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Compensation in Personal Injury Cases: Mean or Median Income?

Abstract

Courts typically base compensation for loss of income in personal injury cases on either mean or median work income. Yet, quantatively, mean and median incomes are typically very different. For example, in the US median income is 65 percent of mean income. In this paper we use economic theory to determine the relation between the appropriate make-whole (full) compensation and mean and median work incomes. Given that consumption uncertainty associated with compensation generally exceeds that associated with work income, we show that the appropriate make-whole compensation exceeds mean (and therefore median) work income. Hence, if the compensation must be either the mean or the median work income, then mean work income should be selected.

JEL-Codes: K130.

Keywords: compensation, personal injury, income loss, uncertainty, risk aversion.

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If the injurer blinded the victim's eye, cut off his hand, broke his leg, we view him as if he were a slave sold in the marketplace, and we evaluate how much he was worth prior to the injury and how much he is worth now.

Mishna Baba Kama 8:1 (Circa 200 CE)

1 Introduction

The appropriate compensation for work-income loss in personal injury cases has been of interest to the legal profession at least since biblical times. Moreover, in today's modern economies human capital tends to be substantially larger than other forms of capital.[1] Indeed, personal injury and medical malpractice torts appear to occupy a significant percentage of lawyers' time and of the time devoted by courts to civil litigation. According to IBIS World (2019), the annual revenue of the personal-injury segment of the law profession is $34.7 billion dollars, which constitutes over 10% of the revenue of the whole legal profession.[2] Furthermore, this issue has become a major component of forensic economics.

This problem involves a what-would-have-been reality, since future work income is not known with certainty, and similarly, the return on any compensation for the injury is uncertain. In view of this, the appropriate compensation must be based on statistical considerations. Courts have therefore typically based awards on statistical measures, mainly mean or median work income,[3] but without meaningful grounding in economics.[4] Indeed, there appears no uniformity in court choices between mean or median income.

[1] Liu (2011) finds that in ten OECD countries, the stock of human capital is on average 4.7 times greater than the stock of physical capital.

[2] For a perspective, this figure is 81.5% of the revenue of all US architects, and 72% of the revenue of the US movie and video production industry.

[3] To the best of our knowledge, when courts have used statistical measures of income, they have only based them on either the mean or the median.

[4] See also Spizman (2013).

Sometimes the justification given by the court for using mean or median income is passive, i.e., it is based on the fact that neither side objected to the measure at hand.[5] For example, one court states[6]

> "Using the statistical average, [named expert] placed Plaintiff's pre-injury earning capacity at ... per year ... In fact, having found no basis for straying from the lost earnings figure [i.e., the statistical average] suggested ..."

whereas another court states[7]

> "... This figure was derived from the median earnings ... There was no testimony to contradict these figures, and we find no abuse in the trial court's award."

Sometimes, the court's choice appears to be anchored in law. In a Workers' Compensation case the ruling was[8]

> "The panel finds that, as per policy, the worker's compensation should be based on the average earnings, not the median earnings, as determined by the Alberta Wage Survey."

In at least one case, the court appears to appeal for guidance on this matter, stating[9]

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[5] We even found a case where a court awards the mean and then proceeds to call it a median. See Lai Kin Wah v Hip Hing Construction Company Limited and Ng Man carrying on business under the name Ng Man Company, Supreme Court of Hong Kong, 1996, No. PI255. Dates of hearing: 16, 17 December 1996 and 10 January 1997. Date of handing down judgment: Friday, 31 January 1997.

[6] Donriel A. Borne v Celadon Trucking Services, Inc. No. W2013-01949-Coa-R3-Cv, Court of Appeals of Tennessee, At Jackson. Filed July 31, 2014.

[7] Aquanetta Demery v The Housing Authority of New Orleans, A/K/A Hano, No. 96-Ca-1024, Court of Appeal of Louisiana, Fourth Circuit, February 12, 1997. Landrieu, Judge.

[8] Appeals Commission for Alberta Workers' Compensation, Docket No.: AC0903-13-33, Decision No.: 2015-0113. The policy referred to is based on the Workers' Compensation Act, Chapter W15.

