality probabilities, no separate calculations of mortality rates would be needed. Another probability to be

¹Each of the various factors considered in this section has an extensive underlying literature. Published articles may be found in the *Journal of Forensic Economics* and the *Journal of Legal Economics*, among others, and in compendiums such as that by Gerald Martin (2012).

considered is the probability of potential periods of unemployment during which the individual might not be earning anything.

In death cases, the typical way of arriving at the financial support lost by the surviving spouse is to subtract the monies that the decedent would have spent on himself out of his earnings. Therefore, the personal consumption (or, in some states, the personal maintenance expenses) of the decedent would be subtracted. Further, in some states, income tax liabilities must be subtracted from projected earnings. So, in our hypothetical New Jersey case, we would need to know Mr. Exposito's past and expected tax liabilities.

Finally, in federal courts and in most state venues, projected figures for future years must be converted to present value by application of an appropriate interest (discount) rate.

3. Case Study Facts and Assumptions

To begin our analysis, we establish a starting base salary figure. Mr. Exposito's last full year (2008) of earnings amounted to \$93,628. His earnings in the year of death (2009), on an annualized basis, would have exceeded that figure. We also observe that his annual earnings had been increasing steadily. So the analyst has some justification in using 2008 earnings as a starting figure.

For our purposes, we make use of the following facts and assumptions:

a) Life expectancy: as of the date of death, and making use of a unisex life expectancy table specified by the courts of New Jersey, persons of decedent's age live to an average age of 81.92 years, implying a statistical date of death of April 10, 2039.

b) Retirement age: as of the date of death, males of age 52.32 years and level of education (high school diploma) have 12.59 years to retirement.² Applying these years results in a statistical retirement age of 64.91 years, occurring on April 6, 2022.

c) Worklife expectancy: males of decedent's age/education/labor-force-activity statistical cohort average 11.57 years of remaining labor force activity.³

d) Worklife-to-retirement ratio: it is our practice to construct a ratio between worklife and retirement expectancies. The number of years from the date of death statistical retirement (12.59 years in this case) exceeds the number of expected remaining working years (11.57 in this case). Thus, arithmetically, the number of years of worklife for this statistical cohort comprises 91.9% of the total remaining number of years until retirement.

e) Probability of future periods of unemployment: this is calculated by first considering a time period in the immediate past that is comparable to the number of years until the projected retirement date. Between 2001 and 2013, males in decedent's age cohort experienced an unemployment rate that averaged 5% per year.⁴

f) Adjusted unemployment probability: in our practice, we consider potential receipt of unemployment compensation benefits that would offset somewhat the loss of earnings.

Unemployment compensation in New Jersey is 60% of weekly pay, or a maximum benefit of \$636 a

² The source we use for this calculation is Gary R. Skoog and James E. Cieccka (2003), by interpolation.

³ The source we use for this measure is Gary R. Skoog, James E. Cieccka and Kurt V. Krueger (2011), by interpolation.

⁴ Unemployment percentages are calculated by us, based on U.S. Dept of Labor, Bureau of Labor Statistics, Labor Force Statistics including the National Unemployment Rate (Current Population Survey - CPS), unemployment rate by age, all males, www.bls.gov/cps.

week (in 2014), whichever is lower.⁵ Thus, we adjust the unemployment rate downward from 5% to 3.5% (5% x 71%) to incorporate the income replacement rate of 29% and to represent the probability of unpaid unemployment (and, hence, lost earnings) during the remaining years of labor force activity.

g) Fringe benefits: none are considered in our simplified example.

h) Income tax liabilities: in New Jersey, income taxes are subtracted from projected earnings losses prior to arriving at a financial support loss to the spouse. The reduction accounts for the likely amounts of federal and state income taxes that would have been paid by the decedent on his projected earnings. Tax burdens vary in accordance with numerous factors that differ from taxpayer to taxpayer. Hence, it is quite difficult to ascertain the relevant liabilities in any individual instance without extensive knowledge of such factors. Upon a review of decedent's 2005 through 2008 federal and state income tax returns (married filing jointly), and decedent's projected earnings, we apply an effective combined federal-state income tax rate of 12% to decedent's projected earnings.

