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Insuring Replaceable Possessions

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Equivalencebetween insuring income and what is bought with income is commonly assumed. It seems to be implicitly held that uninsured but replaceable goods will always be replaced if they fail. This does not follow. People may have difficulty coming up with the money to pay for a replacement out of pocket. Also, the income effect of a loss may mean that replacement is not worthwhile. We show that as a result, equivalence breaks down. Both theory and evidence are provided. Implications include a tendency of empirical papers to overestimate risk aversion, a reason why demand for insurance increases with income, and the mistaken attribution of preference inconsistency.

INTRODUCTION

Two of the goods bought by a consumer cost $1000, and have the same probability of failing, but can be replaced easily at an unchanged price. The consumer may lose $1000 of income with the same probability. Insurance cover for each contingency is available. If a loss occurs, then the policies all pay $1000. Would a rational individual have the same willingness to pay (WTP) to insure each of these losses? The standard view, implied for example in Cook and Graham (1977), is that all these policies are of equal value. This paper shows that this need not be the case. Some evidence is provided, and the consequences for various insurance puzzles and for empirical work that does assume equivalence are discussed.

Although most insurance policies concern the insurance of possessions, the theory of insurance demand, as surveyed comprehensively by Schlesinger (2013), almost entirely concerns the loss of income or wealth. It seems to be assumed implicitly that when an uninsured possession is lost or breaks, it will definitely be replaced. Spending on other goods is therefore lowered by the market price of the replacement, hence the equivalence to income loss. The false step is that failed goods will necessarily be replaced if not insured. There are various reasons why a replacement is not bought. Most obviously, the money to do so is not there. Lusardi *et al*. (2011) find that nearly half of Americans would have difficulty in meeting an unexpected payment of $2000 in 30 days, whether through borrowing, working longer or selling possessions. There is a second, more subtle, reason for the non-equivalence of income and possession insurance. The loss of a good means that real income is lower than when it was bought. If the good is normal and uninsured, then it may not be optimal to replace it even in the absence of borrowing constraints or saving costs.

The best alternative to insurance may therefore be no or delayed replacement. One implication is that the more surplus a good delivers, the greater the loss if it fails, so the higher is the WTP to insure it. This property is ruled out by equivalence.[1] Another implication is that WTP to insure high surplus goods may exceed WTP to insure an income loss equal to replacement cost.[2]

To obtain some evidence on whether high surplus breakables/losables are more likely to be insured, a survey was undertaken. A questionnaire was sent to all 300 non-students on the participant database of the LSE Behavioural Lab. The pay for completing the survey was £5, and the response rate was 76%. Below are the two key questions and the results (in parentheses).

Your friend goes on a shopping trip for an iPad and a TV. They both cost £300. She values the iPad at £380 (that is, if she couldn't get it any cheaper she would pay this much for it) and the TV at £330. She thinks that these items are equally likely to break down. An extended warranty (3 years) is available for each at £85. If she could only buy a warranty for one of these items, do you think she would

- Buy a warranty for the iPad (64%)
- Buy a warranty for the TV (11%)
- Equally likely to buy a warranty for the iPad or for the TV (25%)

Now suppose the iPad warranty costs £100 and the TV warranty costs £85. If she could only buy a warranty for one of these items, do you think she would

- Buy a warranty for the iPad (49%)
- Buy a warranty for the TV (22%)
- Equally likely to buy a warranty for the iPad or for the TV (28%)

As both items have the same cost and breakdown probability, at equal premium, as in the first question, the conventional approach implies that respondents should have the same WTP and therefore be indifferent as to which item would be selected to be insured. In fact, the more valued item was selected by a majority of the respondents. In the second question, the premium on the less valued item is reduced, making it the dominant choice according to the standard analysis. Some subjects do switch from insuring the iPad, but it is still chosen for insurance by more than twice as many as the TV. Even for replaceable items, it is not just price and risk that matter, but also surplus. It is hard to see why respondents favour the iPad other than thinking that they may be unwilling or unable to replace an item, in which case this is the best one to keep. Regret may also be greater if the iPad is lost, but this emotion arises only because the surplus is greater.

Section I adapts the basic model of income and wealth insurance to handle the loss of possessions. A brief extension to multiple risky goods follows in Section II (and the Appendix). Insuring repair cost rather than outright loss is covered in Section III. The consequences for insurance of the option of saving commencing when an item fails is analysed in Section IV. Implications for the measurement of risk aversion, choice inconsistencies and how willingness to insure varies with income comprise Section V (with some evidence in the Appendix). Finally, Section VI is a brief discussion of some remaining issues.

I. Illustrative Models

The canonical static model of insurance assumes uncertain wealth with an opportunity to buy insurance presented before the risk is resolved. Once wealth is known, goods and services are bought and they never fail. Lower wealth is accommodated by (normally) dropping low-surplus indivisible items and buying fewer divisible goods. This gives rise to a concave utility of wealth function and hence to the willingness of an expected utility maximizer to buy actuarially fair wealth insurance.