[9] Rosniak V Government Insurance Office Bc9702453 Australia, Judgment Date 12 June 1997.

> "Median or average? I am unaware of any discussion as to which measure is more appropriate in a case such as the present. In the main, judges have used average weekly earnings as the relevant yardstick although the Court has been told that there are instances where the median has been chosen. Should one be preferred to the other as a matter of principle? ... That evidence would have explained the statistical concepts and explored (in greater detail than I have) the full reasons for the difference between median and average (or mean) in the particular context at hand."

In contrast, some courts appear to have an opinion on the matter and to justify it. One court chooses the median, stating[10]

> "... as it seems to me, the median figure rather than the average pay provides better guidance as to what the claimant might have earned in that this discounts the influence of any remuneration that was extremely high or low;"

Whereas another court prefers the mean, for, it appears, much the same reason as the court mentioned above prefers the median. This court states[11]

> ". . . the way that [named expert] calculated the income is not acceptable because he used a method that simply cut down costs without justification. For example, he used a median income for persons who had not finished high school working in unskilled labour careers rather than an average. This had the result of using a lower income figure ... In addition, use of median incomes takes others out of the income calculation group."

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[10] Waqar Rashid v Mohammed Iqbal, Case No: MK 022191, High Court of Justice Queen's Bench Division, 21 May 2004.

[11] Gordon v Greig (2007), 46 C.C.L.T. (3d) 212 (Ont. S.C.)

And continuing

> " ... using the average incomes of persons in these fields of work as shown in Government of Canada statistics is reasonable and does not distort or inflate the income ... "

The seemingly haphazard way in which the courts appear to choose between mean and median work income is surprising: the difference between mean and median work income is quantitatively significant. For example, in Canada, median work income for all individuals is 76.5 % of mean work income and in the US the median is 64.7% of the mean.[12] Also, while the difference between the two measures tends to decline when the income category is more refined, it generally remains considerable. For example, the median work income of 45-54 years old males with a university BA degree who works full time in Canada is 77.1% of such males' mean work income, and in the US this ratio is 86.2%.[13] Notwithstanding the above, we are not aware of any research which provides a rigorous economic analysis of the mean versus median issue.[14]

This paper uses economic theory to determine the appropriate make-whole compensation for work-income loss incurred by a person who has been injured or otherwise wrongfully denied income.[15] Specifically, we build upon and extend the work of Skogh and Tibilette (1999), who argue that, since lost future income is uncertain " ... the risk-averse victim will be made whole by a compensation smaller than the present value of the stream of

[12] Statistics Canada (2011) and Social Security Administration (2014).

[13] Some estimates of the difference between mean and median work income are even larger. For example, see Spizman (2013) who states that "Comparing ACS [median] and PINC-04 [mean] tables show that mean earnings are always greater than median earnings. The magnitude of the difference varies from a low of 9.74% to a high of 59.48% depending on the plaintiff's age and educational level."

[14] Spizman (2013) considers the issue but provides no meanigful economic answers.

[15] For example, a person whose supporting spouse has been killed or a person who has been wrongfully imprisoned. Of course, in the event of death of a person without dependents, there may be no claimant for an income-related loss.

uncertain lost earnings." Our purpose is to develop this insight further, and use it to consider whether median or mean work income better approximates risk-aversion-discounted make-whole compensation. In particular, we suggest that the real value of the compensation itself is, in the long run, uncertain. Such uncertainty militates for greater compensation for risk-averse individuals. Hence, risk aversion might act to increase rather than reduce the compensation. It transpires that, in a simple model, it is possible to provide some tentative answers to the apparently unanswered question, is the mean or median a better measure of make-whole compensation?