i) A final adjustment entails subtraction of the personal consumption expenditures of the decedent, which represent monies that would not have been available, in any case, to decedent's spouse. In this matter, we apply a personal consumption adjustment rate of 36.5%, based on the consumption pattern of a married couple.⁶

⁵ Unemployment compensation information was obtained from State of New Jersey Department of Labor and Workforce Development, *Figuring Out Your Benefit Amount: How much can you collect?*, and *Maximum Benefit Rates and Taxable Wage Base Changes* (2013).

⁶ Forensic economists are not in full agreement regarding the methodology for determining and measuring the value of personal consumption, but a discussion of the methodological debate is beyond the scope of this paper.

j) Household and other services reportedly were provided to his spouse by the decedent.

However, to streamline our hypothetical case for the purposes of comparing the two methods of analysis and presentation, we drop consideration of lost services from our analysis in this paper.

k) Earnings growth rate: to obtain corresponding earnings estimates from 2009, the year of death, through the present time, we apply an average yearly increase of 3.1%, consistent with average wage growth experienced by the decedent from 2000-2009 that we obtained from ABC, Inc., Salary History for Mr. Exposito. To project pre-injury gross earnings in the future (beginning in 2015), we apply a yearly increase of 3.8%, based on recent and expected wage growth economy-wide.⁷

l) A final assumption is needed, namely, an interest rate to serve as the basis for discounting future projected values. In our practice, the tax-free return on high-grade municipal bonds serves as the basis of our discount rate. Over the past 20 years, the yield on high-grade municipal bonds of varying maturities has averaged 4.96%. Over the past 10 years, it has averaged 4.35%, and over the past 5 years, the yield has averaged 4.21%.⁸

⁷The yearly increase is an overall compound growth rate that encompasses two assumptions. The first is that wage growth through 2016 is likely to reflect wage growth from 2008 to 2012. Accordingly, we assume 1.8% annual wage growth from 2014 to 2016, based on compound wage growth from 2008 through 2012, economy-wide. For these data, we relied on U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics (OES), Median Hourly Earnings, All Occupations. Annual wage growth after 2016 is approximated by reference to the wage rate projections found in the Board of Trustees report, *Principal Economic Assumptions, 2013 Annual Report to the Board of Trustees of the Federal Old-age and Survivors Insurance and Disability Insurance Trust Funds*, Table V.B1.

⁸ Bond Yields and Interest Rates, 1941-2012, *Economic Report of the President (2013)*, Table B-73.

However, in recent years, interest rates have dropped to historically low levels. Through 2016, we assume interest rates will remain at current levels. In future years, rates are expected gradually to resume historical trends. In light of historical municipal bond yields and current financial market trends, we select 2.5% as the appropriate discount rate for the time period applicable to our case study, January 1, 2015, through the statistical retirement date, April 6, 2022.

4. Spreadsheet method of calculation

Having set out all the facts and assumptions upon which we relied to analyze the losses in our hypothetical case, we are now in a position to create our spreadsheet of calculations. It is important to recognize that different forensic economic experts create different spreadsheet layouts. For example, instead of using a single value for life, worklife or retirement expectancy, some apply such probabilities on an annual basis, extending the spreadsheet values through age 90 or beyond. The example in this paper does not use that method, but the reader should be aware that the focus of this paper is not on which spreadsheet method is best. Rather, we are using the spreadsheet outlined here in order to contrast it with the algebraic method discussed in the next section of the paper.

All of the variables that we established in the previous section can be entered into our spreadsheet, attached herein as Exhibit 1. We observe that the spreadsheet contains twelve columns of data. The style by which data are presented by the economic expert can vary widely. For example, another column might be inserted showing the age of the individual in each successive year. Many other variations are possible. For our purposes, we believe that the example presented here is a reasonable representation of the methodology.