There are a variety of ways in which this model can be adapted to accommodate the failure or loss of possessions and whether to insure this risk. We assume two types of good. For simplicity, we assume a single indivisible breakable good, B, costing 1. If it functions, it yields benefit B. With a functioning breakable good, utility is $U = B + g(S)$, and otherwise it is $U = g(S)$, where S is spending on the divisible goods, and $g(S) > 0$, $g'(S) > 0$ and $g''(S) \leq 0$. The utility of spending on non-breakables is assumed differentiable for analytical convenience. An additive utility function is restrictive but intuitive and identifies possibilities as simply as possible. At the outset, wealth is $W + 1$. The breakable fails with probability

$1-\pi$, in which case it can be replaced once with the replacement as likely to fail as the original.[3]

The key to analysing WTP for possession insurance is identifying the best choice if B is not insured. Not replacing B is always an option. Another is replacement by means of wealth that has been set aside for the purpose. The first model assumes that such precautionary saving is the best way to replace an uninsured item. In this case, equivalence almost never applies. The second model analyses the implications of borrowing being the best way to replace when the good is not insured. Even when there are no credit market impediments, equivalence does not always apply. In both cases, it is evaluated how WTP to insure the breakable varies with B and so with consumer surplus, and how it compares with WTP to insure the risk of wealth falling by 1.

Replacement via precautionary saving

Simultaneous purchase of B and other goods is a natural specification. The important implication is that if B is not insured, then financing an immediate replacement requires that either savings have been made or borrowing is undertaken.[4] Both avenues are costly. Precautionary saving entails foregone consumption even if a replacement is not needed.[5] Emergency borrowing may be expensive as a result of asymmetric information, or even unavailable. If a good is uninsured, then the best choice may be not to replace it because of the difficulty in financing it at the time of failure. The value of insurance therefore depends on the surplus contributed by a replaceable item, not just on the cost of replacement, and now potentially exceeds WTP for income insurance.

The timeline is that a consumer with known wealth $W+1$ first chooses what to buy. If the breakable B is purchased, then at the same time it must be decided whether to buy market insurance or self-insure by leaving a unit of income unspent. It is then discovered whether good B has failed.[6] If it has, then it is replaced only if market insurance or self-insurance was chosen. Finally, consumption occurs.

The budget constraint is

$$W+1=I_B+IP+Q+s,$$

where I_B is an indicator variable equal to 1 if indivisible good B is bought, I is an indicator variable equal to 1 if market insurance is purchased for good B at premium P, and s is an indicator variable equal to 1 if a unit of precautionary saving is made.[7] The quantity bought of the divisible good is Q. If B is bought and savings have been set aside to replace it but they are not needed because B did not fail, then utility is

$$U_S=B+g(W-\alpha).$$

In this formulation, unspent savings may not be valueless as $0\le\alpha\le 1$. Leftover savings may be used as a legacy, or be of some use if carried forward to future periods. If $\alpha=0$, then unused precautionary saving is just as valuable as consumption, in which case insurance has no value; and if $\alpha=1$, then unused precautionary saving is completely wasted.[8]Provisionally assume that α is sufficiently high and B is sufficiently low that the best alternative to insurance is non-replacement of B rather than replacement by means of precautionary saving. WTP for insurance must then satisfy

$$g(W-P_S^*)=g(W)-(1-\pi)\pi B. \tag{1}$$

At the threshold B_S^* at which replacement through precautionary saving and not replacing are equally attractive, we have

$$\pi(1+(1-\pi))B_S^* + \pi\, g(W-\alpha) + (1-\pi)\, g(W-1) = \pi B_S^* + g(W).$$

Hence the threshold B below which B is not replaced when uninsured, and therefore equation (1) applies, is

$$B_S^* = \frac{g(W) - \pi g(W-\alpha) - (1-\pi) g(W-1)}{\pi(1-\pi)}. \tag{2}$$

Whether breakage insurance pays cash 1 or provides a replacement, if $B < B_S^*$, the highest premium payable, $P_S^*(B)$, satisfies[9]

$$\pi[1+(1-\pi)]B + g(W-P_S^*) = \pi[B+g(W)] + (1-\pi)g(W),$$

or, rearranging,

$$g(W-P_S^*) = g(W) - (1-\pi)\pi B. \tag{3}$$

It must be checked that the condition for non-equivalence, $B < B_S^*$, is consistent with B being bought initially. This follows from concavity of $g(\cdot)$.[10]

Looking to comparative statics, equation (3) gives

$$\frac{\mathrm{d}P_S^*}{\mathrm{d}B} = \frac{(1-\pi)\pi}{g'(W-P_S^*)} > 0, \tag{4}$$

$$\frac{\mathrm{d}P_S^*}{\mathrm{d}W} = \frac{g'(W-P_F^*) - g'(W)}{g'(W-P_S^*)} > 0. \tag{5}$$

When $B < B_S^*$, WTP to insure the breakable increases in surplus and in wealth.

Turning to the insurance of financial wealth, assume that there is no chance of breakage. The only risk is the loss of financial wealth. Determination of WTP for wealth insurance is then standard. Wealth is $W+1$ with probability π, and W otherwise. Insurance is chosen before income is known, but goods are bought after uncertainty is resolved. If $B > g(W) - g(W-1)$, then B is bought even when wealth is low. The highest premium that would be paid by an expected utility maximizer, Z^*, therefore satisfies

$$g(W-Z^*) + B = \pi g(W) + (1-\pi)g(W-1) + B. \tag{6}$$

To determine how P_S^* compares to Z^*, from equations (3) and (6) we have

$$g(W) - g(W-1) = \pi B - \frac{g(W-Z^*) - g(W-P_S^*)}{1-\pi}. \tag{7}$$

According to equations (7) and (2), $Z^* = P_S^*$ if

$$B = \frac{g(W) - g(W-1)}{\pi} \le B_S^* = \frac{g(W) - \pi g(W-\alpha) - (1-\pi)g(W-1)}{\pi(1-\pi)}. \tag{8}$$

The implication of equation (8) is that depending on B, WTP to insure a possession may exceed or be exceeded by the WTP to insure financial wealth.