We view the issue of compensation within the framework of a one-period model,[16] a log-normal income distribution function, and a constant relative risk aversion utility function.[17] We focus on an injury that has rendered a person completely unable to work.[18] Our approach builds on corrective justice, which is the traditional and natural idea that the role of the compensation is to make the injured person whole again.[19] Specifically, we calculate the lump-sum compensation that will make an injured person whole again, i.e., indifferent to not having been injured, in terms of expected utility from consumption.[20]

The transition from a state of non-injury to a state of compensated injury changes the type of income uncertainties facing an individual. Specifically, in the absence of injury, a

[16] We use a one period model such that income and consumption are identical. Realistically, the term "work income" refers to the present value of all future income derived from work in a non-injured state. In the appendix to this paper we show that our results can be extended to a multi-period model.

[17] For evidence of a lognormal income distribution, see, for example, Atkinson and Bourguignon (2014). For evidence that relative risk aversion is constant, see Brunnermeier and Nagel (2008) and Chiappori and Paiella (2011).

[18] We assume that there are no "intermediate" accidents that reduce but do not eliminate a person's income-generating capacity. This will not alter the essence of our results.

[19] See the mishnaic citation above. Also, as Coleman (1995) succintly states: "corrective justice is the principle that those who are responsible for the wrongful losses of others have a duty to repair them, and that the core of tort law embodies this conception of corrective justice."

[20] Typically, unless the court determines that the victim is incapable of making rational decisions concerning her finances, the court will award lump-sum compensation rather than annuities.

person faces work-income uncertainty resulting from the fact that the realization of work income, which is a draw from that person's future income distribution, is not known in advance. In contrast, in the compensated injured state a person faces real-compensation (i.e., consumption) uncertainty emanating from uncertainty in the real rate of return on the lump-sum compensation awarded.[21] We find that the appropriate make-whole compensation depends on the uncertainties of the consumption facilitated by work income and by the compensation awarded, as well as on the degree of risk aversion.

For accepted values of relative risk aversion (i.e., greater than unity),[22] high work-income uncertainty reduces the appropriate make-whole compensation, whereas high real-compensation uncertainty increases it. The reason is that a risk-averse person benefits from the balancing of the uncertainties associated with consumption in different states of the world. Therefore, if work-income uncertainty exceeds real-compensation uncertainty, a smaller make-whole compensation will be required. Conversely, if consumption in the injured state is more uncertain, a greater make-whole lump-sum compensation will be required. As discussed later in this paper, compensation uncertainty appears to be greater than work income uncertainty. Our analysis therefore suggests that the make-whole compensation exceeds mean work income.

To summarize, this paper attempts to determine whether mean or median income is more appropriate in terms of making an injured person whole again. What the paper does *not* do is search for an incentive based or socially efficient compensation. One of the main reasons for this is that, typically, courts try to determine make-whole compensation first. Once this is done, they determine liability and assign only a proportion of such compensation to the injured party if that party is deemed not to have taken appropriate care. It is these rules

[21] Real compensation is the term we use for the consumption facilitated by the original compensation when the uncertainty in the real rate of return has been resolved.

[22] Chiappori and Paiella (2011) find that relative risk aversion is likely to exceed two, and Barro and Jin (2011) estimate relative risk aversion to be four. Meyer and Meyer (2005) provide a list of estimates.

that determine appropriate care and thereby act as an incentive to efficiency.

2 The Model

Let y denote the uncertain (real) work income of an individual who is not involved in an accident. Naturally, y depends on several parameters including the individual's age, gender, education, profession, work history,[23] and other personal characteristics, as well as on economy-wide variables such as technological developments and economic growth. In addition, as pointed out by Van Wijck and Winters (2001) and further analyzed by Singh (2004),[24] the uncertainty in y also must capture the probabilities of future non-compensable accidents and other random reductions in the ability to work, as well as the impact of any incentives provided to avoid accidents.[25] To capture the inherent uncertainty in a person's work income, we assume that y is lognormally distributed with mean M and coefficient of variation $(e^{\sigma^2} - 1)^{1/2}$, i.e., that $y \sim \Lambda(\ln M - \frac{1}{2}\sigma^2, \sigma^2)$, where Λ is the cumulative lognormal distribution. Hence, the median of y is $\bar{M} \equiv Me^{-\sigma^2/2}$ and a greater σ^2 indicates a more uncertain distribution of work income.

