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Compensation for Loss of Work Income in Personal Injury Cases

Abstract

What is the appropriate lump-sum compensation for loss of work income in personal injury cases? Since generally future work income is not known with certainty, compensation for its loss must be based on statistical considerations. Typically, courts have based awards on mean or median work income, but apparently without meaningful grounding in economics. We use economic theory to address this issue. We find that the relation between the appropriate compensation and the mean and median work income depends on the uncertainties of work income and of consumption facilitated by the lump-sum compensation awarded, as well as the degree of risk aversion. Since the consumption uncertainty associated with compensation generally exceeds that associated with work income, we conclude that the lump-sum compensation should exceed mean and therefore median work income.

JEL-Codes: K130.

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

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If the injurer blinded the victim's eye, cut off his hand, broke his leg, we see 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. This is not surprising, since human capital investment tends to be substantially larger than other investments.[1] Indeed, personal injury torts appear to occupy a significant percentage of lawyers' time and of the time devoted by courts to civil litigation.[2] Furthermore, this issue has been a major component of a new branch of economics, i.e., forensic economics.

This problem involves a what-would-have-been reality, since future work income is not known with certainty. In view of this, the appropriate compensation must be based on statistical considerations. Typically, courts have based awards on mean or median work income, but without meaningful grounding in economics. Yet, 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.[3] Also, while the distance between the two measures tends to decline when the income category is more refined, it generally remains considerable. Thus, the median

[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] According to IBIS World (2017), the annual revenue of the personal-injury segment of the law profession is $31 billion dollars, which constitutes over 10% of the revenue of the whole legal profession. For 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] Statistics Canada (2011) and Social Security Administration (2014).

work income of a 45-54 years old male with a university BA degree who works full time in Canada is 77.1% of his mean work income, and in the US this ratio is 86.2%.[4]

This paper uses economic theory to determine the appropriate compensation for the work-income loss incurred by a person who has been injured or otherwise wrongfully denied income.[5] Specifically, we view the issue within the framework of a constant relative risk aversion utility function[6] and a lognormal income distribution function.[7] Focusing on an injury that has rendered a person completely unable to work,[8] we consider two alternative approaches. The first, builds on the traditional and natural idea that the role of the compensation is to compensate and is based on corrective justice.[9] In this approach we use the term *make-whole* and 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.[10] The second approach is related to the law-and-economics notion that the role of law is to increase efficiency. In this, we calculate the lump-sum compensation that an optimizing individual would choose ex ante in an insurance scheme. We use the term *optimal* to describe this approach.[11]

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[4] Some researchers have estimated potentialy even larger differences between mean and median work income. 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."

[5] For example, a person whose supporting spouse has been killed or a person who has been wrongfully imprisoned.

[6] For evidence that relative risk aversion is constant, see Brunnermeier and Nagel (2008) and Chiappori and Paiella (2011).

[7] For empirical support for this assumption, see, for example, Atkinson and Bourguignon (2014).

[8] For simplicity, 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.

[9] 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."

[10] We do not address the much thornier issue of pain and suffering.

[11] The optimal compensation contains an element of redistrubutive justice, i.e., it is used to improve

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 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.[12] In contrast, in the compensated injured state a person faces real-compensation uncertainty emanating from uncertainty in the real rate of return on the lump-sum compensation awarded.[13] We find that the appropriate lump-sum 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. Consequently, the lump-sum compensation may be smaller than the median, between the median and the mean, or greater than the mean.

For realistic values of relative risk aversion (i.e., greater than unity),[14] high work-income uncertainty reduces the appropriate lump-sum compensation, whereas high real-compensation uncertainty increases it. We believe that these results yield an insight that transcends the specifics of our model: a risk-averse person benefits from the balancing of the uncertainties associated with consumption in different states of the world. If work-income uncertainty exceeds real-compensation uncertainty, a smaller lump sum will be required for both the make-whole and optimal compensations. Conversely, if consumption in the injured state is more uncertain, a greater lump-sum compensation will be required.

