Calculating the Probability of Labor Force Activity: Applying the Skoog-Ciecka-Krueger Transition Probabilities

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Presented at

Fall Forensic Economics Workshops
October 24-25, 2014
Santa Fe, NM

Draft – 10-22-2014
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Abstract

While many forensic economists rely on the Skoog-Ciecka-Krueger work life tables, few seem to make use of the labor force transition probabilities provided as supplemental material to the published tables. This paper explains the calculations needed to compute the probability of labor force activity for a person who is an initially active or an initially inactive labor force participant based on these transition probabilities. Following this explanation, two examples of the application of the probability of labor force participation are presented. Although these examples are based on actual cases, the facts have been altered to preserve anonymity and to facilitate presentation of the underlying analysis. The paper concludes by identifying other issues that use of the probability of labor force participation presents.

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I Introduction

Many forensic economists recognize that future lost earnings will not be attained with certainty and consequently reduce their loss estimates to account for the risk of death, injury, sickness and other events that would keep an individual from being an active labor force participant. For example, in the *2012 Survey of Forensic Economists* (Slesnick, Luthy and Brookshire, 2013), only 7.8 percent of the respondents indicated they ended their loss calculation at some fixed retirement date; 3.0 percent used the LPE method; and 70.3 percent of the remaining respondents indicated they relied on work life tables published in economic journals. The latest such tables, and perhaps the most widely used, are those found in Skoog, Ciecka, and Krueger (2011) – hereinafter "S-C-K". Less widely used are the labor force transition probabilities that were provided as supplemental materials to the S-C-K work life tables.

Skoog and Ciecka (2006) identified two principle approaches adopted by forensic economists when dealing with work life expectancy (WLE). They either assume the WLE comes immediately (front loading) or they spread the WLE over a larger number of years, say to the full Social Security retirement age (uniform loading). Compared to calculating the expected present value of a constant annual loss based on the years of labor force activity at each future age, Skoog and Ciecka showed that front loading overstates the estimated loss for a variety of (positive) net discount rates. Similarly, they showed that uniform loading sometimes overstates and sometimes understates the expected present value of the lost earnings.

Each of these two approaches replaces the probability of labor force activity at each future age with an alternative. For front loading, this alternative sets the probability of labor force activity equal to one up to the age that WLE is reached, and to zero thereafter. For uniform loading, this alternative sets the probability to some fraction, f, equal to WLE divided by the number of years until some specified age is reached for ages less than or equal to that specified age, and to zero thereafter. In Figure 1 these alternatives are compared to the probability of labor force activity for an initially active 30-year old female with an Associate's degree calculated using the S-C-K transition probabilities and the (extended) 2006 life table for females. In this example, the alternative uniform loading probability is based on spreading the 29.61 years of work life through age 67 and equals 0.8003 (29.61 divided by 37).

This paper presents the calculations required to compute the probability of labor force activity for persons of a given age, gender, level of educational attainment and initial labor force status using the S-C-K transition probabilities and extended versions of published life tables. Following this discussion, two examples of the application of the S-C-K transition probabilities are presented. Although these examples are based on actual cases, the facts have been altered to preserve anonymity and to facilitate presentation of the underlying analysis. The paper concludes by identifying other issues that use of the probability of labor force participation presents.

II Required Calculations

Calculating the probability of being an active labor force participant is most easily understood in the context of modeling the size of a synthetic cohort of initially active individuals as the cohort ages, while at the same time calculating the number of deaths and the number of living inactive individuals. (For the corresponding probability of an initially inactive person, the modeled cohort corresponds to initially inactive persons; the number of active persons and the number of deaths are also calculated.) This approach is similar to the calculations underlying a period life table, in which the number of deaths and remaining living persons from an initial cohort is calculated as the cohort ages. A specific example will illustrate the calculation of the probability of being an active labor force participant.

Starting with 100,000 living females at age 30, the number of actives (A_{30}) is set equal to 100,000, and the number of living inactive (IA_{30}) and deaths (D_{30}) are both set equal to zero. At age 31, these values are recalculated as follows:

(1) $A_{31} = A_{30} \cdot {}^{a}\rho^{a}_{30} + IA_{30} \cdot {}^{i}\rho^{a}_{30}$;
(2) $IA_{31} = A_{30} \cdot {}^{a}\rho^{i}_{30} + IA_{30} \cdot {}^{i}\rho^{i}_{30}$; and
(3) $D_{31} = (A_{30} + IA_{30}) \cdot (L_{31}/L_{30})$,

where ${}^{a}\rho^{a}_{x}$ is the probability of someone who is age x transitioning from the active to the active state; ${}^{i}\rho^{a}_{x}$ is the probability of transitioning from the inactive to the active state; ${}^{i}\rho^{i}_{x}$ is the probability of transitioning from the inactive to the inactive state; ${}^{a}\rho^{i}_{x}$ is the probability of transitioning from the active to the inactive state; and where L_x is the number of living persons age x taken from the life table. The ${}^{a}\rho^{a}_{x}$, ${}^{i}\rho^{a}_{x}$, ${}^{i}\rho^{i}_{x}$, and ${}^{a}\rho^{i}_{x}$, are conditioned on the probability of survival. That is, they are the S-C-K transition probabilities multiplied by one minus the probability of death. Note that one minus the probability of death equals L_x/L_{x-1}.

At age 32, the values are recalculated again, as follows:

(1) $A_{32} = A_{31} \cdot {}^{a}\rho^{a}_{31} + IA_{31} \cdot {}^{i}\rho^{a}_{31}$;
(2) $IA_{32} = A_{31} \cdot {}^{a}\rho^{i}_{31} + IA_{31} \cdot {}^{i}\rho^{i}_{31}$; and
(3) $D_{32} = (A_{31} + IA_{31}) \cdot (L_{32}/L_{31})$.

These calculations are repeated for all subsequent ages through some terminal age after which no remaining cohort members are active. The probability of being an active labor force participant at age x, P_x, is calculated as A_x divided by the initial size of the synthetic cohort (100,000). While it is not necessary to calculate the number of deaths in step (3), doing so allows one to check the calculations in steps (1) and (2) since $D_{x+1} = L_x - A_{x+1} - IA_{x+1}$ for all ages.

The required calculations are similar when the initial labor force status is inactive: the number of living inactives (IA_{30}) is set equal to 100,000, and the number of actives (A_{30}) and deaths (D_{30}) are both set equal to zero. At age 31, and for all subsequent ages through the terminal age, these values are recalculated as outlined above. The probability of being an active labor force participant at age x is still calculated as A_x divided by the initial size of the synthetic cohort. This calculation is equivalent to one minus the sum of IA_x and total cumulative deaths divided by the initial size of the synthetic cohort. Note that this sum is the total number of inactive persons – both living and deceased – out of the initial cohort at age x.

Figure 2 presents the calculation of the probability of labor force activity for an initially active 30-year old female with an Associate's degree in spreadsheet form. Figure 3 presents the corresponding calculations for the initially inactive state. In both figures, columns B through E contain the S-C-K transition probabilities for a female with an Associate's degree from age 30 on; these probabilities are not conditioned on the probability of survival. Column F contains the values of the L_x from the 2006 life tables for females.[1] These values are used to calculate the number of survivors at each successive age in column G, given the starting cohort value of 100,000. The number of survivors at age x+1 equals the survivors at age x times the ratio of L_{x+1} to L_x. This ratio equals the probability of a person age x living to age x+1.

The number of cohort members who are active (and alive) is calculated in column H. It equals the number of active cohort members from the prior age times the probability of transitioning from the active to active state, plus the number of living inactive cohort members from the prior age times the probability of transitioning from the living inactive to the active state. This sum is multiplied by the probability of surviving one year from the prior age in order to account for the active and living inactive cohort members who will die within that year.