The individual faces a probability $\phi \in (0, 1)$ of an accident, wrongfully caused by another, that will result in a complete inability to work. If such an accident occurs, the individual is awarded a lump-sum compensation A. Upon receipt, A is invested and the real value of the compensation is Az, where z captures the uncertainty concerning the consumption that is facilitated by the lump-sum compensation. This uncertainty encompasses financial developments of purchasing power, interest rates, etc. We assume that z is lognormally

[23] Not all individuals will have a profession, or indeed, an education or a work history. For example, a child will typically not have a profession. Nonetheless, a child's future work income will be a random variable drawn from a particular distribution.

[24] Van Wijck and Winters (2001) and Singh (2004) focus on economic efficiency and optimal care, which topics are not addressed in this paper.

[25] This point is adressed in an empirical paper by Philipsen (2009).

distributed with mean equal to one and coefficient of variation equal to $\left(e^{s^2}-1\right)^{1/2}$, i.e., $z \sim \Lambda(-\frac{1}{2}s^2, s^2)$. Hence, a greater s^2 indicates a more uncertain real compensation.

The individual's utility function exhibits constant relative risk aversion $S > 0$ and is $\left(n^{1-S}-1\right)/(1-S)$ if $S \neq 1$ and $\ln n$ if $S = 1$, where $n = y$ for an individual not involved in an accident, and $n = Az$ for an individual involved in an accident. Therefore, using that if $S \neq 1$ then y^{1-S} is lognormally distributed with $\Lambda\left[\left(\ln M - \frac{1}{2}\sigma^2\right)(1-S), \sigma^2(1-S)^2\right]$ and has the mean $M^{1-S}e^{S(S-1)\sigma^2/2}$, the individual's no-injury expected utility is

$$\begin{cases} \displaystyle\int_0^\infty \frac{y^{1-S}-1}{1-S} d\Lambda(\ln M - \tfrac{1}{2}\sigma^2, \sigma^2)dy = \frac{M^{1-S}e^{S(S-1)\sigma^2/2}-1}{1-S} & \text{if } S \neq 1, \\ \displaystyle\int_0^\infty \ln y d\Lambda(\ln M - \tfrac{1}{2}\sigma^2, \sigma^2)dy = \ln M - \tfrac{1}{2}\sigma^2 & \text{if } S = 1. \end{cases} \tag{1}$$

Similarly, if $S \neq 1$ then z^{1-S} is lognormally distributed with $\Lambda\left[\frac{1}{2}s^2(1-S), s^2(1-S)^2\right]$ and has the mean $e^{S(S-1)s^2/2}$. Therefore, the individual's compensated injury expected utility is

$$\begin{cases} \displaystyle\int_0^\infty \frac{(Az)^{1-S}-1}{1-S} d\Lambda(-\tfrac{1}{2}s^2, s^2)dz = \frac{A^{1-S}e^{S(S-1)s^2/2}-1}{1-S} & \text{if } S \neq 1, \\ \displaystyle\int_0^\infty \ln(Az)\, d\Lambda(-\tfrac{1}{2}s^2, s^2)dz = \ln A - \tfrac{1}{2}s^2 & \text{if } S = 1. \end{cases} \tag{2}$$

To determine A we assume that the purpose of the compensation is to make the victim whole, i.e., to bring the victim back to the level of expected utility (from work income) absent the accident. This requires certainty equivalence between the states of no-injury and of compensated injury.[26]

3 Making the Victim Whole

The make-whole compensation, A, is obtained by setting (1) equal to (2). This implies that

$$A = Me^{S\delta}, \tag{3}$$

[26] As mentioned above, we abstract from a victim's pain and suffering. Our results do not change if these are incorporated either multiplicatively or additively in the utility function.

where $\delta \equiv (s^2 - \sigma^2)/2$. The make-whole compensation is therefore proportional to mean work income, M, and depends on the uncertainties of work income and of real compensation.