Proposition 1. If all goods are bought simultaneously and $\alpha > 0$, then there is an interval in which WTP to insure the breakable is increasing in the surplus it delivers. Above this interval, WTP is invariant to surplus. When surplus is low, WTP to insure a breakable is exceeded by the WTP for equivalent income insurance. When surplus is high, the reverse is true.

Figure 1 summarizes the relation between B and WTP. Only if the breakable is valued at $\hat{B}$ does $P_S^* = Z^*$ and thus equivalence holds.

To illustrate, let utility be $\log S$, $W = 3$ and $\pi = 0.95$. With a low cost of wasted precautionary saving of $\alpha = 0.1$, at $B = 0.34$, P_S^* equals the actuarially fair premium 0.05. When $B = 0.405$, $P_S^* = Z^* = 0.06$. The highest WTP of $\overline{P} = 0.15$ occurs at $B = 1.1$. The threshold B below which B is not bought without insurance is 0.303. So if $B \in (0.303, 0.34)$, B is bought but WTP to insure it is below the cost of provision. For $B \in (0.34, 0.405)$, P_S^* increases in B but is below Z^*, while for $B \in (0.405, 1.1)$, $P_S^* > Z^*$. For $B > 1.1$, $P_S^* = 0.15$.

Replacement via borrowing

Replacing an uninsured breakable can also be accomplished by borrowing if available. This subsection shows in a simple model that even if unlimited, frictionless borrowing is possible, equivalence does not apply.

There are two periods. A payment of $W + 1$ is received in the second period, which can be borrowed against in the first period at a zero interest rate. In the first period, there is no payment but a breakable good B is available for purchase that yields utility B if it functions. In each period, utility from other goods is $g(S)$, where S is spending on them in that period. First-period utility from B is added to utility from other goods in period 1, $g(S)$, to give total utility.

The timeline is that in the first period, it is decided whether to buy and insure B. Also, it is decided how much to spend on other goods. If B fails, which it does with probability $1 - \pi$, then it can be replaced once, financed from either insurance or borrowing.

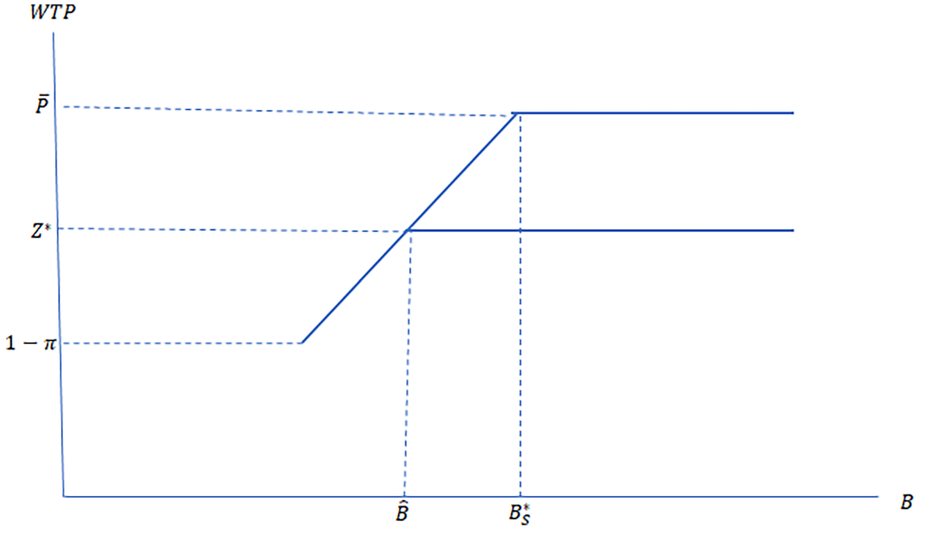

FIGURE 1. Relationship between B and WTP.

The structure of the argument is to show that when the best response to the failure of an uninsured breakable is not to replace it, WTP to insure it is increasing in B. This interval ends at B^*, where there is indifference whether or not to replace. At B^*, WTP to insure income and the breakable are the same.[11]Consequently, there is an interval in which WTP to insure B is increasing in B but below WTP to insure income.

More explicitly, as $g(\cdot)$ is concave, utility is additive and the interest rate is zero, if B is bought, not insured and not replaced in the event of failure, then consumption of non-breakables is equal in both periods. Expected utility is thus

$$E_N = \pi B + 2g(0.5W). \tag{9}$$

With non-replacement the best alternative to insurance, WTP to insure B satisfies

$$B\pi(1 + (1 - \pi)) + 2g\ (0.5(W - P)) = \pi B + 2g(0.5W),$$

with

$$\frac{\mathrm{d}P}{\mathrm{d}B} = \frac{\pi(1 - \pi)}{2g'\ (0.5(W - P))} > 0.$$

To determine B^*, if B is replaced when uninsured, then expected utility is

$$E_R = B\pi(1 + (1 - \pi)) + g(s_1) + \pi g(W - s_1) + (1 - \pi)g(W - 1 - s_1), \tag{10}$$

where s_1 is chosen to maximize E_R. At B^*, we have $E_N = E_R$, so WTP to insure B satisfies

$$\begin{aligned} &B^*\pi(1 + (1 - \pi)) + 2g\ (0.5(W - P)) \\ &= B^*\pi(1 + (1 - \pi)) + g(s_1) + \pi g(W - s_1) + (1 - \pi)g(W - 1 - s_1). \end{aligned}$$

From equations (9) and (10), $E_R - E_N$ is increasing in B, so when $B < B^*$, it is better not to replace a failed and uninsured B.

