Full Coverage for Minor, Recurrent Losses?

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Abstract. This note looks at insurance of minor, recurrent losses. The main concern is with efficiency properties of full coverage. As motivation and running example we concider a regime, currently operative in several European countries, that offers employees complete wage reimbursement during short spell sickness. Assembled here are some arguments speaking against this sort of insurance policy.

Key words: risk sharing, coinsurance, deductible, non-insurable risk, Pareto efficiency, mutual insurance, arbitrage, adverse selection, moral hazard.

1. Introduction

Suppose your bicycle repeatedly is stolen and never recovered. To protect yourself against that recurrent and notable, yet minor loss, you might arrange ex ante for complete indemnity. Indeed, full theft insurance is available in some bicycle shops. Should you reasonably buy it?

Similarly, a flue might occasionally constrain you to stay briefly away from work. Should you - or your employer or society at large - then have secured you *full* reimbursement of the resulting wage loss? Such insurance were indeed provided in the former Soviet Union, and it remains a part of social security in several European countries (including Denmark, Germany and Norway[1]). Clearly, so extreme a policy affects supply, demand and productivity of labor - as well as incentives.

In these and similar cases there are ample reasons to inquire about insurance, its appropriateness and impacts. In particular, *what does full coverage indicate about the so-called loading factor on the premium? How does such a policy fare in terms of risk sharing? Why is there no coinsurance? What does insisting on no deductible imply in terms of risk aversion? Will the policy provide efficient mutual insurance? Are worries about hazard well accounted for?*

Concerning these and other questions I assemble some observations, each casting doubts on the efficiency of full insurance. The arguments are simple, but ought not be overlooked. Few of the results collected below are original. Most are well known, but scattered in the literature. Therefore a main motive for this note is simply to assemble them.

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[1] The Norwegian regime as of Jan. 21, 2002 gives the employee the right to be absent 8 consequtive days from work, maintaining full wage, without a doctor's certification of illness. Such absence can accumulate to 24 days a year.

2. Is Full Coverage Reasonable?

How will a risk averse agent behave when offered full insurance? Mossin (1968) already addressed that issue:

Proposition 1. (On purchase of full insurance)
(i) *If the agent is strictly risk averse, he is willing to pay more than the actuarial value of full insurance.*
(ii) *If moreover, his absolute risk aversion decreases, his willingness to pay decreases as he becomes more wealthy.*
(iii) *However, only if the loading factor on the insurance premium is* ≤ 0, *will he purchase full cover.*

Concerning (i), it appears safe to assume typical agents strictly risk averse regarding even minor economic losses. One may expect them to demand some insurance, albeit not full coverage, and maybe less as they become better off. Concerning (ii) and (iii), the fact that unions of workers - whose members have become more prosperous - insist on complete reimbursement of minor wage losses suggests presence of subsidies.

3. Is the Risk Sharing Efficient?

In general it seems prudent that contracting parties agree on *efficient* arrangements. Efficiency here simply means that they underwrite a treaty which leaves no room for improving the lot of one party without inflicting losses on the other.

In our context suppose an insurance policy is agreed upon which stipulates indemnity $I(x)$ to be paid by the employer to the employee in case of wage loss x. The first party (the employer) has wealth W, utility function $U(\cdot)$, and receives a premium π from the second who holds wealth w and utility function $u(\cdot)$. For good and obvious reasons I tacitly assume that $0 \leq I(x) \leq x$ - and that any utility function be smooth and strictly monotone. Suppose moreover that $U''(\cdot)$ and $u''(\cdot) < 0$. This last assumption is reasonable: It simply says that both parties are strictly risk averse (although maybe moderately so). Efficiency then entails existence of a positive constant μ such that, modulo that number, marginal utilities are equal:

$$U'(W + \pi - I(x)) = \mu u'(w - \pi - x + I(x)) \text{ for all } x. \tag{1}$$

Proposition 2. (Risk sharing and coinsurance [15].[2]) *It follows from (1) that* $0 < I'(x) < 1$ *Thus concerns with efficiency imply some degree and form of* ***coinsurance****.* □

Full cover for short spell sickness (henceforth SSS) is certainly not up to that standard. But $I(x) = x$ becomes, of course, explicable by assigning no welfare weight to the employer. Absent dictatorial power to the proletariat, such rulings are hardly defendable.

[2] One could posit, quite reasonably, that *no loss yields no indemnity*, i.e. $I(0) = 0$, to have $\mu = U'(W + \pi)/u'(w - \pi)$.