If there is no uncertainty in the real make-whole compensation, i.e., if $s^2 = 0$, then $A = Me^{-S\sigma^2/2}$. Thus, the greater the uncertainty of work income, and therefore the smaller the expected utility derived from it by a risk-averse individual, the smaller is the make-whole compensation. Hence, σ^2 has a negative impact on A. Furthermore, the more risk averse the individual, i.e., the greater is S, the greater is the absolute (negative) effect of an increase in σ^2 on A. Recalling that median work income is $Me^{-\sigma^2/2}$, the make-whole compensation equals the median work income if $S = 1$. Also, if $S > 1$, the make-whole compensation is smaller than the median work income, and the greater is S, the more distant it is from the median. Last, if $S < 1$, the make-whole compensation is greater than median work income; and the smaller is S, the more distant is A from the median.

If there is no uncertainty in work income, i.e., $\sigma^2 = 0$, but there is uncertainty in the real make-whole compensation, i.e., $s^2 > 0$, then $A = Me^{Ss^2/2}$. This implies that the greater the uncertainty in the real compensation, the smaller the expected utility derived by a risk-averse individual from a given lump sum, and therefore the larger the make-whole compensation. Hence, s^2 has a positive impact on A, and, in this case, a greater S implies a greater make-whole compensation.

In reality, both uncertainties are likely to be present, i.e., $\sigma^2 > 0$ and $s^2 > 0$, and their combined effects are captured by δ. If $\delta = 0$, the two uncertainties neutralize each other. Therefore, the make-whole compensation is not impacted by the degree of risk aversion and equals mean work income, i.e., $A = M$ independently of the risk aversion.

If $\delta > 0$, the uncertainty in work income is outweighed by the uncertainty in real compensation. In this case, therefore, the compensated injured individual has exchanged a stream of income for one that is more uncertain. To ensure that expected utility is the same in both the non-injured and the injured states of the world, the make-whole compensation must be greater than mean work income, i.e., $A > M$. Conversely, if $\delta < 0$, then the victim's make-whole compensation must be less than mean work income, i.e., $A < M$.

The sign of δ therefore determines the direction of the deviation of the make-whole compensation from the mean work income. As can be seen from (3), δS determines the extent of this deviation. Therefore, in effect, S is a scaling factor that causes the impact on A of the difference in the two types of uncertainty to increase with the individual's risk aversion.

While δ provides sufficient information to determine the relation between make-whole compensation and mean work income, it does not always provide sufficient information to determine the relation between make-whole compensation and median work income. This is because δ captures the net effect of the two uncertainties on the make-whole compensation, whereas median work income, $Me^{-\sigma^2/2}$ is a function of σ^2 but not s^2.

If $S < 1$, then σ^2 has a smaller proportional effect on the make-whole compensation than on median work income, $\bar{M}$. Also, as shown above, if $S = 1$ and $s^2 = 0$, then $A = \bar{M}$. Hence, since s^2 has a positive effect on the make-whole compensation and no effect on median work income, if $s^2 = 0$ then $S < 1$ implies that $A > \bar{M}$, and if $s^2 > 0$, then $S = 1$ implies that $A > \bar{M}$.

If $S > 1$, then σ^2 has a greater proportional effect on the make-whole compensation than on median work income. Since s^2 always has a positive effect on A and no effect on $\bar{M}$, the relative magnitudes of A and $\bar{M}$ depend on the values of σ^2, s^2, and S. In particular, if $S > 1$ we have $A \gtreqless \bar{M}$ as $Ss^2/(S-1) \gtreqless \sigma^2$. Specifically, whenever $\delta < 0$, greater S and σ^2 imply that less income is needed in the injured state in order to keep the victim whole. Since the median is less than the mean with a lognormal distribution, for sufficiently high S and σ^2, the make-whole compensation becomes so low that it is not only less than M but even less than $\bar{M}$.[27]

[27] The distribution of the real make-whole compensation, Az, is $\Lambda\left(\ln M + S\delta - \frac{1}{2}s^2, s^2\right)$, which has mean

Assuming $s^2 > 0$, the characteristics of the make-whole compensation and its relationship to the mean and the median work income are summarized in Figure 1, where S is measured on the horizontal axis and σ^2 on the vertical axis. The horizontal line $A = M$ corresponds to $\sigma^2 = s^2$. The curve $A = \bar{M}$ is given by $\sigma^2 = Ss^2/(S-1)$. Below the line $A = M$ we have that $M < A$ (and also that $\bar{M} < A$ since $\bar{M} < M$). Between the line $A = M$ and the curve $A = \bar{M}$ we have that $\bar{M} < A < M$, and above the curve $A = \bar{M}$ we have that $A < \bar{M}$ (and hence $A < M$).