As discussed later in this paper, real-compensation uncertainty is generally greater than

ex-ante social welfare. It does not, however, attempt to alter behavior, which is an important issue beyond the scope of this paper.

[12] For simplicity, 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.

[13] 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. In addition to real-compensation uncertainty, an injured person also faces verdict uncertainty, which is not modelled here.

[14] 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.

income uncertainty. Given this, our analysis suggests that both the make-whole and optimal lump-sum compensations exceed the mean. Moreover, we find that in this case the optimal lump-sum compensation subceeds (is less than) the make-whole compensation. This implies that the injured individual is better off with the make-whole compensation than with the optimal compensation.

In Section 2, we present the model. In section 3 we derive and discuss the make-whole compensation. In Section 4 we derive and discuss the optimal lump-sum compensation. Section 5 summarizes our results and discusses the uncertainties of work income and of real compensation and their implications.

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,[15] and other personal characteristics, as well as on economy-wide variables such as technological developments and economic growth. 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 $y \sim \Lambda(\ln M - \frac{1}{2}\sigma^2, \sigma^2)$. 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, realized value of the compensation is Az, where z captures the uncertainty concerning the consumption that is facilitated by the lump-sum compensation. This uncertainty encom-

[15] 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.

passes financial developments of purchasing power, interest rates, etc. We use the term real compensation to refer to Az. We assume that z is lognormally 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.

All income – whether from work or from the compensation received in the case of an accident – is taxed at the proportional rate t.[16] 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 $n = y(1-t)$ for an individual not involved in an accident, and $n = Az(1-t)$ for an individual involved in an accident. Therefore, for a given t, the individual's no-injury expected utility is

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

and the individual's compensated injury expected utility is

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

We determine A using two alternative approaches: In the first, 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. The make-whole approach therefore requires certainty equivalence between the states of no-injury and of compensated injury.[17] This approach is divided into two subcases. In the first, the tax rate

[16] A proportional tax that is imposed solely on work income (rather than also on the compensation for an accident) would complicate the analysis without meaningfully altering the results.

[17] 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.

is exogenous (and possibly equal to zero). In the second, the tax rate is endogenous and set to make the compensation scheme self financing: the expected tax collected must equal the expected compensation to accident victims. Therefore, the endogenous t must satisfy

$$\begin{aligned} [(1-\phi)M + \phi A]\, t &= \phi A \\ \Rightarrow \qquad t &= \frac{\phi A}{(1-\phi)M + \phi A}. \end{aligned} \tag{3}$$

The second approach recognizes that making the victim whole is generally not optimal in the sense that, ex ante, an optimizing individual would not choose make-whole compensation insurance. We therefore determine the compensation that an optimizing individual will prefer and compare it with the make-whole compensation.

3 Making the Victim Whole

The (lump-sum) make-whole compensation, denoted by A_w, is obtained by setting (1) equal to (2). This implies that, for any t,

$$A_w = Me^{S\delta}, \tag{4}$$

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. Also, since (4) is independent of t, the make-whole compensation is the same whether t is exogenous or endogenous: the two subcases of the make-whole compensation yield the same result.

If there is no uncertainty in the real make-whole compensation, i.e., if $s^2 = 0$, then $A_w = Me^{-S\sigma^2/2}$. 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_w. Furthermore, the more risk averse the individual, i.e., the greater is S, the greater is the (negative) effect of an increase in

σ^2 on A_w. 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_w 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 $A_w = Me^{Ss^2/2}$. 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_w, 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., $A_w = M$ 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: $A_w > M$. Conversely, if $\delta < 0$, then the victim's make-whole compensation is less than mean work income, i.e., $A_w < M$.

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 (4), δS determines the extent of this deviation. Therefore, in effect S is a scaling factor that causes the impact on A_w 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. Also, as shown above, if $S = 1$ and $s^2 = 0$, then $A_w = \bar{M}$. 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 $A_w > \bar{M}$, and if $s^2 > 0$, then $S = 1$ implies that $A_w > \bar{M}$.