The spreadsheet method of making the calculations has a number of appealing strengths. First of all, it is easy to use. By entering specific beginning values in each column and applying a specified formula to all subsequent values, the spreadsheet readily calculates all needed values.

More important, though, is the fact that when the analyst chooses to change one or more inputs, all remaining calculations are made automatically and seamlessly. The power of a spreadsheet to recalculate all values when inputs are changed, thereby relieving the analyst from the need to perform numerous recalculations, is probably the most appealing as well as the most powerful attribute of the spreadsheet method.

Another benefit of using spreadsheets is that the analyst can readily perform multiple calculations of “what if” scenarios based on alternative assumptions. At trial, this may be very helpful to jurors.

Also, many experts like the idea of presenting their loss estimates in a single spreadsheet because it streamlines the work needed on a case. Accompanied by a few pages of explanation of background data and assumptions, an economic loss report could be completed in an expeditious manner.⁹

However, power in performing complex calculations is both the strength and the weakness of the spreadsheet methodology. The weakness of this method has to do with the degree to which it is capable of communicating clearly to those who read the report: the attorney, and in some cases the attorney’s client, the opposing attorney(s), and opposing expert, if any. While the opposing expert may be in a position to readily understand the array of numbers, many non-experts are not.

⁹ It is assumed in this paper that an economic expert report that presents spreadsheet calculations incorporates a clear and thorough explanation of each and every variable, assumption, and fact, and, further, that their bases are clearly presented in the report. In short, it is assumed that a narrative explanation accompanies the spreadsheet calculations.

Further, if a case were to go to trial, the spreadsheet most likely would be enlarged and shown to the jury, with the implied hope that the average juror would understand the spreadsheet calculations and conclusions. It is our guess that some experts have wished secretly that their spreadsheets could be simpler, with fewer columns, so that the jury would be faced with an array of data that could be more readily digested.

5. Algebraic Method of Calculation

Since many of the variables included in a loss calculation affect other variables, there is an inherent relationship among the variables that can be expressed in simple algebraic terms. For example, if it is determined that the plaintiff would have likely faced a three (3) percent probability of becoming unemployed, an algebraic expression representing this assumption would be:

$$AE = GE \times (1 - 0.03)$$

where AE represents adjusted earnings and GE represents gross earnings.

The algebraic method has an analog in the area of commercial litigation. In that area, nearly all of the adjustments to the projected figures are built into the determination of an appropriate discount rate. The “build-up” method specifically incorporates various types of business risks. That method is typically presented in narrative form with, perhaps, some simple arithmetic relationships shown. Although in injury and death cases, any adjustments to gross earnings are made prior to applying the discount rate, the build-up method may be viewed as an analog to the algebraic method in personal tort cases insofar as nearly all of the risks affecting earnings and other adjustments are discussed and summarized prior to making any spreadsheet calculations.

Exhibit 2 presents an example of the algebraic method as it applies to the death case presented in Exhibit 1. Notice that the arithmetic equations are applied in sequence, just as they

would be in a spreadsheet. Notice, also, how simple the relationships are in arithmetic terms. The reason this methodology is termed the algebraic method is that there is a complex, underlying algebraic equation that summarizes the step-by-step arithmetic calculations, as follows:

$$\text{AIF} = (\{[\text{GE} \times \text{WLE}] (1 - \text{UF})\} (1 - \text{TL})) (1 - \text{PC})$$

where AIF represents the adjusted earnings factor, GE represents gross earnings, WLE represents the worklife expectancy, UF represents the unemployment probability, TL represents the income tax liability, and PCE represents the personal consumption factor. The equation relates that a worklife adjustment is first applied to gross earnings. Then, an unemployment probability is applied, followed by income tax liabilities. Finally, personal consumption is applied to after-tax earnings.

However, instead of showing this equation to the reader, the calculations are shown step-by-step as in Exhibit 2. In the exhibit, the calculations indicate that adjusted income, i.e., the funds available to surviving family members, would have amounted to 49.56% of decedent's projected gross earnings. To confirm this result, we refer to the spreadsheet figures of Exhibit 1, and divide column (k) Adjusted Income by column (c) Gross Earnings, a process that yields 49.56%.