Proposition 2 advocates that partial self-insurance had better be built into a good policy. Specifically, it seems reasonable that the insured agent fully covers a first, lower part of the risk. He would then hold a cap-loss policy of the type $I(x) = \max\{x - D, 0\}$ where $D > 0$ is a so-called *deductible*. A problem appears here though: The cap-loss format violates the above result $0 < I'(x) < 1$. Operating expenses change the picture, however. As seen next, they will set things right:

4. SHOULD THERE BE A DEDUCTIBLE?

Some existing insurance policies for SSS offer full coverage, no coinsurance, and no deductible. Can such policies reasonably be justified? What attitudes do they display? Arrow [1] proved the following

Proposition 3. (Coverage only above a deductible) *If any insurance policy is available at a premium which depends merely on its actuarial value, then it becomes optimal for a risk-averse buyer to secure himself cover - and in fact, full cover - of own loss only above a deductible minimum.* □

Thus the agent takes full self-insurance up to a *deductible* D.[3] Drèze [6] related D to the so-called *loading factor* $l > 0$ and to the agent's *relative risk aversion* R. His analysis provided the following bound and insights:[4]

Proposition 4. (Bounds on relative risk aversion) *Consider a risk-averse agent with smooth concave utility function $u(\cdot)$ and wealth w, who faces risk X, and who can get cap-loss indemnity $I(X) := \max\{X - D, 0\}$ at a premium $\pi = \pi(EI) = \pi(D)$ which depends only on the actuarial value $EI(X)$. Let the threshold $Y := w - \pi - D$ denote his income after deduction D. Then the relative risk aversion $R(Y)$ is bounded below at the said threshold income Y as follows:*

$$R(Y) := -\frac{Yu''(Y)}{u'(Y)} \geq \frac{l}{1+l}\frac{Y}{D}.$$

Equivalently, in terms of the relative risk tolerance $T(Y) := 1/R(Y)$ it holds that

$$T(Y) \leq \frac{1+l}{l}\frac{D}{Y}.$$

[3] Related studies include [6], [9], [10], [8], [17], [18], [21]

[4] Relative to the threshold income $Y := w - \pi - D$ Dreze used the approximation

$$u'(w - \pi - x) \approx u'(Y) - (x - D)u''(Y)$$

for the domain $x \leq D$. Closer inspection reveals that the inequality

$$u'(w - \pi - x) \geq u'(Y) - (x - D)u''(Y)$$

suffices in that domain. But the last inequality is satisfied automatically for a concave smooth $u(\cdot)$.

Consequently, a choice $D = 0$ would reflect infinite relative risk aversion - or equivalently, zero risk tolerance - on the part of the buyer. □

I conclude: *Full wage reimbursement during SSS reflects that workers are* ***infinitely risk averse****. Equivalently, they have* ***no risk tolerance*** *whatsoever when it comes to wage loss of short duration.*

Such attitudes appear neither reasonable nor plausible. Full cover can hardly be justified by commonly observed risk attitudes. Could it be then, that suitable justification comes in terms of other non-insurable risk? I doubt it. Nonetheless, I shall pursue that argument next.

5. Should The Value of Leisure be insured?

Given the prevalence of insurance loading ($l > 0$), and the fact that insurance typically generates administrative costs, why do we still observe contracts with complete cover?

Doherty and Schlesinger (1983) found that presence of a supplementary, *non-insurable risk* might induce risk-averse agents to arrange for full indemnity even at an actuarially unfair tariff. Intuitively, this result hinges upon a positive association between two types of risks: one insurable, the other non-insurable.

A standard example comes with an employer who may loose more than his (presumably insurable) opportunity cost when sick and absent. The productivity of his employees is then likely to be lower, and that loss can hardly be covered by insurance.[5]

Now, what about similar short-term absence among employees? *Besides the insured risk, do they face other positively correlated, non-insurable risks that could justify full cover of the insurable one?*

As said, the basic insurable risk is here the worker's wage loss, stemming from short-duration sickness (and resulting absence from paid work). Such sickness comes in diverse degrees of severity, however, ranging from light indisposure to full work-inability. If the agent is only mildly hit, his value of attending leisure remains positive. The worker is thus, in principle and reality, exposed to a composed, two-stage risk: *First*, he may fall sick and thereby, if absent from work without insurance, loose his salary. *Second*, during work absence his illness may block desirable, alternative activities and affect the value of his leisure.[6]

To formalize the situation, suppose a worker enjoys smooth, strictly increasing, strictly concave utility $u(r)$ of his monetary revenue r. When working, he receives daily wage w. He faces a risk of short-term sickness (S for sickness) causing income loss

$$X := \begin{cases} x > 0 & \text{with probability } p_S > 0 \\ 0 & \text{with probability } 1 - p_S. \end{cases}$$

The part $I(X) \in [0, X]$ of that loss can be recompensed via insurance, available at premium $\pi = (1 + l)p_S$ per unit covered. As above, l is the *loading factor*. It usually

[5] This simple observation prompts an immediate question: Why are employers not offered insurance for SSS?