4 Concluding Comments

The main message of this paper is that the uncertainties associated with work income and real compensation as well as the risk aversion of the injured individual play major roles in determining the make-whole compensation for an injury that has caused a loss of work income. For a risk-averse person, high work-income uncertainty implies a smaller expected utility. Hence, the greater this uncertainty, the smaller is the make-whole compensation required to make up for the loss of work income. Conversely, the greater the uncertainty of the consumption facilitated by a given lump-sum compensation, the smaller is the expected utility from such compensation. This in turn implies that a greater real-compensation uncertainty requires a greater make-whole compensation.

These conclusions are general and transcend our model's specific assumptions. They are independent of the lognormality of the work-income distribution and of the distribution of the consumption obtainable from the lump-sum compensation, and, similarly, they are independent of the constancy of relative risk aversion. Of course, the precise size of the make-whole compensation does depend on the specific assumptions made.

We model real-compensation uncertainty as emanating from the uncertainty associated

$Me^{S\delta}$ and median $Me^{S\delta - s^2/2}$. It is straightforward to show that an individual's expected utility decreases with the likelihood of an accident, ϕ, and with both uncertainty measures, σ^2 and s^2.

with the real return to the investment of a lump sum, i.e., the uncertainty in the return to financial capital. Such uncertainty appears to be significantly greater than that inherent in the return to human capital. For instance, Bucciol and Miniaci (2011) find that the standard deviation of the percent return to human capital is 2.5% as compared with 8.7% for bonds, 17.6% for stocks, and 7.9% for real estate.[28]

In addition, the injured person faces another potential major source of real-compensation uncertainty, which we have not explicitly incorporated into the model. This is the possibility that the court will incorrectly estimate the parameters of the distribution of the injured person's work income. Such uncertainty emanates from an imperfect knowledge of a particular victim's characteristics as well as from the inherent uncertainty concerning future economic developments. This ignorance is, after all, one of the major reasons for resorting to a court. And, while the point of the proceedings is to reduce the court's uncertainty, such uncertainty is unlikely to be completely eliminated.[29] Indeed, even scholars who believe that court awards are predictable, find that the unexplained component of the variance of awards exceeds 50%.[30] Adding this source of uncertainty is equivalent to magnifying real-compensation uncertainty.

In view of the above considerations, we believe that, generally, real-compensation uncertainty exceeds work-income uncertainty. The practical implication is that for typically risk-averse individuals (whose relative risk aversion exceeds unity), the make-whole compensation exceeds mean (and therefore median) work income. Hence, if the compensation must be either the mean or the median work income, then mean work income should be selected.

[28] See also Palacios-Huerta (2003).

[29] There is an ongoing discussion in the literature concerning the variance in awards. Some view verdicts as highly random. See, for example, Atiyah (1997). Others view court verdicts as predictable and meaningfully based on economic considerations. See, for example, Osborne (1999).

[30] See Osborne (1999).

Appendix

The main body of this paper presents a simple one-period framework that abstracts from the fact that the mean value of work income is likely to vary over time, and that both work income and the consumption attainable from the compensation may follow random processes that evolve over time. In particular, the uncertainty of both work income and the consumption attainable from the compensation are likely to increase over time. However, our model can be extended to incorporate these considerations.