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_w and no effect on $\bar{M}$, the relative magnitudes of A_w and $\bar{M}$ depend on the values of σ^2, s^2, and S. In particular, if $S > 1$ we have $A_w \gtreqless \bar{M}$ 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 $\bar{M}$.[18]

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 $A_w = M$ corresponds to $\sigma^2 = s^2$. The curve $A_w = \bar{M}$ is given by $\sigma^2 = Ss^2/(S-1)$. Below the line $A_w = M$ we have that $M < A_w$ (and also that $\bar{M} < A_w$ since $\bar{M} < M$). Between the line $A_w = M$ and

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[18] The distribution of the real make-whole compensation, $A_w z$, is $\Lambda\left(\ln M + S\delta - \frac{1}{2}s^2, s^2\right)$, which has mean $Me^{S\delta}$ and median $Me^{S\delta - s^2/2}$. It is straightforward to show that the endogenous t increases with $S\delta$ and that an individual's expected utility decreases with the likelihood of an accident, ϕ, and with both uncertainty measures, σ^2 and s^2.

the curve $A_w = \bar{M}$ we have that $\bar{M} < A_w < M$, and above the curve $A_w = \bar{M}$ we have that $A_w < \bar{M}$ (and hence $A_w < M$).

4 The Optimal Compensation

In the make-whole case, compensation is used to ensure that expected utility is invariant to the state of the world. This, however, is not generally efficient because equality of expected utilities in the different states does not imply equality of marginal expected utilities. An optimizing individual would not, therefore, generally choose make-whole compensation in an insurance scheme.[19]

Denoting the optimal compensation by A_o and the corresponding tax (insurance) rate by t_o given by (3) and using (1) and (2), an individual's expected utility is given by

$$\begin{cases} (1-\phi)\dfrac{(1-t_o)^{1-S}M^{1-S}e^{S(S-1)\sigma^2/2}-1}{1-S}+\phi\dfrac{(1-t_o)^{1-S}A_o^{1-S}e^{S(S-1)s^2/2}-1}{1-S} & \text{if } S \neq 1, \\ (1-\phi)(\ln M - \frac{1}{2}\sigma^2)+\phi(\ln A_o - \frac{1}{2}s^2)+\ln(1-t_o) & \text{if } S = 1. \end{cases}$$

Maximizing with respect to A_o yields that

$$A_o^S e^{S(S-1)\sigma^2/2} = M^S e^{S(S-1)s^2/2},$$

and hence

$$A_o = Me^{(S-1)\delta}.$$

As in the case of make-whole compensation, the optimal lump-sum compensation is proportional to M. However, whereas for A_w the impact of δ is always positive, for A_o the sign of the impact of δ depends on whether $S \gtreqless 1$.

[19] Whether this fact should be considered in formulating judicial policy is, of course, another matter. An optimal compensation rule may induce moral-hazard behavior. However, since it is generaly impossible to meaningfully compensate for the pain and suffering associated with personal injury, moral hazard may not be a major consideration.

The intuition for this result is similar to that for optimal saving decisions: for a logarithmic utility function, i.e., $S = 1$, the allocation of saving between periods is independent of the uncertainty in the rate of return. Furthermore, if $S > 1$, more income is allocated to the period with the greater uncertainty. Conversely, if $S < 1$, more income is allocated to the period with the smaller uncertainty. The optimal compensation problem analyzed here is isomorphic with the optimal saving decision, except that here the individual optimally allocates income between states of the world with different uncertainties rather than allocating consumption between periods.

Hence, if $S = 1$, the optimal lump-sum compensation equals mean work income. If $S > 1$, the compensation is used to ensure that a greater expected consumption is allocated to the state with greater uncertainty, and a smaller expected consumption is allocated to the state with smaller uncertainty. The converse holds when $S < 1$.