Moreover, if one or more of the variables were to change, then the resulting adjusted earnings factor would change, easily and readily, by simply changing one or more of the equations.

The Adjusted Income Factor of 49.56% is then entered into a much simpler spreadsheet as shown in Exhibit 3. Notice that Exhibit 3 is reader-friendly in the sense that it is much easier to read and understand, given its mere five columns of data. This is the method's greatest strength.

The unique strength of this method lies in its clarity to even the average person. In effect, the algebraic steps in arriving at the AIF take the place of many spreadsheet columns, and allows the remaining spreadsheet to be much simpler and clearer.

The author has found that, for purposes of trial presentation, the AEF algebraic calculations can be shown in an even more simplified way.¹⁰ Exhibit 4 “translates” the relationships given in Exhibit 2. In Exhibit 4, everything has been stripped down to its fundamentals so that a jury may see clearly what adjustments were made to gross earnings to arrive at an income loss to the family. While technically not fully accurate (after all, multiplication by the inverse of a percentage is clearly not identical to a simple subtraction), the method, in conjunction with oral testimony, is a highly effective vehicle for communicating the essence of the adjustments being made by the expert.

At trial, presentation to the jury of a chart such as shown in Exhibit 4 would be followed by a streamlined spreadsheet such as given in Exhibit 3. The two exhibits are clear and laid out sequentially, and are much easier to understand than a single, relatively complex spreadsheet.

6. Conclusion

If the job of the economic expert is to calculate economic losses as accurately as possible, and to communicate his or her findings in a clear, cogent manner, then the algebraic method would appear to have an edge over the spreadsheet method. While both methods generate comparable estimates of loss, the algebraic method is superior in its clarity and, hence, more readily grasped by attorneys, their clients and triers of fact.

While this author clearly favors use of the algebraic method, the algebraic method does not require experts to give up their spreadsheets. Rather, by introducing arithmetic relationships as a preceding step, the resulting spreadsheet becomes much simpler, gaining substantial clarity in the process.

¹⁰ Use of trial charts is explained in more detail in Tinari (2010).

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(Insert Exhibit 1 spreadsheet on this page)

Exhibit 2

Adjustments to Earnings

Gross Earnings Base	100.00%
x worklife adjustment	91.90%
= Worklife-Adjusted Earnings	91.90%
x (1 - 3.5% unemployment factor)	96.50%
= Adjusted Earnings Base	88.68%
x (1 - 12% tax liabilities)	88.00%
= Tax-Adjusted Base	78.04%
x (1 - 36.5% personal consumption)	63.50%
= Adjusted Income Factor	49.56%

Exhibit 3

Simplified Spreadsheet

Year	Portion of Year	Gross Earnings	Adjusted Income	Present Value
(a)	(b)	(c)	(d)	(e)
			(b)x(c)x49.56%	3.25%
2009	33%	\$ 96,530	\$15,786	\$15,786
2010	100%	99,523	\$49,320	49,320
2011	100%	102,608	\$50,848	50,848
2012	100%	105,789	\$52,425	52,425
2013	100%	109,068	\$54,050	54,050
2014	100%	112,450	\$55,726	55,726
2015	100%	116,723	\$57,843	56,437
2016	100%	121,158	\$60,041	57,877
2017	100%	125,762	\$62,323	56,621
2018	100%	130,541	\$64,691	56,922
2019	100%	135,502	\$67,149	57,226
2020	100%	140,651	\$69,701	57,531
2021	100%	145,995	\$72,349	57,837
2022	26%	151,543	\$19,526	15,118
				\$693,722

Exhibit 4

Trial Chart

Gross Earnings Base	100%
x worklife adjustment	91.9%
- unemployment factor	3.5%
- tax liabilities	12%
- personal consumption	36.5%
= Adjusted Income Factor	49.56%