Thus, suppose that the victim had $T \geq 1$ remaining periods of working life when the accident happened. A natural generalization of the person's one-period work-income uncertainty is to assume that the work income in period $t = 1, 2, \cdots, T$, denoted by y_t, is lognormally distributed with $y_t \sim \mathbf{\Lambda}\left(\ln M_t - \frac{1}{2}\sigma^2 t, \sigma^2 t\right)$. That is, the mean of y_t is M_t, which may vary over time; the coefficient of variation of y_t is $\left(e^{\sigma^2 t} - 1\right)^{1/2}$, which increases over time; and the median of y_t is $M_t e^{-\sigma^2 t/2}$, which increases (decreases) from period t to period $t+1$ if $\ln(M_{t+1}/M_t) > (<) \frac{1}{2}\sigma^2$.

From the properties of the lognormal distribution, the individual's no-injury expected utility in period t is

$$\begin{cases} \displaystyle\int_0^\infty \frac{y_t^{1-S} - 1}{1-S} \Lambda\left(\ln M_t - \tfrac{1}{2}\sigma^2 t, \sigma^2 t\right) dy_t & = \dfrac{\left(M_t e^{-S\sigma^2 t/2}\right)^{1-S} - 1}{1-S} \quad \text{if } S \neq 1, \\ \displaystyle\int_0^\infty \ln y_t d\Lambda\left(\ln M_t - \tfrac{1}{2}\sigma^2 t, \sigma^2 t\right) dy_t & = \ln M_t - \tfrac{1}{2}\sigma^2 t \quad \text{if } S = 1. \end{cases} \tag{4}$$

Assume that the total lump-sum compensation paid in the period of the accident (i.e., in period $t = 1$) must ensure that the victim can be made whole in each of the T periods. Let the amount A_t be the make-whole compensation received (in the period of the accident) for period t. That is, the total compensation A can be divided into $A_1, A_2, \cdots, A_T$ with $A = \sum_{t=1}^{T} A_t$.[31] In keeping with the assumptions made in the main body of the paper,

[31] Thus, the one-time compensation A provides the victim with the same expected utility as an annuity that pays A_t in period t. See footnote 20.

let the real value of the make-whole compensation for period t be $A_t e^{r(t-1)} z_t$, where r is the interest rate and z_t is lognormally distributed according to $z_t \sim \Lambda\left(-\frac{1}{2}s^2 t, s^2 t\right)$. Therefore, the mean of z_t is unity for all t while its coefficient of variation, $\left(e^{s^2 t} - 1\right)^{1/2}$, increases over time. The make-whole compensation A_t therefore enables the individual to obtain a compensated injury expected utility[32] in period t that is equal to

$$\begin{cases} \displaystyle\int_0^\infty \frac{\left[A_t e^{r(t-1)} z_t\right]^{1-S} - 1}{1-S} d\Lambda\left(-\tfrac{1}{2}s^2 t, s^2 t\right) dz_t & = \dfrac{\left\{A_t e^{\left[r(t-1) - Ss^2/2\right]t}\right\}^{1-S} - 1}{1-S} \quad \text{if } S \neq 1, \\ \displaystyle\int_0^\infty \ln\left[A_t e^{r(t-1)} z_t\right] d\Lambda\left(-\tfrac{1}{2}s^2 t, s^2 t\right) dz_t & = \ln A_t + r(t-1) - \tfrac{1}{2}s^2 t \quad \text{if } S = 1. \end{cases} \tag{5}$$

In view of (4)-(5), certainty-equivalence between the expected utility from work income and from the make-whole income from the accident compensation for each t requires that $A_t = M_t e^{-r(t-1)+\delta St}$. That is, the accident compensation for the first period is $A_1 = M_1 e^{\delta S}$ (the same as in the one-period case) and then changes at a rate of $\ln(M_{t+1}/M_t) - r + \delta S$ from period t to period $t+1$. The rate of change in A_t reflects the rate of change in the mean value of work income and is reduced by the interest rate r, while the period-to-period effects of δ and S are the same as their one-period effects.

We therefore have that

$$A = \sum_{t=1}^{T} M_t e^{-r(t-1)+\delta St}.$$

It follows immediately that the total make-whole compensation, A, increases with each M_t and decreases with r. Additionally, just as in the one-period setting, A decreases with σ^2 and increases with s^2, with their impacts increasing with S.