To compare the optimal lump-sum compensation with the median work income, we are interested in whether

$$Me^{(S-1)(s^2-\sigma^2)/2} \gtreqless Me^{-\sigma^2/2}$$

$$\Leftrightarrow \qquad s^2(S-1) \gtreqless \sigma^2(S-2).$$

Assuming $s^2 > 0$, the characteristics of the optimal lump-sum compensation and its relationship to mean and median work income are summarized in Figure 2, where, once again, S is measured on the horizontal axis and σ^2 on the vertical axis.

We distinguish between the cases $S = 1$, $S > 1$, and $S < 1$:

If $S = 1$, we have that $A_o = M > \bar{M}$.

If $S > 1$, then the impact of δ on A_o is in the same direction as its effect on A_w. Therefore, the part of Figure 2 for $S > 1$ is identical to the whole of Figure 1 if $S - 1$ is substituted for S.

If $S < 1$, the impact of δ on A_o is opposite to its impact on A_w: an increase in δ reduces A_o. Hence, for $S < 1$, an increase in σ^2 increases A_o and an increase in s^2 decreases it. We know that if $s^2 = \sigma^2$ then $A_o = M$. Hence, for $S < 1$, if σ^2 is smaller than s^2, A_o is smaller than M; for σ^2 that is smaller still, A_o equals the median, $\bar{M}$; and, for yet smaller σ^2 it will be smaller than $\bar{M}$. Also, a σ^2 that is greater than s^2 combined with $S < 1$ implies that $\bar{M} < M < A_o$. This is illustrated in the $S < 1$ range of Figure 2. This part of Figure 2 mirrors the part of Figure 1 for $S > 1$, since the incentives to allocate income between states of the world with different uncertainties are opposite for $S > 1$ and for $S < 1$.[20]

Finally, note that $A_o = A_w e^{-\delta}$, which implies that the optimal compensation equals the make-whole compensation only in the special case where $\delta = 0$. Moreover, the optimal compensation exceeds the make-whole compensation if $\delta < 0$, and subceeds the optimal compensation if $\delta > 0$. This is illustrated in Figure 3. Also, if $\delta < 0$, the expected utility in the injured (and optimally compensated) state is greater than the expected utility in the non-injured state. The converse holds for $\delta > 0$.

5 Concluding Comments

The main insight of this paper is that the uncertainties associated with work income and real compensation as well as the extent of risk aversion play a major role in determining the appropriate 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 lump-sum 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 lump-sum compensation.

[20] The distribution of the optimal compensation, $A_o z$, is $\Lambda\left[\ln M + (S-1)\delta - \frac{1}{2}s^2, s^2\right]$, which has the mean $Me^{(S-1)\delta}$ and the median $Me^{(S-1)\delta - s^2/2}$. The tax rate increases with $(S-1)\delta$ while, as in the make-whole compensation case, an individual's expected utility decreases with ϕ, σ^2, and s^2.

We model real-compensation uncertainty as emanating solely from the uncertainty associated with the 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.[21]

Moreover, the injured person faces another major source of real-compensation uncertainty, which we have not incorporated into the model. This is the possibility that the court will incorrectly estimate the injured person's work income parameters. 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, a major reason 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.[22]

Indeed, even scholars who believe that court awards are predictable, find that the unexplained component of the variance of awards exceeds 50%.[23] Adding this source of uncertainty is equivalent to magnifying real-compensation uncertainty.

In view of the above considerations, it is reasonable to conclude that, generally, real-compensation uncertainty exceeds work-income uncertainty. The implication is that, for typically risk-averse individuals (whose relative risk aversion exceeds unity), both the make-whole compensation and the optimal compensation exceed mean (and therefore also of median) work income. A further implication is that the make-whole compensation exceeds the optimal compensation, and hence that the make-whole compensation makes the victim

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

[22] There is an ongoing discussion in the literature concerning the variance in awards. Some scholars 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).

[23] See Osborne (1999).

better off than does the optimal compensation.