The number of cohort members who are alive and inactive is calculated in column I. It equals the number of active cohort members from the prior age times the probability of transitioning from the active to inactive state, plus the number of living inactive cohort members from the prior age times the probability of transitioning from the living inactive to the living inactive state. Again, this sum is multiplied by the probability of surviving one year from the prior age in order to account for the active and living inactive cohort members who will die within that year.

Column J calculates the number of cohort members who have died at each age: it equals the number living at the prior age times one minus the probability of surviving one additional year. As noted earlier, the number of deaths is not needed to calculate the probability of being active in the labor force; it is used to check the validity of the other calculations. This is done in column K which equals the number living for the prior age in column G minus the number of alive and active, the number of alive and inactive, and the number of deaths in columns H, I and J.

The probability of being active is calculated in column L: it equals A_x divided by the initial cohort size of 100,000. The sum of column L equals the mean WLE. Because all of the foregoing calculations assume end-of-year transitions, for initially active persons the resulting sum is 0.5 years higher than those reported in the published S-C-K tables. Consequently, the mid-year adjustment shown at the bottom of Figure 2 is needed to tie to the published WLE values. No such adjustment is needed in Figure 3 for initially active persons. The reason for this is that the sum of column L is really sum of each probability times the period of time each probability corresponds to. For end-of-year transitions, this period is one year for all terms in the sum, while for mid-year transitions it is 0.5 years for the first term of the sum, and one year for all others. The difference between end-of-year and mid-year transitions consequently equals the difference between the two first terms of these summed products. For initially active persons, this difference equals (100% x 1) minus (100% x 0.5), which equals 0.5 and gives rise to the mid-year adjustment shown at the bottom of Figure 2. For initially inactive persons, this difference equals (0% x 1) minus (0% x 0.5), which equals zero and obviates the need for the mid-year adjustment.

An alternative to the mid-year adjustment is shown in column M, which calculates the average of P_x and P_{x+1} for each age x. This column is an estimate of the probability of labor force activity at mid-year. Consequently, the sum of the average probabilities in column M equals the WLE based on mid-year transitions and requires no further adjustment. These average probabilities are also consistent with mid-year discounting of annual losses.

The calculations outlined above produce the probability of being active for a female who is exactly 30 years old. It would be an extreme coincidence if the date of the injury, death or other triggering event corresponded exactly to a plaintiff's or decedent's birthday. More often than not, the probability of being active is needed for a person who is not exactly an integer number of years old. The solution to this problem is relatively straightforward and is similar to that explained by Tucek (2009) in connection with the survival probability of a person with a non-integer age. Suppose, for example, we were dealing with a female who was 30.4 years old instead of exactly 30 years old. The desired probability of being active may be calculated by first calculating the number of living and active persons (A_x) for a 30-year old starting with an initial cohort of 100,000 at age 30, along with the number of living and active persons ($\tilde{A}_x$) for a 31-year old starting with an initial cohort of 100,000 at age 31. The weighted average of A_x and $\tilde{A}_{x+1}$, with the weights being determined by the fractional part of the individual's age, can be used to calculate the probability of being an active labor force participant. Note that the largest weight is assigned to the set of living and active cohort members closest to the individual's age. In our example, A_x would be assigned a weight of 0.6, while $\tilde{A}_x$ would be assigned a weight of 0.4.[2]

II First Example: Misuse of Uniform Loading

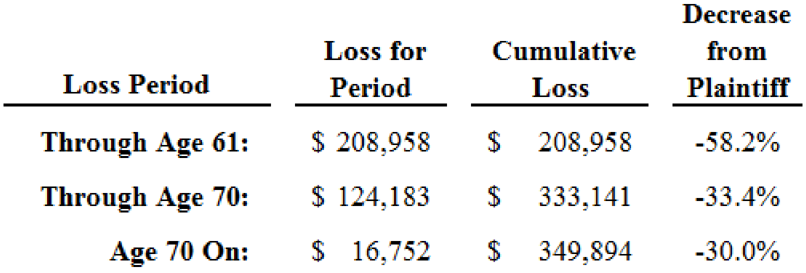
This case involves a 52.4 year-old female plaintiff who was injured in an automobile accident and who, according to the testimony of a vocational expert, is unable to work again. The plaintiff's level of educational attainment is "some college, but no degree" and at the time of the accident she was not an active labor force participant. Based on a single 7-month stint employed in an away-from-home union construction job, and on the plaintiff's statements, the plaintiff's economic expert has assumed her earnings lost would persist through age 61, at which time she would retire with a union pension. At the time of her injury, the plaintiff had a remaining WLE of 7.20 years based on the S-C-K tables.

While there were numerous errors in the plaintiff expert's report – for example, he assumed the plaintiff would work 2,058 hours per year in the union job; he did not adjust for the probability that the plaintiff might be unemployed; and he did not consider the impact of the subpar recovery from the Great Recession in assessing the validity of the assumed earnings base – the error that is the focus of this paper is his use of uniform loading to reduce the projected earnings loss to account for the plaintiff's 7.20 years of remaining WLE. A comparison of the plaintiff expert's assumed probability of labor force activity with the probability derived from the S-C-K transition probabilities appears in Figure 4. As illustrated in Figure 4, the plaintiff expert has forced all 7.20 years of remaining work life into the 8.60 years remaining until the plaintiff's 61st birthday and assumed retirement. The probability of being an active labor force participant in Figure 4 has been calculated using the S-C-K transition probabilities and the 2009 life tables. Additionally, the calculation accounts for the fact that the plaintiff has not died since the date of the accident and for the assumption that she will be alive on the date of the trial. This was accomplished by replacing the L_x used in the calculations with values that reflect zero mortality through the date of the trial and normal mortality thereafter. These augmented calculations resulted in an increase in the WLE from 7.20 to 7.34 years.

There are several flaws the plaintiff expert's approach. First, the plaintiff expert has equated the assumption that the plaintiff would retire from her union job with the assumption that she would never again be employed or seek employment. Second, the plaintiff expert has assumed a probability of labor force activity (83.72%) in the period before age 61 that far exceeds the maximum value (46.94%) based on the S-C-K transition probabilities. Put another way, he assumed 7.20 years of labor force activity in this period when there are only 3.09 years of labor force participation expected before age 61, even after accounting for the mortality improvements inherent in the 2009 life tables and zero mortality risk through the trial date. Finally, setting aside errors in the plaintiff expert's estimate of lost earnings, he has forced all of the plaintiff's remaining work life into a period in which her earnings are at the higher, union, level rather than at the level that might be expected after she left the union but continued working.

Because of these flaws, this case is a good example of the misapplication of the uniform loading approach to accounting for the remaining WLE of an injured person or decedent. The defense expert responded to these flaws by presenting a chart similar to Figure 4; by pointing out the plaintiff expert assumed that all of the plaintiff's future earnings would be at the level projected for the union position; and by noting that he failed to consider the possibility that the plaintiff might obtain employment at a lower income level or on a part-time basis after retiring from the union job. Three estimates of the earnings loss were calculated by the defense expert. The first two estimates corresponded to the loss periods ending at the assumed retirement age of 61 and at age 70, the age beyond which there is no incentive to delay receipt of Social Security benefits. The third loss period extended beyond age 70 and ended when the probability of labor force activity fell to zero.[3] For the first of these three loss periods, the lost earnings were based on the assumption of employment in the union construction job, albeit at a different level of hours per year. For the second loss period, the earnings loss was set to one-half of the union earnings. This earnings level corresponds to the average wage for all workers in the plaintiff's local labor market and accounts for the prohibition of a retiree having no more than 40 hours per month of union employment without forfeiting the pension payment for that month. For the third loss period, the earnings were reduced by 50 percent to account for the possibility that the plaintiff may only seek part-time employment after age 70. The defense loss estimates for each of these periods, along with the percent decrease from the plaintiff expert's total lost earnings estimate appear in Table 1 below. These estimates only reflect the earnings assumptions outlined above and the application of the probability of labor force activity depicted in Figure 4; they do not reflect the effect of the correction of any other errors made by the plaintiff expert.[4]