For comparison, suppose that B never fails but wealth may fall by 1 with probability $1 - \pi$. Then W is not determined until period 2. At B^*, WTP for wealth insurance Z satisfies

$$B^* + 2g\ (0.5(W - Z)) = B^* + g(s_1) + \pi g(W - s_1) + (1 - \pi)g(W - 1 - s_1).$$

Hence at B^*, we have $Z = P$.

Proposition 2. When borrowing is frictionless, there is an interval in which WTP to insure a breakable is increasing in the surplus that it delivers, and is below that for equivalent income insurance except at the upper limit where equivalence holds.

To illustrate, suppose that $g(S) = \log S$, $\pi = 0.95$ and $W = 3$. Then $B^* = 1.1$ and $P = Z = 0.078$, above the actuarially fair rate 0.05. At $B = 0.71$, $P = 0.05$, so there will certainly be no insurance at lower B, but even at this limit, the utility from buying and insuring B is 1.5, which exceeds that from non-purchase, 1.39.

In this section, although an uninsured possession that fails can be replaced via borrowing, the income effect may mean that the owner chooses not to replace it. As the loss of an inexpensive possession involves only a minor change in real income, this effect is unlikely to apply to such goods. However, the behavioural phenomenon of mental accounting (Thaler 1985), whereby spending is not fungible, may mean that even a cheap item may represent an appreciable fraction of the income allocated to its consumption category.

II. Many Unreliable Items

Which goods are protected by market insurance (or warranties) depends on their characteristics as well as the terms on which the insurance is offered. In particular, both insurance and precautionary saving may now be adopted. To illustrate, suppose that there are many breakable goods. If insurance is available on actuarially fair terms, then all goods will be insured. Now suppose that one of the goods can be insured only on quite unfair terms.[12]It may be preferable that precautionary saving is chosen to protect that good. As the saving may not be needed for the uninsured good, it may also be best that insurance is not purchased for one of the goods for which it is available on fair terms. The first subsection of the Appendix provides an example.

III. Repairs (Including Medical)

Consistently with our general theme, whether to take insurance to repair an item depends on the value placed on restoration as well as on its cost. Consider, for example, the repair of health. Although the initial level of health is reasonably regarded as endowed not bought, principles similar to the replacement analysis apply. Suppose that without treatment, a medical condition lowers the utility function from $U(W)$ to $U(W,\beta)$. In both states, utility is concave in initial wealth W. Here, β is a shift variable, with higher β representing more severe illness, so $U_\beta(W,\beta) < 0$. A treatment is available that completely cures the illness and costs M. An insurance contract is available that provides full cover.

The timeline is that illness occurs after goods are bought and medical insurance decided on. Without insurance, if the treatment is paid for out-of-pocket when ill, then sufficient precautionary savings must be available. If they are available but not needed, then utility is $U(W-\alpha M)$, and if there is no saving, then expected utility is $\pi\ U(W) + (1-\pi)\ U(W,\beta)$. In the absence of insurance, precautionary saving is not made and the treatment is not bought if

$$\pi U(W) + (1-\pi)U(W,\beta) > \pi U(W-\alpha M) + (1-\pi)U(W-M). \tag{11}$$

Whether this condition holds depends *inter alia* on how serious the illness is and the cost of treatment. As noted by de Meza (1983) and Nyman (1999), if $M > W$, then it is impossible to buy the treatment in the absence of insurance, and more generally, the income effects of insurance will increase demand for treatment independently of moral hazard. From now on, it will be assumed that the best alternative to insurance is not to be treated, that is, inequality (11) holds.

Now introduce insurance. As the treatment cures the condition, it is optimal that the contract covers the full cost of treatment, since then the marginal utility of non-medical spending is the same in both states. WTP for insurance satisfies

$$U(W-w(1-\pi)M) = \pi U(W) + (1-\pi)U(W,\beta), \tag{12}$$

where $w-1$ is the maximum loading factor that the individual is willing to pay, and

$$\frac{\mathrm{d}w}{\mathrm{d}\beta} = \frac{U_\beta(W,\beta)}{MU'(W-w\pi M)} > 0.$$

Given the cost, the more severe the illness, the higher WTP for insurance. The effect of wealth on WTP is

$$\frac{\mathrm{d}w}{\mathrm{d}W} = \frac{U'(W-\alpha\pi M) - \pi U'(W) - (1-\pi)U_W(W,\beta)}{(1-\pi)MU'(W-w\pi M)}. \tag{13}$$

From concavity, a sufficient but not necessary condition for $\mathrm{d}w/\mathrm{d}W$ to be signed positive is $U_{W\beta} \leq 0$.