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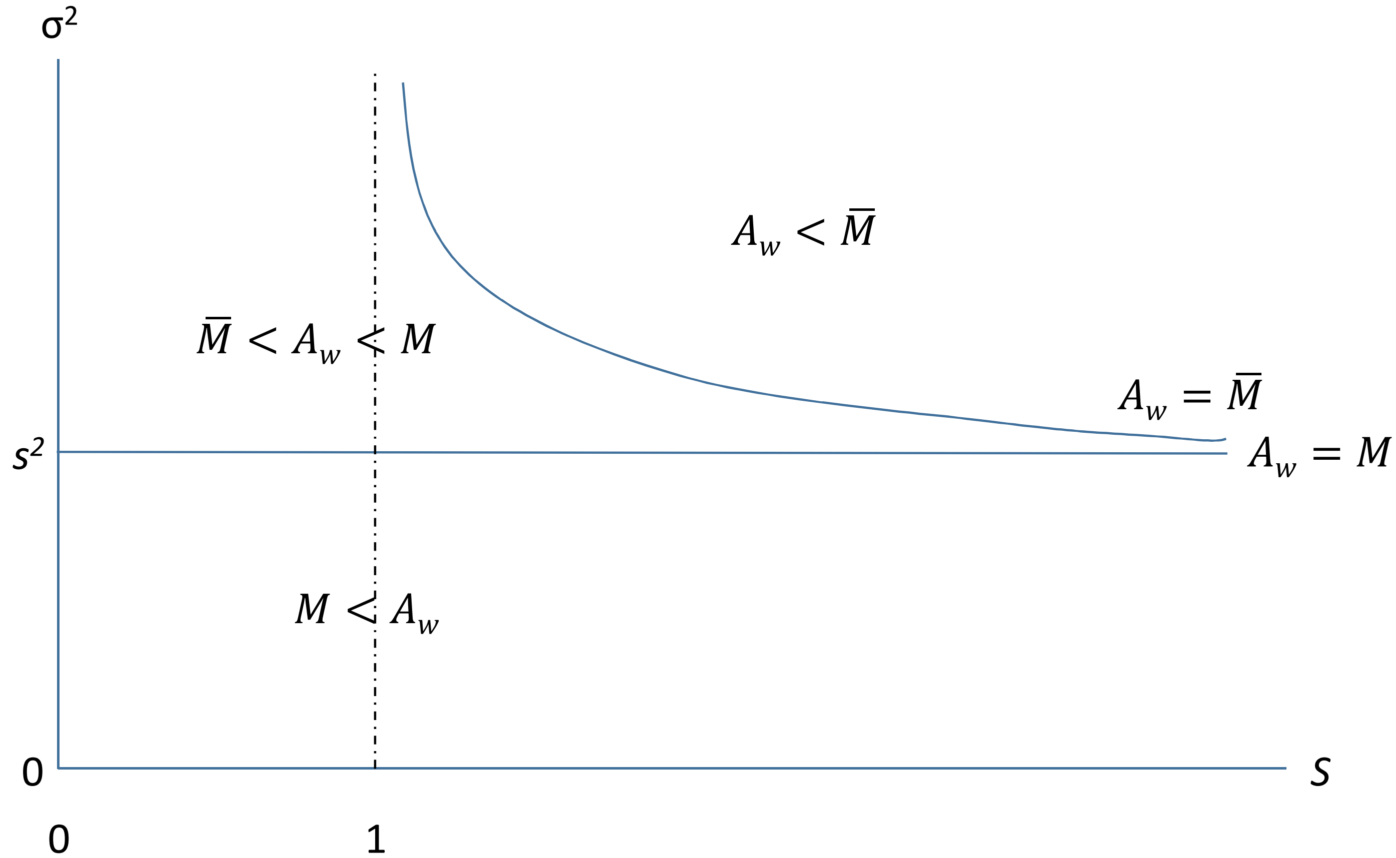
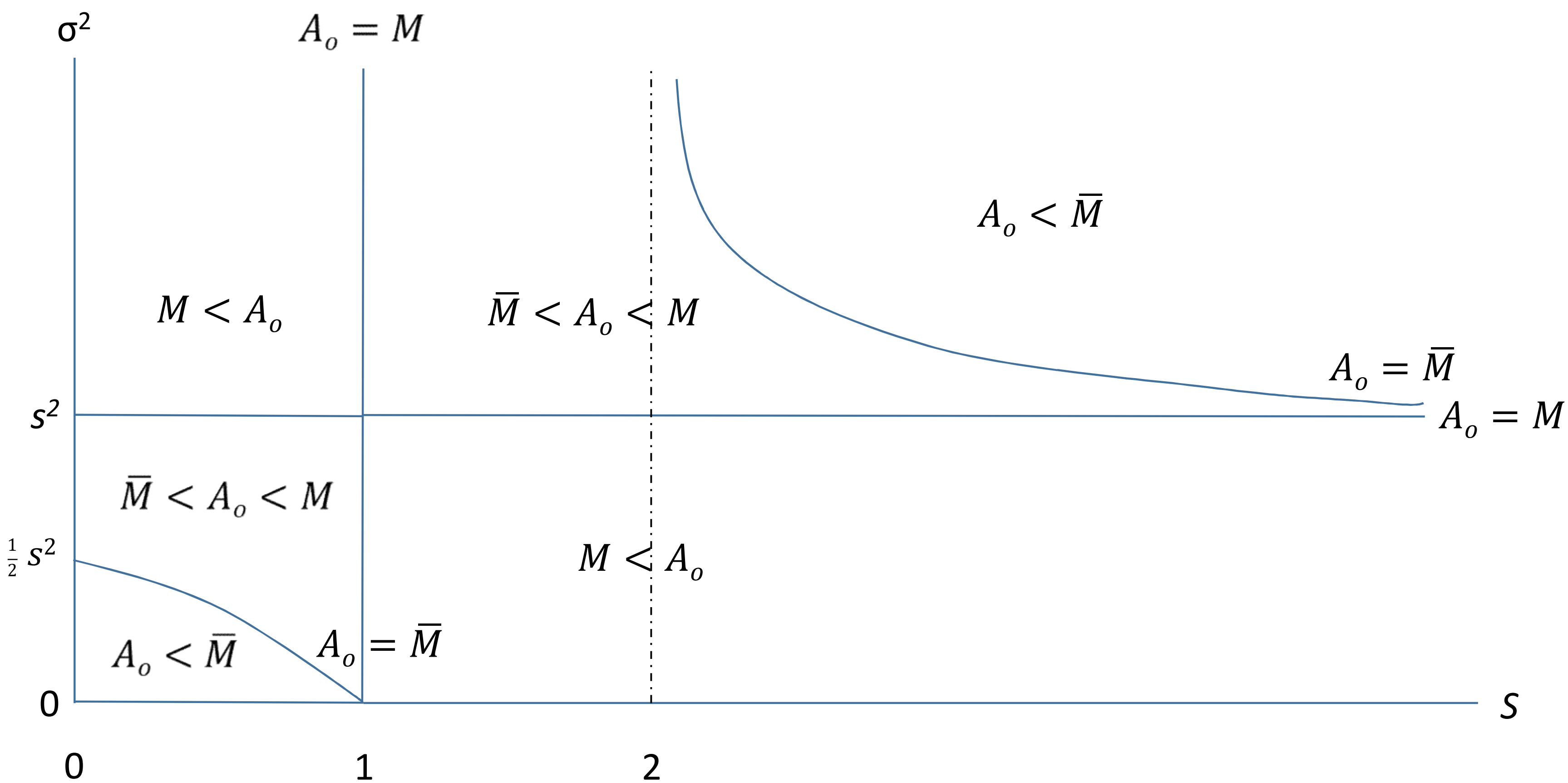