Table 1 – Defense Estimates of Lost Earnings in Case #1



Loss Period	Loss for Period	Cumulative Loss	Decrease from Plaintiff
Through Age 61:	$ 208,958	$ 208,958	-58.2%
Through Age 70:	$ 124,183	$ 333,141	-33.4%
Age 70 On:	$ 16,752	$ 349,894	-30.0%

As can be seen in this table, stopping the plaintiff's loss at age 61 while properly accounting for her probability of labor force activity results in a nearly 60 percent reduction in the earnings loss estimate. Extending the loss period to age 70 at the average local wage rate decreases the percent reduction to about 33 percent, while allowing for part-time employment after age 70 decreases the percent reduction to 30 percent. This overall 30 percent decrease is almost half again as big as the decrease of assuming uniform loading through the plaintiff's full Social Security retirement age with earnings based on the average local wage rate after age 61. Put another way, uniform loading through the plaintiff's full Social Security retirement age overstates the loss by 11.2 percent.

III Second Example: Losses Due to Increased Mortality Risk

This case involves a 30 year-old female plaintiff whose cancer was not diagnosed until it had metastasized, resulting in increased mortality risk and a reduced life expectancy. The plaintiff possesses an Associate's degree and is employed in a position commensurate with that level of educational attainment. Plaintiff's medical expert has testified that her remaining life expectancy as of the date the cancer was finally detected was 4 years. This is significantly lower than her normal remaining life expectancy of 51.9 years.

The plaintiff's economic expert identified four categories of expected future economic losses: (1) lost earnings; (2) lost employer-provided medical insurance; (3) lost employer match to a 401k plan; and (4) lost household services. The lost medical insurance and the lost household services are losses that would be incurred by the plaintiff's spouse, a named party in the lawsuit, as a result of her death. The lost earnings and the lost 401k match are losses incurred by both the plaintiff and her spouse. For each loss category, the net loss equals the corresponding present value calculated under the normal mortality assumption minus the present value calculated under the increased mortality assumption. Because this is not a wrongful death case, no offset of the plaintiff's future personal consumption was made by the plaintiff's economic expert.[5]

Estimation of all four of these loss categories requires calculation of the plaintiff's normal survival probability as well as her survival probability given her increased mortality risk. Further, both survival probabilities need to be calculated as of the trial date as opposed to the date her cancer was detected. Calculation of her normal survival probability is relatively straightforward – see Tucek (2009). Calculation of the plaintiff's survival probability given her increased mortality risk is a two-step process. The first step involves creation of a modified life table corresponding to her 4-year remaining life expectancy as of the date her cancer was detected. This was accomplished by multiplying the probabilities of dying within one year (q_x) in the normal life table for age 30 on by a constant so that her remaining life expectancy at age 30 was only 4 years.[6] The second step consists of calculating her survival probability from the trial date on, assuming she is alive at the time of trial. This calculation is the same as explained in Tucek (2009) except that the L_x from the modified life table calculated in the first step are used. Using the normal and modified life tables, and the S-C-K transition probabilities, the plaintiff's probability of labor force participation was calculated as outlined above.[7]

Figure 5 shows the probabilities of survival and labor force participation under both mortality scenarios. It is clear that the increased mortality risk dominates the probability of labor force activity. This is made even clearer in Figure 6, which shows the difference between the survival probability and the probability of labor force participation for each mortality scenario. Under the increased mortality scenario, the difference declines rapidly, reaching zero around age 45 when the survival probability falls to zero.

Under the normal mortality scenario, the difference begins to fall and approaches zero at a much higher age.

The plaintiff's normal and modified probabilities of survival were used to reduce the household services loss to account for her normal and increased mortality risk. Because household services loss is incurred by the spouse, his mortality risk was used to reduce the loss of household services as well.[8] The expected loss of the other loss components was reduced in each year to account for the plaintiff's probability of labor force participation. Again, because loss of the employer-provided medical insurance is incurred by the spouse, the medical insurance loss was reduced to account for his mortality risk. As with household services the difference between the present value assuming normal mortality risk and the present value assuming the increased mortality risk equals the net loss of earnings, employer 401k match and employer-provided medical insurance.

The earnings, medical insurance and 401k match loss categories were calculated for four alternative loss periods, corresponding to ages 62, 67, 70 and through the end of the life table. The first three periods correspond to the earliest age that Social Security retirement benefits can be claimed, full Social Security retirement age and the age beyond which deferring receipt of Social Security results in no increased benefits. After age 70, earnings were reduced by 50 percent to account for the possibility of part time employment. The earnings loss for each of the four loss periods appears in the table below:

Table 2 – Estimates of Lost Earnings in Case #2

	Normal Mortality Risk	Increased Mortality Risk	Net Loss
Through Age 62:	$ 902,314	$ 109,265	$ 793,050
Through Age 67:	$ 964,158	$ 109,265	$ 854,893
Through Age 70:	$ 984,403	$ 109,265	$ 875,138
Age 70 On:	$ 995,879	$ 109,265	$ 886,614

An alternative to the above estimates calculates the loss as the difference between the earnings earned with certainty through the S-C-K WLE expectancy (29.61 years) for a 30-year-old minus the earnings earned with certainty through the plaintiff's remaining life expectancy of 4 years at the time her cancer was detected. This alternative results in a normal mortality present value of $1,062,772 and an increased mortality present value of $141,612 for a net earnings loss of $921,160. This is 3.9 percent higher than the total loss shown in the last row of Table 2.

The household services loss component was based on the average time spent providing household services for a married woman with no children who worked full time. This creates a mismatch in the implicit circumstances underlying the earnings and household services loss components: while the estimated earnings loss admits the possibility of leaving the labor force in order to raise children, the calculation of household services loss does not reflect the increased level of services such women perform while out of the labor force. To compensate for this mismatch, some forensic economists provide a lost earnings calculation that relies on the corresponding male WLE, which is greater than that for females. The resulting higher earnings loss estimate is either presented as the plaintiff's loss under the assumption that she would not have left the labor force to raise children, or it serves as the upper bound of a range that reflects only the possibility of remaining in the labor force because she will not leave to raise a family. This approach imposes both the male transition probabilities and male mortality risk on the female plaintiff, and may consequently underestimate the labor force participation of women who do not exit the labor force to raise a family. The plaintiff expert in this case used the S-C-K transition probabilities for both male and females to calculate an earnings loss estimate that preserved the female mortality risk. This alternative method is illustrated in Figure 7. This figure shows the probability of labor force participation for an initially active 30.25-year-old female with an Associate's degree calculated with both the female and male S-C-K transition probabilities, and with the normal mortality risk underlying Figure 5.

As can be seen in Figure 7, the probability of labor force participation based on female transition probabilities is below that based on male transition probabilities until about age 58; one possible reason for this relationship is the effect of women leaving the labor force to raise a family. The two probabilities coincides until about age 65 and then the probability of labor force participation based on female transition probabilities falls below that based on male transition probabilities. Possible reasons for the decline include relative lower rewards to remaining in the labor force because of lower earnings for women and the timing of retirement by women to coincide with that of an older spouse. In lieu of calculating an alternative loss estimate based solely on male WLE or the male S-C-K transition probabilities, the plaintiff expert produced an alternative calculation of lost earnings based on the dashed line in Figure 7 through age 58 and on the solid line thereafter. In other words, the two alternative calculations of labor force participation were spliced together at age 58 so that the male S-C-K transition probabilities were only utilized from age 30 through 58.