The WTP for an equally probable income loss of M must satisfy

$$U(W - \gamma(1-\pi)M) = (1-\pi)U(W-M) + \pi U(W), \tag{14}$$

where $\gamma - 1$ is the maximum loading factor that the individual would pay. From equations (12) and (14),

$$U(W - w(1-\pi)M) - U(W - \gamma(1-\pi)M) = (1-\pi)[U(W,\beta) - U(W-M)].$$

Rather obviously, WTP to insure income exceeds that to insure health if loss of income has a greater impact than loss of health.

Note that as W increases, at some point inequality (11) ceases to hold and the relevant alternative to insurance is paying out of pocket. At the indifference level and for higher W, we have

$$U(W - w(1-\pi)M) = \pi U(W - \alpha M) + (1-\pi)U(W-M).$$

When wealth is above the threshold at which paying out of pocket is preferable to not being treated, the utility of not insuring is independent of B. Hence w is independent of W and B.

Proposition 3. WTP for medical insurance exceeds or is exceeded by WTP for income insurance depending on the utility loss from illness.

For example, if when well utility is $\log W$, and when ill it is $\log W - \beta$, then with $W = 3$, $\pi = 0.9$, $M = 2$ when $\beta = 1$, $w = 1.43$ and $\gamma = 1.56$. When $\beta = 1.2$, $w = 1.7$ and $\gamma = 1.56$.

IV. Ex Post Saving

In a dynamic setting, a broken but uninsured item can be replaced at some future time by reducing upcoming spending until a sufficient balance has been built up. It is disruptive to suddenly change consumption plans, so gradually adjusting consumption is optimal, but doing so delays repurchase of the failed good.[13] For relatively low-surplus breakables, *ex post* saving may be preferable to precautionary saving and to high-loading-factor insurance. As insurance allows immediate replacement, as in the earlier models, it is more valuable the higher is the surplus generated by the good. Hence WTP for insurance is again increasing in surplus, perhaps greatly so.

More formally, let instantaneous utility be $U_t = U(E_t, D) = u(E_t) + DK_t$, where E_t is spending on non-durables at t, and K_t an indicator variable that equals 1 if a working durable is owned, with D the utility flow yielded by ownership. The price of the durable is unity, the real interest rate is zero, and income is Y_t.

We join the story when the durable has failed and is to be replaced by saving at rate s. If $u(E_t)$ is concave, then it is best to save at a constant rate s until the purchase price is achieved. This requires a delay of T, where $s\int_0^T \mathrm{d}z = 1$, so $T = 1/s$. For simplicity, it is assumed that there is no chance that the replacement fails. The consumer has time horizon τ, so utility is

$$U = \int_0^{1/s} u(Y-s)\ \mathrm{d}t + \int_{1/s}^{\tau} (u(Y) + D)\ \mathrm{d}t,$$

which is to be maximized with respect to s. For example, suppose that $u = \ln z$, $\tau = 100$, $Y = 1$ and $D = 0.07$. Then the optimal value is $T = 3.3$. If D is lower at 0.04, then it is not so urgent to obtain the item and the optimal T rises to 4.2.

If insurance is held, then the durable can be replaced immediately, yielding utility

$$W = \int_0^{\tau} (u(Y) + D)\ \mathrm{d}t.$$

Making use of the envelope theorem, we have

$$\frac{\mathrm{d}(W - U)}{\mathrm{d}D} = \frac{1}{s} > 0.$$

The higher D, the more attractive insurance. In the example with $D = 0.07$, the gross gain from insurance relative to saving increases by more than three times a marginal rise in D. The cost of the insurance is borne at an earlier point and is independent of the surplus of the insured item. Hence high-surplus goods are more likely to be insured.

Proposition 4. If ex post saving is the best alternative to insurance, then WTP for insurance is increasing in surplus.

V. Implications

First, it is a puzzle that individuals are often willing to insure at very unfair loss ratios; see, for example, Abito and Salant (2019) for extended warranties and Sydnor (2010) for auto deductibles.[14]Behavioural aspects such as misperception of risk or reference-dependent preferences may be involved, but our analysis shows that even expected utility with rational expectations has this implication when consumer surplus is taken into account. Consumers may be aware that they will be unable to replace without insurance. Hence the value at risk is use value, not price, making high loading factors tolerable.

Second, our approach shows that choices that otherwise appear inconsistent with expected utility theory may not be. If equivalence applies, then two equally costly replaceable possessions with the same loss probability should have the same WTP for insurance. If they do not, then this is a potential refutation of the standard theory. Suppose that a consumer chooses a high deductible for motoring insurance but a low deductible for home contents insurance. After adjusting for loss probabilities and premium differences, a discrepancy still arises. This may reflect that what is really involved is the insurance of possessions not income. Most contracts that feature deductibles involve bundles of policies. For example, motoring insurance with a low deductible covers everything from minor scratches to total write-offs. A high deductible is therefore (partly) a choice not to insure minor scratches, perhaps due to tolerance of scratches rather than of risk in general. Finding different choices of deductibles in, say, motoring and home contents policies need not imply that the standard model must be modified by introducing probability misperception, rank-dependent preferences or similar.