Moreover, within a multi-period setting, for each period's make-whole compensation, the insights presented within the context of the one-period model concerning the relation between mean and median work income and the make-whole compensation remain valid. Hence, the results derived for the one-period model can be generalized.

[32] For simplicity we assume that a person spends the income in the period in which it is received.

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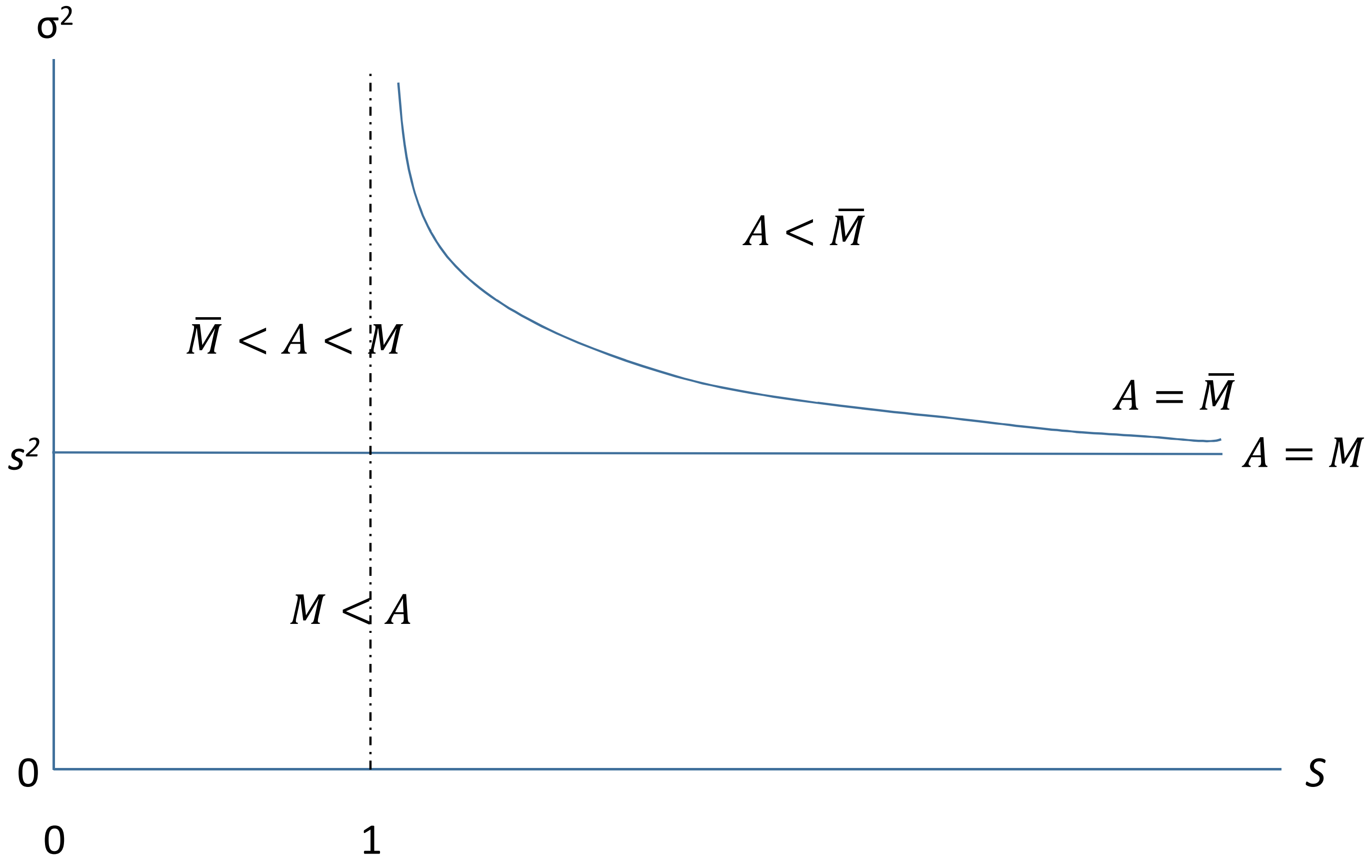

Figure 1