A comparison of the spliced probabilities with the male probability of labor force participation is shown in Figure 8. Relative to the male probability of labor force participation, the splice probabilities are greater from the mid-forties to about age 70, and do not fall below the male curve until the mid- to late seventies. In terms of WLE, the spliced probabilities produce a higher result: 31.15 versus 30.80 years. Both of these values are greater than the S-C-K female WLE of 29.41 years.

The earnings loss using the spliced probabilities for each of the four loss periods appears in the table below:

Table 3 – Estimates of Lost Earnings in Case #2 Using Spliced Probabilities of Labor Force Participation

	Normal Mortality Risk	Increased Mortality Risk	Net Loss
Through Age 62:	$ 965,285	$ 109,265	$ 856,020
Through Age 67:	$ 1,027,128	$ 109,265	$ 917,864
Through Age 70:	$ 1,047,373	$ 109,265	$ 938,108
Age 70 On:	$ 1,058,849	$ 109,265	$ 949,584

The earnings loss is ranges from 7 to 8 percent higher than the losses in Table 2, even though the underlying WLE is only 5.8 percent higher.

IV Discussion and Conclusions

It is clear from Figures 1 and 4 that non-zero probabilities of labor force participation extend well beyond the age WLE is reached. The reason for this is not that the S-C-K transition probabilities and the probability of survival extend to age 110, the terminal age in the underlying Markov increment/decrement model.[9] The reason is that some individuals actively participate in the labor force at ages well beyond WLE and beyond what is loosely referred to as a normal retirement age. Because they do not account for this, both front loading and uniform loading are only approximations to the impact of the risks preventing someone from participating in the labor force. How close the approximations are depends on the expected years of labor force activity beyond the age WLE is reached for front loading, and on the expected years of labor force activity beyond the presumed permanent labor force exit for uniform loading. In terms of present value, it also depends on how far in the future the age that WLE is reached is, and on the interest rate used to discount future losses to the present. Because the presumed age of permanent labor force exit is typically greater than the age at which WLE is reached, uniform loading will be the better of the two approximations, other things being equal.

An alternative to front or uniform loading is to extend the present value calculations (with the losses calculated with certainty) for a period of years beyond the age that WLE is reached. This approach presents a range of possible outcomes to the jury, but transforms the decision to be made. Instead of having to decide on a reasonable estimate of the plaintiff's <u>expected</u> earnings loss that is informed by the probability that the plaintiff would remain in the labor force, the jury must now make a decision on the basis of a small number of loss estimates computed with certainty for a range of ages around the age at which the plaintiff's WLE is reached. Absent information on the shape of the WLE distribution, the jury has no information on which to base this decision. In effect, this approach is nothing more than front loading in disguise: while all of the estimates from the WLE age and beyond are possible outcomes, they will necessarily overestimate the <u>expected</u> earnings loss, as may the estimates just before this age.[10] Additionally, like front and uniform loading, this approach moves all of the loss forward in time and forces it into a period in which earnings can be expected to be near their highest level.

Case #1 is a good example of the shortcomings of uniform loading: 61, the presumed age of permanent labor force exit, is only 1.40 years beyond the age the plaintiff reaches her WLE, based on the published tables. After accounting for the mortality improvements inherent in the 2009 life tables and zero mortality risk through the trial date, this interval is only 1.25 years. Thus, in this instance, uniform loading is nearly equivalent to front loading and shifts more than 40 percent of the plaintiff's remaining work life to the period before age 61. Moreover, as noted earlier, the plaintiff expert has compounded this error by forcing the plaintiff's entire remaining work life into a period of time in which her earnings are much greater than would be expected if she were to retire from the union and subsequently seek employment in her local labor market. The error is also compounded by the relatively short timeframe in which the loss is expected to occur and by the plaintiff expert's use of a ladder of current Treasury rates (coupled with start-of-period discounting) to discount the lost earnings to the present.

Case #2 illustrates some of the benefits to calculating the probability of labor force participation versus front or uniform loading. As noted earlier, doing so allows one to use updated mortality tables and to account for the implicit assumption that the injured plaintiff will be alive on the date of the trial. Also, as in this case with household services and medical insurance provided to her spouse, oftentimes a loss is contingent upon the survival of a plaintiff who is not the injured person. The expected present value of such losses necessarily depends on the survival probability of the noninjured plaintiff. And, if the loss is also contingent on the employment of the injured person, explicit use of the probability of labor force participation in lieu of front or uniform loading provides a consistent means of accounting for the risk that the loss component may not have been realized even if the event leading to the tort had not occurred. Of course, it is sometimes argued that the mortality risk of the noninjured plaintiff need not be explicitly accounted for because his/her remaining life expectancy is greater than the injured person's remaining WLE. This argument suffers from the same shortcomings as does front loading: it sets the noninjured plaintiff's probability of survival equal to one up to his or her remaining life expectancy and to zero thereafter, even though it is well know that the survival probability declines and remains positive for a period beyond the remaining life expectancy. Finally, in cases involving both an earnings and household services loss for a female plaintiff or decedent who had no children, use of the S-C-K transition probabilities provides an alternative to substituting male WLE for female WLE and thus avoids imposing male mortality risk on the female plaintiff or decedent.

There are drawbacks to using the probability of labor force participation in lieu of front or uniform loading, or in lieu of just extending the present calculations for a few years beyond the age that WLE is reached. For one thing, the required calculations are necessarily more complex. Additionally, using the full range of the probability of labor force participation requires an estimate of earnings for years beyond age 70.

Even though the calculations are more complex than those required by front or uniform loading, they are within the reach of any competent forensic economist and can easily be performed using an Excel spreadsheet or similar application. More important, just because the calculations are complex doesn't mean that explanation has to be. To object to use of the probability of labor force participation for this reason is to abdicate one's role as an expert: if use of only simple calculations were a requirement for loss estimates, then the courts would have little need for economic experts. It is clearly not necessary to explain how the probability of labor force participation is calculated, just as it is not necessary to explain how present values or survival probabilities are calculated. It is sufficient only to explain that the underlying calculations take into account that the plaintiff may die, may become injured or sick, or may not be an active labor force participant for any other reason. In short, the same explanation as is given for WLE will suffice.

The need to estimate annual earnings for years beyond age 70 is a more substantive drawback. While use of an age-earnings profile may capture an expected decline in full-time earnings at older ages, it will not necessarily reflect the decrease due to part-time employment.[11] The real issue, however, is whether assuming, as the alternative approaches do, that earnings equal zero once a certain age is reached is more reasonable than presenting earnings assumptions that cover the full range of the probability of labor force participation. As Case #2 demonstrated, it is possible to make reasonable assumptions about earnings beyond WLE or some assumed retirement age, and to present the loss estimates in such a way that the jury can adjust them as they believe best based on the specifics of the case. For example, in Case #1, if the jury believed that the plaintiff would retire from the union job at age 61 and never reenter the labor force, the loss estimates in the first row of Table 1 would apply. Alternatively, if they believed that the plaintiff would only work half-time after age 61, then the total loss estimate would be reduced by $62,092 – one-half of the $124,183 shown in the first column of Table 1's second row. Finally, if the jury decided that "part time" meant something other than half time, similar adjustments to the loss estimates would apply.

On balance, even though using the probability of labor force participation in lieu of other commonly-used alternatives requires a bit more explaining and a somewhat more detailed presentation of the loss estimates, the advantages seem to overcome the drawbacks. No one can say for certain what a plaintiff's future earnings would have been but for his injury. At best, a forensic economist can only estimate the expected loss. Because the alternative approaches move the loss forward in time, and because earnings at ages beyond what is considered to be normal retirement may be lower, the alternatives are biased in favor of overstating the expected loss. At bottom, the fact that other means of accounting for WLE ignore the underlying probability distribution, as well as the fact that earnings in the years beyond the age WLE is reached may very well be at a lower level, carries the decision in favor of fully utilizing the S-C-K transition probabilities as explained above.