Recognizing that selecting a deductible is not necessarily equivalent to a choice of income gamble leads to reinterpretation of existing findings. For example, based on choice of deductible, Barseghyan *et al*. (2011) report that revealed risk aversion is different for motoring and home insurance, leading them to reject the hypothesis of objective expected utility maximization. It is possible that seeming inconsistencies are instead the result of heterogeneous consumer surpluses of items that are insured in different domains even if deductibles and probabilities are the same. Similarly, Ericson *et al*. (2021) apply revealed preference reasoning from choice over medical insurance policies to draw conclusions about risk preferences. The analysis assumes that medical expenditure is non-discretionary so that the choices amount to income insurance, but conclusions would differ if there is a choice of treatment.

Third, in the standard formulation, Mossin (1968) shows that income insurance is generally an inferior good. The better off have lower WTP to insure a given income assuming decreasing absolute risk aversion (DARA), as is invariably found in empirical estimates of risk aversion (e.g. Guiso and Paiella 2008). Under DARA, WTP decreasing in income does not apply when the issue is insuring possessions. As shown by expressions (5) and (13), WTP to insure a given replaceable possession increases with income when non-equivalence holds. The difference arises because income loss is handled by decreasing marginal spending, the same spending from which an insurance premium is paid. When someone is better off, the value of marginal spending is lower, depressing both the utility cost of a given income loss and the utility cost of paying a premium to compensate for the loss. Which effect dominates depends on the shape of the utility function. If the marginal utility of wealth schedule tends to steepen with wealth, then the utility cost of the premium relative to the benefit of loss compensation increases with wealth. In the case of possessions, the premium is paid from marginal spending, so is less of a burden for the better off, but it serves to prevent the loss of an unchanged intra-marginal item with unchanged utility value. Hence willingness to insure will increase with wealth. In a sense, the premium is more affordable.

Some other papers derive insurance increasing with wealth, but for different reasons and in different circumstances. Noting that premiums are paid up front, an endogenous feature of their model, in Rampini and Viswanathan (2018) insurance delivers state-contingent saving. Households with a negative shock to current income rationally save less, including reducing income insurance. In our model, goods insurance involves only infratemporal transfers, with the value of the transfer depending on wealth. A different point is that the absolute (as opposed to relative) potential wealth loss that people face tends to increase with their wealth. As noted by Chesney and Louberge (1986) and Cleeton and Zellner (1993), this implies that the better off buy more insurance in total. Similarly, the rich normally choose more expensive medical care than the poor, so buy more actuarially fair insurance because they have higher costs, as Jaspersen (2022) shows.[15]

In all the models analysed here, the relationship between WTP for replaceable insurance and wealth is not monotonic. When wealth is low, $g(W) - g(W-1) > \pi B$, so the good is not bought at all. As wealth increases, the good is bought, but if not insured, is not replaced. This is the non-equivalence zone and as shown where WTP increases in wealth. Eventually, wealth is sufficiently high that without insurance it is better to replace through precautionary saving than go without the good. For the well off, the spending that is lost through saving is of little value. This is the equivalence zone where WTP falls in wealth given DARA.

Proposition 5. The simultaneous choice model implies that as their income rises, an individual goes from not buying the good, to buying it with WTP to insure it increasing in wealth, to WTP eventually decreasing in wealth given DARA.

The second subsection of the Appendix provides observational evidence that buying extended warranties is strongly increasing in family income. This is in line with the observation of an Australian insurance analyst that 'Increase in home insurance premiums will lead to underinsurance or no insurance as lower and middle-income groups will look to reduce policy coverage if they are unable to afford high premiums'[16] and the *Economist* story 'The poor, who most need insurance, are least likely to have it'.[17] Giné *et al*. (2008) report that participation in rainfall insurance programmes increases in wealth, while according to Cole *et al*. (2013), the most frequently stated reason for being uninsured is 'insufficient funds to buy insurance'.

For repairs, including medical insurance, it remains true that WTP for insurance depends on income or wealth as shown by equation (13).

VI. Conclusion

This paper proposes a framework to analyse the insurance of replaceable possessions. The main result is that since uninsured replaceables are not necessarily replaced when they fail, equivalence between the insurance of wealth and of possessions is not implied by rational behaviour. Repurchase may not happen because, for good reason, the money has been spent elsewhere and borrowing is difficult. Willingness to pay to insure a good is then increasing in the surplus that it generates, a property incompatible with equivalence. The income effect of losing an uninsured possession also gives rise to non-equivalence as replacement may not be worthwhile even if frictionless borrowing is possible.

It does not follow from these observations that the demand to insure possessions can be fully or even mainly accounted for by rational considerations. What can be concluded is that rational behaviour can account for more of the demand to insure possessions than has previously been thought. Unscrambling the rational and behavioural is not easy. In many cases, behavioural and rational are complementary. For example, time inconsistency may undermine the provision of precautionary saving, exacerbating the lack of money when it is needed. Likewise, regret is plausibly higher for the loss of high-surplus goods, augmenting heterogeneity in WTP to insure replaceables.[18]This paper has not attempted to empirically decompose the behavioural and rational. Its role is conceptual, to point out that the dividing line has been located wrongly. What have been regarded as anomalies may not prove to be so. Similarly, attempts to estimate risk aversion parameters from choices over willingness to insure possessions will be biased, as will welfare analysis based on the estimates.

Our modelling also provides a simple explanation of why the poor do not insure although the rich do. The common complaint 'I would like to insure but I just can't afford it' makes sense even though the conventional analysis suggests it is the poor that should be the most willing to insure.