[6] For example, he can read, clean his car, or do some house work.

is positive and reflects the costs of the insurance provider.

Leisure tends to have positive monetary value. However, when a worker is forced by accidental illness to stay briefly away from paid work, most likely his value of leisure is less than usual. One can hardly exclude though that occasionally, in some situations, a positive benefit accrues to the unfortunate, sick worker. That benefit may then be seen as a partial recompense for bad luck. I shall model this feature by introducing uncertainty about the economic value $\mathcal{L}$ of leisure as perceived during sickness and/or absence from paid work. Specifically, let

$$\mathcal{L} := \begin{cases} L > 0 & \text{with probability } p_L > 0 \\ 0 & \text{with probability } 1 - p_L. \end{cases}$$

The risk (lottery) $\mathcal{L}$ is here seen as non-insurable. I naturally posit that $w > L$. As usual, rational purchase of insurance assumes the form of optimization:

$$\text{maximize } Eu(w - \pi I - X + \mathcal{L} + I(X)) \text{ subject to } I(X) \in [0, X] .$$

Four scenarios must be kept in mind here. These correspond to which - or how many - risks have materialized. Their nature and probabilities are spelled out in the following table:

scen $(X, \mathcal{L})$	**wage without insur.**	**wage with insur.**	**probability**
$1 : (0, 0)$	w	$w - \pi I$	$1 - p_S - p_L + p_S p_{L\|S}$
$2 : (x, 0)$	$w - x$	$w - \pi I - x + I$	$p_S(1 - p_{L\|S})$
$3 : (0, L)$	w	$w - \pi I$	$p_L - p_S p_{L\|S}$
$4 : (x, L)$	$w - x + L$	$w - \pi I - x + L + I$	$p_S p_{L\|S}$

For simplicity let p_s, u_s, u'_s denote the probability, the utility, and the marginal utility, respectively in state (or scenario) $s = 1, \ldots, 4$. To find a most desirable indemnity schedule $I(\cdot)$ amounts a priori to

$$\text{maximize } Eu = p_1 u_1 + \cdots + p_4 u_4 \ \text{ with respect to } \ I(X) \in [0, X] .$$

For the argument assume that full cover $I = x$ is optimal. One may then argue that[7]

$$(1 + l) \le \frac{(1 - p_{L|S})u'_2 + p_{L|S}u'_4}{(1 - p_S p_{L|S})u'_2 + p_4 u'_4} \text{ when } I = S. \tag{2}$$

[7] For completeness the argument, also found in Henriet & Rochet (1991) is reproduced here: Since the objective is concave, full cover is optimal iff $\frac{\partial}{\partial I} Eu\,|_{I=x} \ge 0$, that is, iff

$$-p_1 u'_1 \pi + p_2 u'_2 (1 - \pi) - p_3 u'_3 \pi + p_4 u'_4 (1 - \pi) \ge 0 \text{ when } I = x.$$

$I = x$ yields $u'_1 = u'_2 = u'_3$. Therefore the preceding inequality amounts to

$$\left[-(1 - p_S p_{L|S})\pi + p_2\right] u'_2 + p_4 u'_4 (1 - \pi) \ge 0 \text{ when } I = x,$$

which can be reformulated as

$$\pi \le \frac{p_2 u'_2 + p_4 u'_4}{(1 - p_S p_{L|S})u'_2 + p_4 u'_4} \text{ when } I = x,$$

or equivalently as (2).

Note that $u_2' > u_4'$ and $p_{L|S} > p_4$. Therefore (2) implies $l < 0$ whence

Proposition 5. (Partial insurance of SSS). *Suppose SSS occasionally provides a positive monetary value of associated leisure; that is, suppose $p_{L|S} > 0$ with $L > 0$. Then the loading l of insurance premium must be negative to justify full cover for short-term sickness.*[8] □

Proposition 5 indicates (together with Proposition 1) that employees, or their unions, regard SSS insurance as subsidized by the public sector - or, if not, it ought be so.