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Figure 1

Front and Uniform Loading Compared to Probability of Being an Active Labor Force Participant

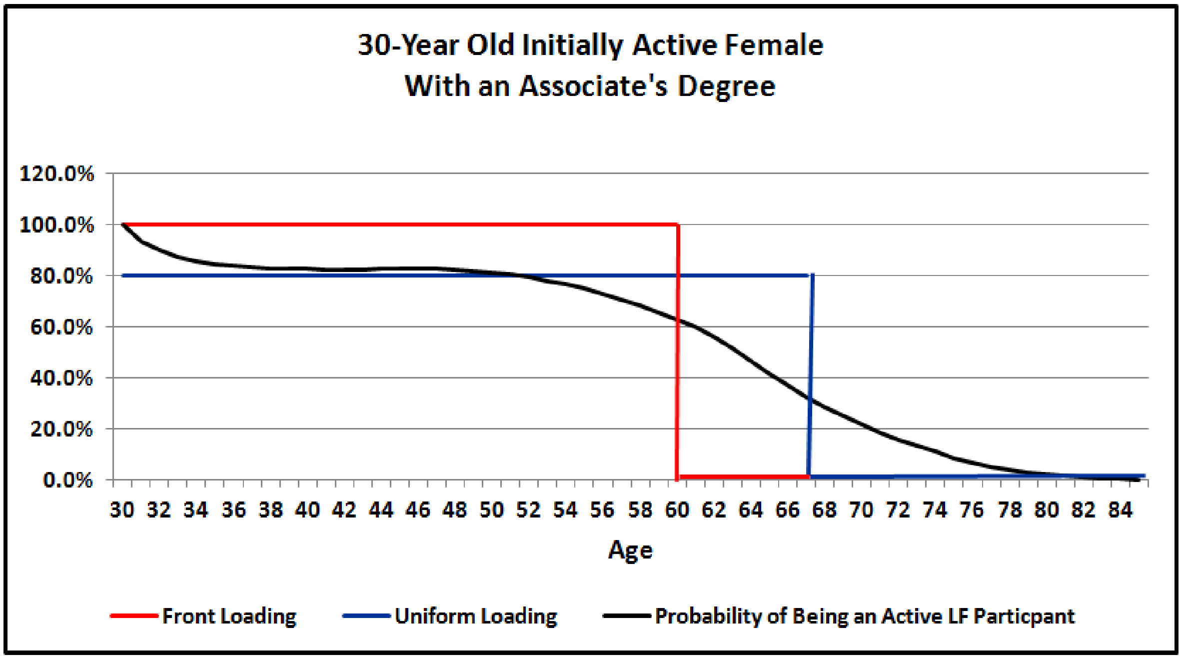

Figure 2

Calculating the Probability of Being An Active Labor Force Participant – Initially Active State

[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]
	S-C-K Transition Probabilities Females With An Associate's Degree											
Age	**Inactive to Inactive**	**Inactive to Active**	**Active to Inactive**	**Active to Active**	**L_x**	**Alive**	**Alive & Active**	**Alive & Inactive**	**Dead**	**Check Difference On Alive**	**Probability of Being Active**	**Average for Mid-Year Discounting & Transitions**
30	0.70303	0.29697	0.06164	0.93836	98,461	100,000	100,000	0	0		100.00%	96.89%
31	0.71164	0.28836	0.05738	0.94262	98,399	99,937	93,776	6,160	63	0.00000	93.78%	91.94%
32	0.72864	0.27136	0.05540	0.94460	98,333	99,870	90,111	9,759	67	0.00000	90.11%	88.91%
33	0.74605	[illegible]	[illegible]	4628	98,262	99,798	87,704	12,094	72	0.00000	87.70%	86.85%
34	0.75996	[illegible]	[illegible]	4949	98,186	99,721	85,998	13,723	77	0.00000	86.00%	85.44%
35	0.75831	[illegible]	[illegible]	[illegible]	[illegible]	99,638	84,878	14,761	83	0.00000	84.88%	84.53%
36	0.76535	[illegible]	[illegible]	[illegible]	[illegible]	99,550	84,183	15,367	89	0.00000	84.18%	83.91%
37	0.76975	0.23025	0.04837	0.95163	97,923	99,453	83,632	15,822	96	0.00000	83.63%	83.39%
38	0.76201	[illegible]	[illegible]	[illegible]	[illegible]	99,348	83,141	16,207	105	0.00000	83.14%	83.04%
39	0.76977	[illegible]	[illegible]	[illegible]	[illegible]	99,232	82,942	16,290	116	0.00000	82.94%	82.86%
40	0.76561	0.	[illegible]	[illegible]	[illegible]	99,104	82,783	16,321	128	0.00000	82.78%	82.73%
41	0.75483	0.	[illegible]	[illegible]	[illegible]	98,963	82,681	16,281	141	0.00000	82.68%	82.67%
42	0.75451	0.24549	0.04638	0.95362	97,288	98,808	82,654	16,155	155	0.00000	82.65%	82.65%
43	0.75211	[illegible]	[illegible]	[illegible]	[illegible]	98,639	82,645	15,994	169	0.00000	82.64%	82.77%
44	0.75803	[illegible]	[illegible]	[illegible]	[illegible]	98,454	82,887	15,566	185	0.00000	[illegible]	[illegible]
45	0.76781	0.23219	0.04227	0.95773	96,740	98,252	83,062	15,190	202	0.00000	[illegible]	[illegible]
46	0.76876	0.23124	0.04105	0.95895	[illegible]	[illegible]	82,892	15,140	220	0.00000	82.89%	82.84%
47	0.77808	0.22192	0.03999	0.96001	96,289	97,794	82,789	15,006	238	0.00000	82.79%	82.69%
48	0.79302	0.20698	0.04037	0.95963	[illegible]	[illegible]	2,592	14,947	256	0.00000	82.59%	82.36%
49	0.80167	0.19833	0.04186	0.95814	95,767	97,264	82,119	15,145	274	0.00000	82.12%	81.78%
50	0.80868	0.19132	0.04431	0.95569	95,4	[illegible]	[illegible]	15,532	294	[illegible]	1.44%	80.99%
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109	0.99975	0.00025	0.96978	0.03022	16	16	0	16	18	0.00000	0.00%	0.00%
110	0.99977	0.00023	0.97280	0.02720	7	7	0	7	9	0.00000	0.00%	0.00%
										End-of-Year Transition	30.11	29.61
										Midyear Adjustment	-0.50	---
										Calculated WLE	29.61	29.61
										S-C-K Table Value	29.61	

Initial values for synthetic cohort.