APPENDIX

Simultaneous market and self insurance

Each of three breakable goods has market price unity, probability of loss $1-\pi$, and utility if working B. For simplicity, a replacement breakable does not fail. The utility contributed by the divisible goods is linear in spending on them according to gS. The actuarially fair premium on each good is $1-\pi$, but loading factors are positive and differ according to the good. The market premia are $1-\pi < P_1 < P_2 < P_3 < 1$. Initial wealth is W. Relevant strategies are as follows.

- No insurance, no self-insurance:

$$EU_1 = 3B\pi + g(W-3).$$

- Insure good 1 only, no self-insurance:

$$EU_2 = B + 2B\pi + g(W-3-P_1).$$

- Insure good 1 only, 1 unit of self-insurance:

$$EU_3 = B\left(3 - (1-\pi)^2\right) + g(W - 4 - P_1).$$

- Insure goods 1 and 2, no self-insurance:

$$EU_4 = 2B + \pi B + g(W - 3 - P_1 - P_2).$$

- Insure all three goods:

$$EU_5 = 3B + g(W - 3 - P_1 - P_2 - P_3).$$

- No insurance, 1 unit of self-insurance:

$$EU_6 = B\left((1-\pi)^3 + 6(1-\pi)^2\pi + 9(1-\pi)\pi^2 + 3\pi^3\right) + g(W - 4).$$

- No insurance, 2 units of self-insurance:

$$EU_7 = 3B\left(1 - (1-\pi)^3\right) + 2B(1-\pi)^3 + g(W - 5).$$

Other possibilities—i.e. insure good 1 only and 2 units of self-insurance, or insure goods 1 and 2 and 1 unit of self-insurance, or 3 units of self-insurance—are all dominated by insuring all three goods.

It is optimal to insure good 1 only, and provide 1 unit of self-insurance for the following parameter values: $B = 2$, $\pi = 0.8$, $W = 10$, $P_1 = 0.28$, $P_2 = 0.4$, $P_3 = 0.8$, $g = 0.5$.

Extended warranty purchase and income

In the survey referred to, subjects were asked the binary question, coded 1 for yes:

Do you buy extended warranties (e.g. for electrical appliances)?

They were also asked (with the variable entered as interval mean except above £96K entered as £96K):

What is your household (family) income?

- Less than £13K
- £13K to less than £19K
- £19K to less than £26K
- £26K to less than £32K
- £32K to less than £48K
- £48K to less than £64K
- £64K to less than £96K
- £96K or more

Table A1 shows the regression of the first question on family income and age. Other variables are available, but their inclusion does not materially affect the income coefficient.

TABLE A1
REGRESSION OF EXTENDED WARRANTY PURCHASED ON INCOME

Variables	Warranty purchase	
Age	13.92***	(4.92)
Family income	0.0046***	(4.05)
Constant	−351.7***	(2.97)

Notes
$N = 207$, $R^2 = 0.16$; t-scores in parentheses; *** indicates significant at 1%.

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NOTES

1. Comparison of income and possession insurance is complicated by the timing of loss sometimes being necessarily different. The cleanest demonstration that the standard procedure is not applicable is if WTP for possession insurance depends on consumer surplus.
2. As far as we know, only Cook and Graham (1977) directly address the insurance of goods. Their paper is focused on irreplaceable items and makes use of a reduced-form utility of wealth function rather than deriving it from a utility of goods function. They mention in passing (p. 149) that just as for income loss, if insurance is available on actuarially fair terms, then frictionlessly replaceable commodities will be fully covered. In drawing this conclusion, the underlying assumption is that an uninsured replaceable commodity would be replaced.
3. Some of the applied papers assume for simplicity that only the original purchase may fail. This implies that the replacement is more valuable than the original. Making the two purchases of equal quality seems more reasonable. An alternative is to allow unlimited replacement. Qualitative results are the same in all these cases.
4. Saving could be started when failure occurs. Replacement is then made with delay. This and the other channels are considered in subsequent sections.
5. That savings are lost in case the durable does not fail is similar to Davidoff *et al*. (2005), who motivate annuity demand in a similar way.
6. A more realistic, less simple, though still stylized formulation is that failure may occur partway through the period. Results are similar.
7. As this is essentially a static model, borrowing is not possible. Ericson and Sydnor (2018) study a dynamic model of income loss that allows for liquidity constraints. Depending on when premiums must be paid, this gives rise to seeming violations of rationality if choices were evaluated from the perspective of a static model. Their analysis does not look at insurance of individual items.
8. With partial cover, the shortfall must be met by precautionary saving, which is more expensive given that insurance is preferred under full cover. The condition for precautionary saving to be chosen is that the loading factor on market insurance exceeds $\alpha/(1-\pi)$. For example, if $\pi = 0.95$ and $\alpha = 0.1$ implying little waste, then the premium must be double the fair rate.
9. Cash would be spent on the breakable as wealth is then $W + 1$.
10. The condition for B being bought if uninsured is $\pi B > g(W+1) - g(W)$. From equation (2), the condition for $B < B_S^*$ when $\alpha = 1$ is $\pi B < (g(W) - g(W-1))/(1-\pi)$. When $\alpha < 1$, the right-hand side of this expression is even larger. So buying B but not replacing it is consistent.
11. When borrowing 1 requires repayment $\lambda > 1$, $B^* > Z$, so there is an interval with $P > Z$ as in the precautionary saving analysis.
12. If there is a fixed cost to writing a contract, then the payout ratio will be worse on goods with a low probability of failing.
13. de Meza and Dickinson (1984) and Chetty and Szeidl (2007) show that when there are costs of adjusting consumption of some goods, risk-seeking behaviour can arise. They do not look at the implications for willingness to insure goods.
14. Abito and Salant (2019) estimate that almost all the demand for extended warranties is due to overestimation of loss probabilities rather than risk aversion. If so, rational buyers must believe that insurers lose money on warranties, or possibly they believe that insurers can undertake repairs more cheaply than consumers.
15. Jaspersen (2022) assumes actuarially fair policies. Everyone fully insures their medical spending unless illness decreases the marginal utility of non-medical consumption. The best treatment is chosen by all above some wealth threshold. Were the loading factor positive, DARA implies that among those taking the best policy, insurance is decreasing in wealth.
16. See https://www.globaldata.com/media/insurance/rising-insurance-costs-make-home-insurance-unaffordable-australia-finds-globaldata (accessed 5 November 2022).
17. See https://www.economist.com/international/2019/08/22/the-poor-who-most-need-insurance-are-least-likely-to-have-it (accessed 3 November 2022). Admittedly, the article concerns crop insurance.
18. Hsee and Kunreuther (2000) provide convincing evidence that demand to insure irreplaceable objects is influenced by a 'consolation' effect. That is, WTP for insurance is higher for objects for which affection is felt. According to standard theory, there should be no effect as the loss of something to which there is an emotional attachment does not alter the marginal utility of income. Even for replaceable commodities, a version of the consolation effect is possible. It is upsetting to lose something that has been paid for independently of the consumer surplus that is contributed by the good. For the role of regret aversion, see Braun and Muermann (2004), and Gollier and Muermann (2010).