Figure 1



σ2
$A_o = M$
$A_o < \bar{M}$
$M < A_o$
$\bar{M} < A_o < M$
$A_o = \bar{M}$
s^2
$A_o = M$
$\bar{M} < A_o < M$
$\frac{1}{2} s^2$
$M < A_o$
$A_o < \bar{M}$
$A_o = \bar{M}$
0
S
0
1
2

Figure 2

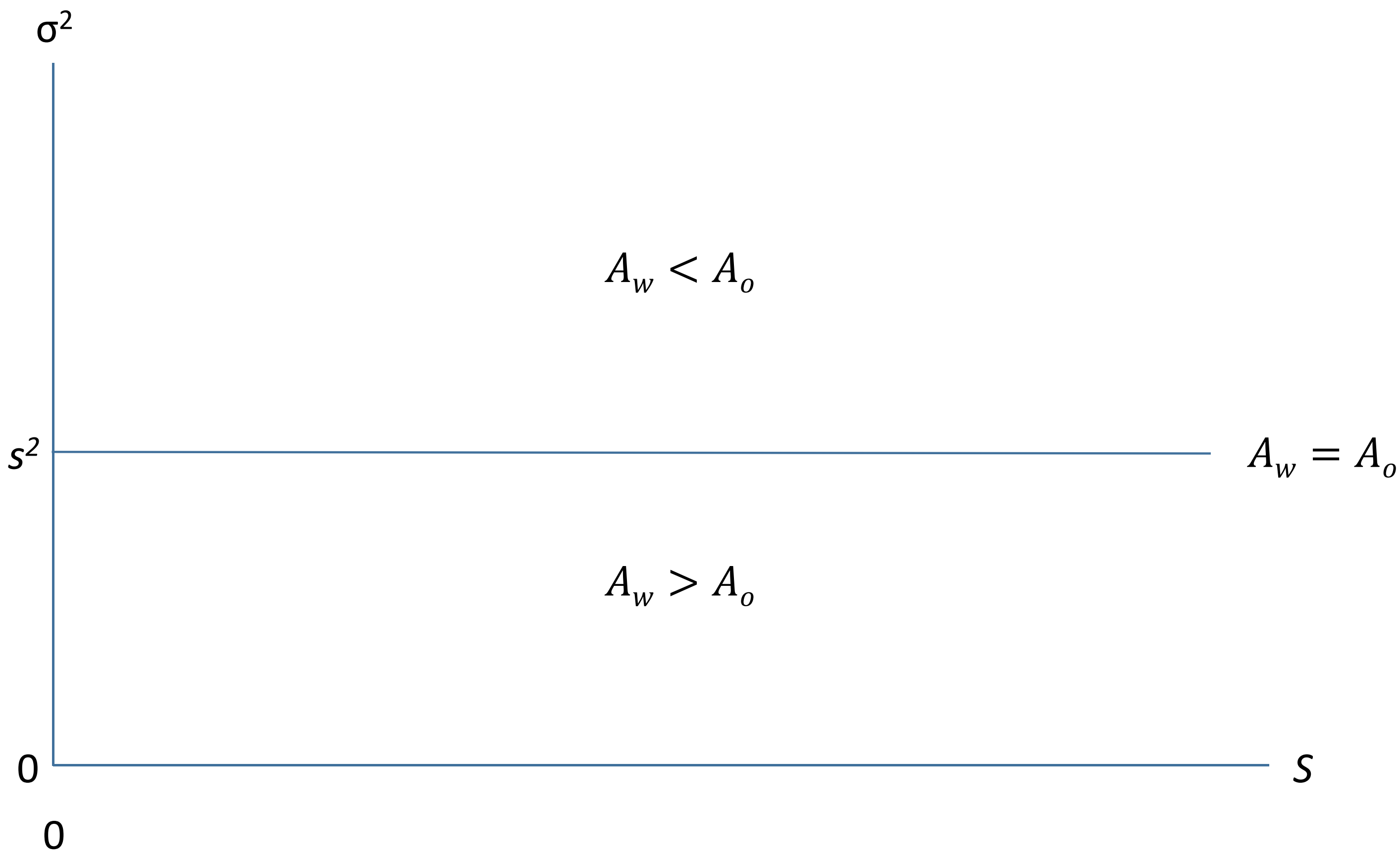


Figure 3