100,000 x 98,399 ÷ 98,461

99,937 x 98,333 ÷ 98,399

(100,000 x 0.93836 + 0 x 0.29697) x 98,399 ÷ 98,461

(93,776 x 0.94262 + 6,160 x 0.28836) x 98,333 ÷ 98,399

(0 x 0.70303 + 100,000 x 0.06164) x 98,399 ÷ 98,461

(6,160 x 0.71164 + 93,776 x 0.05738) x 98,333 ÷ 98,399

100,000 x (1 - 98,399÷98,461)

99,937 x (1 - 98,333÷98,399)

100,000 - 93,776 - 6,160 - 63

99,937 - 90,111 - 9,759 - 67

100,000 ÷ 100,000

93,776 ÷ 100,000

(100.00% + 93.78%) ÷ 2

(93.78% + 90.11%) ÷ 2

Figure 3

Calculating the Probability of Being An Active Labor Force Participant – Initially Inactive State

[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]	[M]
	S-C-K Transition Probabilities Females With An Associate's Degree											
Age	Inactive to Inactive	Inactive to Active	Active to Inactive	Active to Active	L_x	Alive	Alive & Active	Alive & Inactive	Dead	Check Difference On Alive	Probability of Being Active	Average for Mid-Year Discounting & Transitions
30	0.70303	0.29697	0.06164	0.93836	98,461	100,000	0	100,000	0		0.00%	14.84%
31	0.71164	0.28836	0.05738	0.94262	98,399	99,937	29,678	70,259	63	0.00000	29.68%	38.94%
32	0.72864	0.27136	0.05540	0.94460	98,333	99,870	48,202	51,667	67	0.00000	48.20%	53.86%
33	0.74605	[illegible]	[illegible]	[illegible]	98,262	99,798	59,510	40,288	72	0.00000	59.51%	63.00%
34	0.75996	[illegible]	[illegible]	[illegible]	98,186	99,721	66,493	33,228	77	0.00000	66.49%	68.77%
35	0.75831	[illegible]	[illegible]	[illegible]	[illegible]	99,638	71,051	28,587	83	0.00000	71.05%	72.72%
36	0.76535	[illegible]	[illegible]	[illegible]	[illegible]	99,550	74,389	25,161	89	0.00000	74.39%	75.50%
37	0.76975	0.23025	0.04837	0.95163	97,923	99,453	76,617	22,837	96	0.00000	76.62%	77.35%
38	0.76201	[illegible]	[illegible]	[illegible]	[illegible]	99,348	78,086	21,262	105	0.00000	78.09%	78.71%
39	0.76977	[illegible]	[illegible]	[illegible]	[illegible]	99,232	79,335	19,897	116	0.00000	79.34%	79.76%
40	0.76561	[illegible]	[illegible]	[illegible]	[illegible]	99,104	80,175	18,929	128	0.00000	80.17%	80.49%
41	0.75483	[illegible]	[illegible]	[illegible]	[illegible]	98,963	80,808	18,155	141	0.00000	80.81%	81.07%
42	0.75451	0.24549	0.04638	0.95362	97,288	98,808	81,329	17,479	155	0.00000	81.33%	81.52%
43	0.75211	[illegible]	[illegible]	[illegible]	[illegible]	98,639	81,708	16,931	169	0.00000	81.71%	81.97%
44	0.75803	[illegible]	[illegible]	[illegible]	[illegible]	98,454	82,225	16,229	185	0.00000	[illegible]	[illegible]
45	0.76781	0.23219	0.04227	0.95773	96,740	98,252	82,588	15,664	202	0.00000	82.59%	82.57%
46	0.76876	0.23124	0.04105	0.95895	[illegible]	[illegible]	82,549	15,483	220	0.00000	82.55%	82.54%
47	0.77808	0.22192	0.03999	0.96001	96,289	97,794	82,540	15,255	238	0.00000	82.54%	82.47%
48	0.79302	0.20698	0.04037	0.95963	[illegible]	[illegible]	[illegible]	15,130	256	0.00000	82.41%	82.19%
49	0.80167	0.19833	0.04186	0.95814	95,767	97,264	81,981	15,283	274	0.00000	81.98%	81.66%
50	0.80868	0.19132	0.04431	0.95569	[illegible]	[illegible]	[illegible]	15,637	294	[illegible]	[illegible]	80.99%
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109	0.99975	0.00025	0.96978	0.03022	16	16	0	16	18	0.00000	0.00%	0.00%
110	0.99977	0.00023	0.97280	0.02720	7	7	0	7	9	0.00000	0.00%	0.00%
										End-of-Year Transition	27.09	27.09
										Midyear Adjustment	---	---
										Calculated WLE	27.09	27.09
										S-C-K Table Value	27.09	

Initial values for synthetic cohort.

100,000 x 98,399 ÷ 98,461

99,937 x 98,333 ÷ 98,399

(0 x 0.93836 + 100,000 x 0.29697) x 98,399 ÷ 98,461

(29,678 x 0.94262 + 70,259 x 0.28836) x 98,333 ÷ 98,399

(100,000 x 0.70303 + 0 x 0.06164) x 98,399 ÷ 98,461

(70,259 x 0.71164 + 29,678 x 0.05738) x 98,333 ÷ 98,399

100,000 x (1 - 98,399÷98,461)

99,937 x (1 - 98,333÷98,399)

100,000 - 29,678 - 70,259 - 63

99,937 - 48,202 - 51,667 - 67

0 ÷ 100,000

29,678 ÷ 100,000

(0% + 29.688%) ÷ 2

(29.688% + 49.20%) ÷ 2

Figure 4

52.4 Year Old Initially Inactive Female With Some College but No Degree

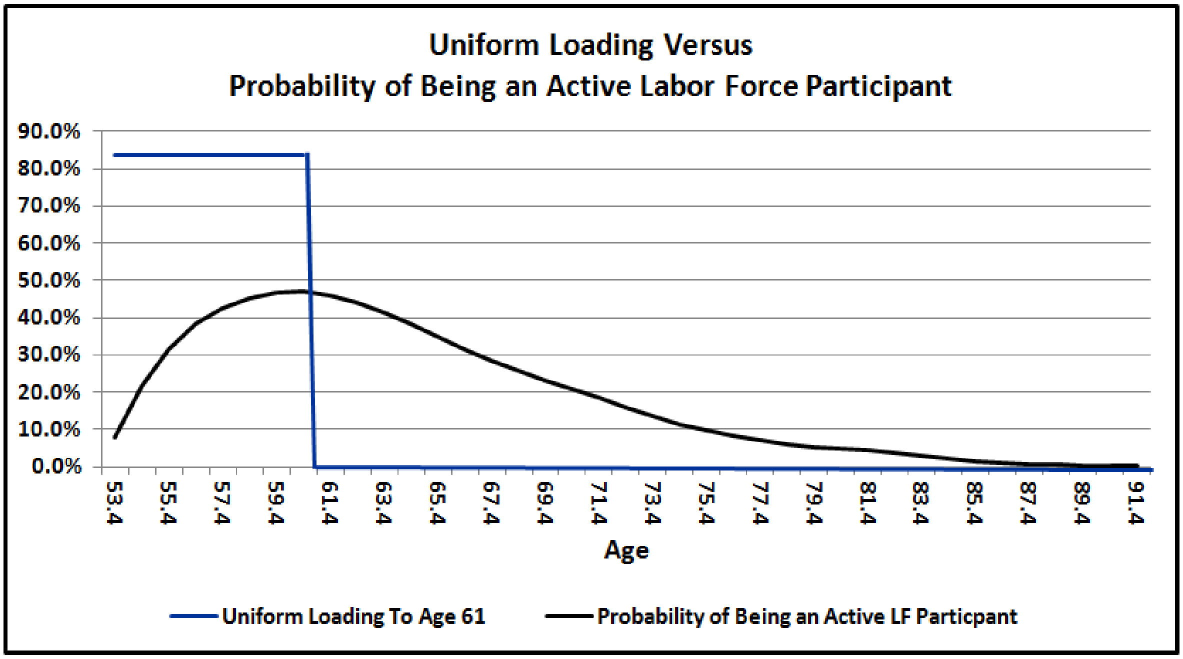
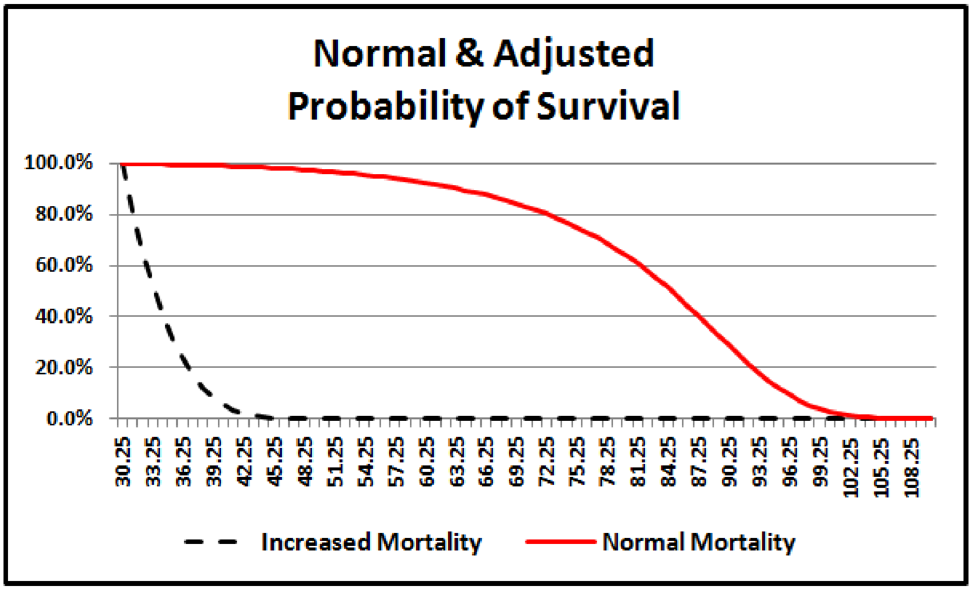