I conclude on the coupling between work and leisure by mentioning a fairly extreme case. Suppose someone - say, a young man - enjoys so robust and perfect health that his risk of SSS is negligible during a specified period. Suppose also that the same person then faces great uncertainty (or simply large variability) in the monetary value $\mathcal{L}$ of his leisure. Being guaranteed take-home wage w he obtains on the average $Eu(\max\{w, \mathcal{L}\})$. Thus, while intending to insure his labor income, one has in fact insured the value of his leisure. Admittedly this is a peculiar arrangement and hardly justifiable. To reinforce the absurdity, suppose the person at hand is risk neutral with respect to income. He then obtains a payoff (or utility) $\max\{w, \mathcal{L}\}$ which is *convex* in $\mathcal{L}$. For that reason he would be willing to pay for increased uncertainty. A fortiori, he would hesitate in joining a mutual insurance company. Other workers, of more common sort, might want to join. Why and how?

6. Does Constant Coverage fit Mutual Insurance?

Many workers are members of a productive cooperative. (Others could, at least ideologically, be conceived of as such.) Random fluctuations in factor availability (including labor) are then problematic for their joint enterprise. For mitigation the members could pool their resources. Pooling must be generated and upheld by compensations (side payments). For its viability the underlying scheme had better be efficient, incentive compatible, and "equitable". To serve these ends cooperative game theory advocates that a so-called *core solution* be implemented. Such a solution amounts to specify individual compensations that induce overall efficiency and encourage no party to protest.

Now, in mutual insurance, what determines a core solution? In essence only two things: first, the aggregate (pooled) risk; and second, the "aggregate", "representative" (pooled or convoluted) preference; see [2], [3], [12], [14]. Broadly speaking, the worker (or employer) who with relative ease can assume risk will do so and thereby be compensated. *If the pool members differ in risks and attitudes, their sharing will neither be uniform nor egalitarian.* And most important: *if some risk still remains in the aggregate, it will not be eliminated at the individual level.*

I conclude that an insurance policy for SSS which offers the same, stable indemnity to everybody, irrespective of aggregate risk, violates one or more respectable

[8] Note that this claim did not presume any sort of correlation between the two risks. The reason is that increased value of leisure has no consequence when at work (scenario $s = 3$).

conditions: It is inefficient, or it leaves some group worse off than alone.

The first defect is worrisome, but concerning the last one might simply say: The purpose of social security is solidarity and assistance. Consequently, fortunate groups should not be allowed to defect. I have, of course, much sympathy for this objection. It appears however, somewhat misplaced here. Solidarity works best for *major risks*, little affected by moral hazard or adverse selection. Short spell sickness is, almost by definition, a *minor risk* - and certainly not immune to hidden action or information. Anyway, the issue of solidarity touches on how risks should be pooled. So let us consider that issue.

7. Pooling across Persons or Periods?

Insurance relies, both in theory and practice, on two chief results of probability theory, namely: the *law of large numbers* and the *central limit theorem* [11]. Crucial for the validity and applicability of these results is the independence (or quite weak association) of the intervening risks. Broadly speaking, independence (or weak correlation) ensures that aggregate risks are less variable than their constituent terms might indicate. Aggregation and averaging then applies to the entire pool of risk holders.

Probability theory points however, to another average, namely that taken over time. Under fairly weak conditions, called ergodicity - and apparently satisfied in the case of SSS - the two procedures are equivalent [22]:

Proposition 7. (Equivalence of population and time averages) *Consider a population that is homogenous with respect to productivity and SSS. Denote by* $\mathbb{S}$ *a finite but exhaustive set of possible states* s *regarding SSS. Suppose any agent, if today in state* $s \in \mathbb{S}$, *will tomorrow reach state* $s' \in \mathbb{S}$ *with positive probability* $p_{ss'}$. *Then there is a unique steady-state distribution over the population. It is described by the relative frequencies* π_s *of various states, as the only non-negative solution of*

$$\sum_{s \in \mathbb{S}} \pi_s p_{ss'} = \pi_{s'} \quad \text{for all} \quad s' \in \mathbb{S}, \sum_{s \in \mathbb{S}} \pi_s = 1.$$

For any state-dependent wage system w_s, $s \in \mathbb{S}$, *cum indemnity minus premium, and for any worker with state trajectory* $s(1), s(2), \ldots$ *it holds that the expectation equals the time average:*

$$Ew_{\bullet} := \sum_{s \in S} \pi_s w_s = \lim_{T \to +\infty} \frac{w_{s(1)} + \cdots + w_{s(T)}}{T}. \quad \square$$

This says result that, within a homogenous risk class the frequencies of diverse, relevant events *over the population* coincide with those of a representative risk *over time.* In other words: Cross sections and time averages are equal. Consequently, for small recurrent risks the agent can "pool with himself." He transfers thereby money from happy, sunny days to less amusing, rainy days. Instruments for doing so abound. They are usually grouped under the heading of precautionary savings.

8. Possibilities for Arbitrage?

As is well known, and increasingly visible, there are close connections between insurance and finance. Both fields provide instruments for reallocating wealth or claims across states and times. A fundamental concept in finance, simpler than the notion of equilibrium, is that of *arbitrage* [13]. This phenomenon refers to financial possibilities of making guaranteed pure profit. Clearly, no well-functioning financial market - and no viable institution - could offer such opportunities for extended periods. Bankruptcy would soon ensue somewhere.

The most simple instance of arbitrage involves merely two papers: one always yields lower net dividend than the other. If so, one had better sell the first paper and use the proceeds to buy the second. In financial jargon the advice is to take a short position in the first to finance a corresponding long position in the second.

Does this elementary recipe apply to full insurance for SSS? I think it does! One "paper" is to receive wage compensation for the disutility and effort that might go along with work. The alternative option is to receive the same wage, be relieved of work disutility and enjoy some leisure. If not subject to moral inhibition or social disapproval, the latter choice appears most attractive in any state of health. Consequently, some employees are likely to exploit such arbitrage opportunities to the full. When their behavior eventually becomes widely adopted, and maybe acquires the status of a tacit convention, deliberate absence will only be limited by imposed bounds. Competent workers become rational shirkers. We face a problem referred to as *moral hazard*.

9. Is Asymmetric Information accounted for?

Asymmetric information usually causes problems for efficient insurance. These stem from adverse selection or moral hazard. Problems of this type occur when unobservable properties or actions affect economic outcomes.[20] For our example, sometimes others cannot ascertain whether a worker shirks - or has pursued activities which rendered him temporarily less fit for work. Therefore, to induce care and effort the employer might reasonably apply tariffs that incorporate some degree of coinsurance. Clearly, full reimbursement for SSS is at glaring variance with such arrangements.

Generally, asymmetric information may justify use of personal policies, typically in the form of non-linear indemnity schedules. If so, workers will face a menu of SSS policies, among which they can choose. Two features then appear fairly robust: First, more comprehensive coverage comes at higher unitary premium; second, more coverage will be demanded by riskier agents. Again: full, egalitarian, and uniform reimbursement for SSS is markedly at odds with a composite menu.

The severity of asymmetric information is, of course, an empirical issue. While contract theory has developed at rapid pace, it still comprises fairly few empirical studies. As pointed out by Chiappori [4], asymmetric information implies positive correlation between two conditional distributions. It seems therefore interesting to relate SSS to weather, holidays, or jours de fetes. In short, there should be ample possibilities of empirical work.

10. Concluding Remarks

Insurance of minor, recurrent losses (such as SSS) must be seen and evaluated from *three* viewpoints. First, risk - when seen as a commodity, to be allocated over time and contingencies - has some aspects of a private commodity. Second, there are contractual arrangements worthy of investigation as such. Third, one cannot avoid questions about equity and solidarity. I shall conclude by brief elaboration of each of these three aspects.

First, an insurance policy, in offering contingent indemnities, may fit the Arrow-Debreu general notion of a private commodity traded in competitive equilibrium. Just like financial assets the underlying treaty transfers wealth across time and states. To the extent this view point is fitting, it indicates that agents exposed to small, infrequent, recurrent risks can tackle the related inconveniencies by precautionary savings. The ergodic nature of the underlying phenomenon tells that time averages serve the same purpose as population averages. In extremis, this speaks for self-insurance. The problems with asymmetric information and incentives then become less pressing.

Second, insurance treaties are *contracts*, written under *asymmetrical information* and suffering from incompleteness. Therefore their design and implementation remains a challenge and potentially, a source of dispute. Since insurance generally is beset with *moral hazard* (hidden action) and *adverse selection* (hidden type), this last view seems most appropriate. The Arrow-Debreu optic simply ignores these crucial features. So, whether in theory or practice, the specific design of SSS insurance had better rely on insights offered by *information economics* and *theories of contracts.* Those insights all stress the importance of risk sharing or coinsurance. I have indicated here above that on major accounts full coverage falls significantly short of reasonable requirements.

Third, whether by intention or not, SSS insurance redistributes income across various groups and risks. In that capacity it qualifies as an object of scrutiny for theories of social justice. Those theories apply at best though, to risks that affect major faculties and options [19]. It seems far from clear that short-spell work incapacity - say, during a day or two - falls directly into such categories. At least one might beg leave to doubt it.

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