Figure 5

30.25 Year Old Initially Active Female
With an Associate's Degree



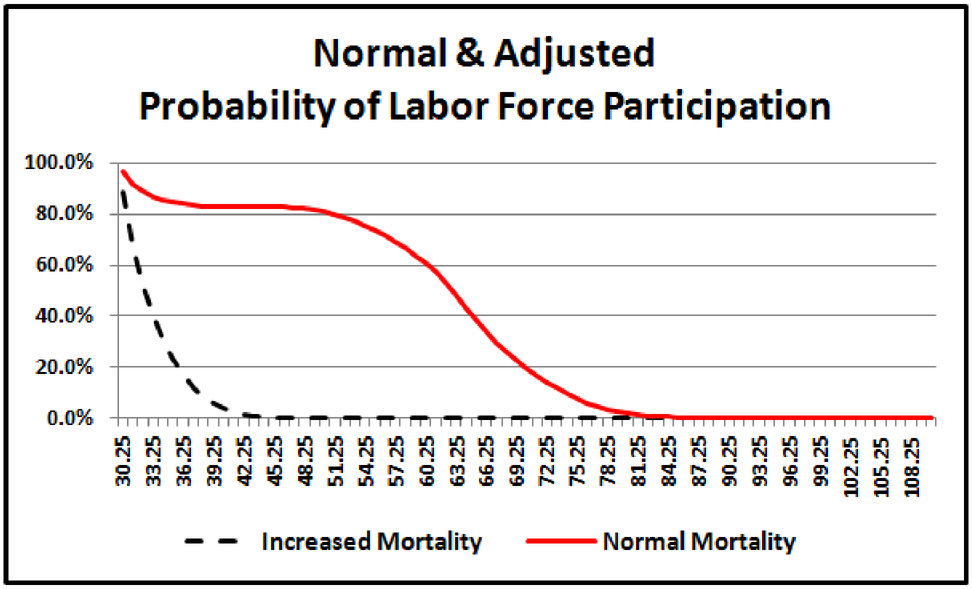
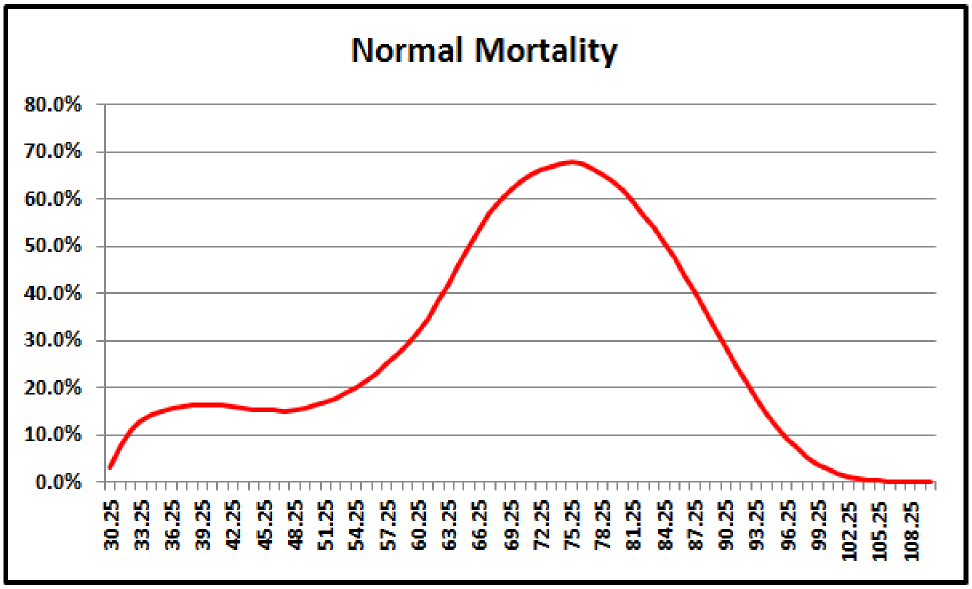


Figure 6

Probability of Survival Minus the Probability of Labor Force Participation

(30.25 Year Old Initially Active Female
With an Associate's Degree)



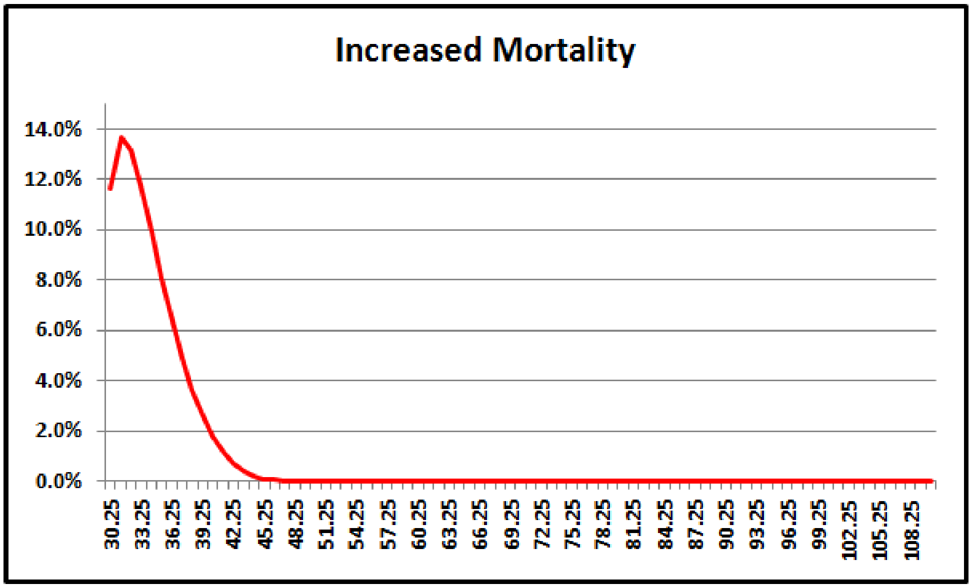


Figure 7

Probability of Labor Force Participation

(30.25 Year Old Initially Active Female
With an Associate's Degree)

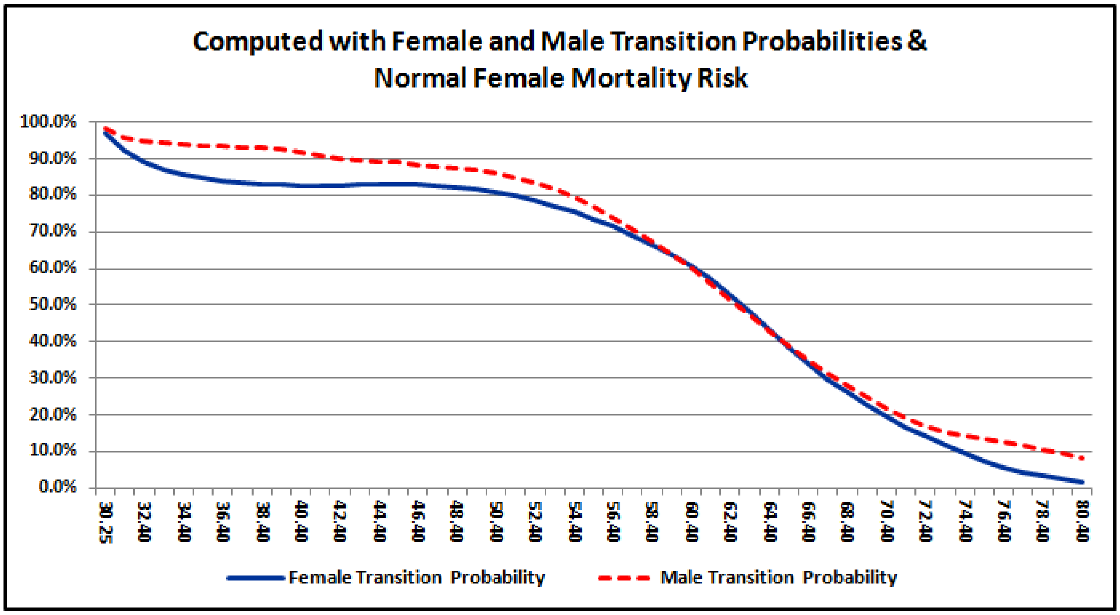
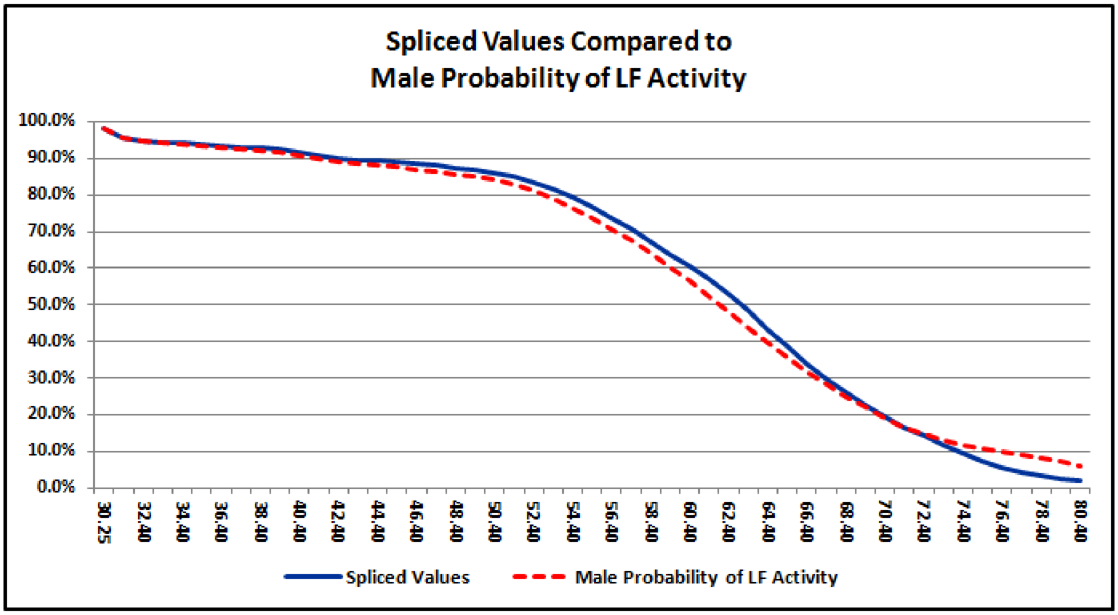


Figure 8

Probability of Labor Force Participation

(30.25 Year Old Initially Active Person
With an Associate's Degree)



Note: Male probability of labor force activity computed using 2006 life table.

Endnotes

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[1] This is the table that the S-C-K WLE's are based upon. The values shown have been extended through age 110 according to the methodology presented in Arias (2010).

[2] In general, if t is the fractional part of the age of the individual in question, then the desired probability is written as $P_x = [t\cdot\tilde{A}_{x+1} + (1\text{-}t)\cdot A_x]/100{,}000$, where the initial cohort size is 100,000 for both starting integer ages. The numerator in the right-hand expression is derived by linear interpolation of the difference between $\tilde{A}_{x+1}$ and A_x: the interpolated value equals $A_x + t\cdot(\tilde{A}_{x+1} - A_x)$ which equals $[t\cdot\tilde{A}_{x+1} + (1\text{-}t)\cdot A_x]$.

[3] The expected years of labor force participation in these three loss periods are 3.09, 2.99 and 1.27 years, respectively, for a total WLE of 7.34 years. As noted earlier, this exceeds the S-C-K table value due to the use of the 2009 life tables and to zero mortality risk before the trial date.

[4] The losses in Table 1 have been scaled to a plaintiff expert's estimated loss of $500,000.

[5] The reason a decedent's personal consumption is included as an offset in a wrongful death case is that the money spent on the decedent's personal consumption could not have been spent on the plaintiffs had the decedent survived. Consequently, failing to include a personal consumption offset over compensates the plaintiffs. This logic does not apply in a personal injury case even though the ultimate outcome may be the untimely death of one of the plaintiffs: money is fungible on a present value basis and it does not matter what the still-living plaintiff may have spent her lost earnings on in the future because we can replace those lost earnings with an equivalent present value dollar amount that she can spend today. For example, the injured plaintiff may decide to take a trip to Hawaii that she always hoped to take, or she may decide to provide for the care of an elderly relative or for the education of a niece or nephew. To include an offset for her own future personal consumption would necessarily under compensate her.

[6] In this case the required constant was 276 – in other words, the plaintiff was 276 times more likely to die within one year after age 30 than would normally be expected. Note that whenever 276 times q_x resulted in a number greater than one, the resulting modified q_x was set equal to 1. See Anderson (2002).

[7] The plaintiff's remaining WLE given the increased mortality risk is only 3.55 years, compared to a normal WLE of 29.44 years. Note that this is slightly higher than the S-C-K value of 28.97 years due to the use of the 2009 life tables.

[8] In addition to the plaintiff's normal and increased mortality risk and the spouse's mortality risk, the expected household services at each age were also reduced for the plaintiff's morbidity risk as published by Expectancy Data (2014). For the normal mortality risk present values, the calculations were made through age 100 with totals shown at age 75, 80, 85, 90, 95 and 100. The range in these values was less than 2.5 percent of the age 75 total. The present value through age 85 minus the present value of the household services assuming the plaintiff's increased mortality risk was presented as the net loss of household services.

[9] Even though 110 is the terminal age of the Markov process, the S-C-K WLE tables extend only to age 75. While it is possible to extend the WLE calculations beyond this age, the paucity of data at older ages makes the resulting WLE estimates less reliable.

[10] For Case #2, an interval of 5 years on either side of the age at which WLE is reached includes 50 percent of all possible outcomes. In terms of the present value of the net loss, this corresponds to a range of $760,359 to $1,072,695. The midpoint of this range is $916,627, slightly lower than $921,160 present value of the loss front-loaded through WLE.

[11] Use of the U.S. Census Bureau's PINC-04 tables for all persons with earnings may overcome this limitation.