REFERENCES

ABITO, J. and SALANT, Y. (2019). The effect of product misperception on economic outcomes: evidence from the extended warranty market. *Review of Economic Studies*, **86**(6), 2285–318.

BARSEGHYAN, L., PRINCE, J. and TEITELBAUM, J. C. (2011). Are risk preferences stable across contexts? Evidence from insurance data. *American Economic Review*, **101**, 591–631.

BRAUN, M. and MUERMANN, A. (2004). The impact of regret on the demand for insurance. *Journal of Risk and Uncertainty*, **71**(4), 737–67.

CHESNEY, M. and LOUBERGE, H. (1986). Risk aversion and the composition of wealth in the demand for full insurance coverage. *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, **122**(3), 359–69.

CHETTY, R. and SZEIDLV, A. (2007). Consumption commitments and risk preferences. *Quarterly Journal of Economics*, **122**(2), 831–77.

CLEETON, D. and ZELLNER, B. (1993). Income, risk aversion, and the demand for insurance. *Southern Economic Journal*, **60**(1), 146–56.

COLE, S., GINÉ, X., TOBACMAN, J., TOPALOVA, P., TOWNSEND, R. and VICKERY, J. (2013). Barriers to household risk management: evidence from India. *American Economic Journal: Applied Economics*, **5**, 104–35.

COOK, P. and GRAHAM, D. (1977). The demand for insurance and protection: the case of irreplaceable commodities. *Quarterly Journal of Economics*, **91**(1), 143–56.

DAVIDOFF, T., BROWN, J. R. and DIAMOND, P. A. (2005). Annuities and individual welfare. *American Economic Review*, **95**(5), 1573–90.

deMEZA, D. (1983). Health insurance and the demand for medical care. *Journal of Health Economics*, **2**, 47–54.

——— and DICKINSON, P. (1984). Risk preferences and transaction costs. *Journal of Economic Behavior and Organisation*, **5**, 223–36.

ERICSON, K., KIRCHER, P., SPINNEWIJN, J. and STARC, A. (2021). Inferring risk perceptions and preferences using choice from insurance menus: theory and evidence. *Economic Journal*, **131**, 713–44.

———, and SYDNOR, J. (2018). Liquidity constraints and the value of insurance. *NBER Working Paper* **no. 24392**.

GINÉ, X., TOWNSEND, R. and VICKERY, J. (2008). Patterns of rainfall insurance participation in rural India. *World Bank Economic Review*, **22**, 539–66.

GOLLIER, C. and MUERMANN, A. (2010). Optimal choice and beliefs with ex ante savoring and ex post disappointment. *Management Science*, **56**(8), 1272–84.

GUISO, L. and PAIELLA, M. (2008). Risk aversion, wealth, and background risk. *Journal of the European Economic Association*, **6**(6), 1109–50.

HSEE, C. and KUNREUTHER, H. (2000). The affection effect in insurance decisions. *Journal of Risk and Uncertainty*, **20**, 141–59.

JASPERSEN, J. G. (2022). When full insurance may not be optimal: the case of restricted substitution. *Health Economics*, **31**(6), 1249–57.

LUSARDI, A., SCHNEIDER, D. and TUFANO, P. (2011). Financially fragile households: evidence and implications. *Brookings Papers on Economic Activity*, **42**(1), 83–150.

MOSSIN, J. (1968). Aspects of rational insurance purchasing. *Journal of Political Economy*, **76**(4), 553–68.

NYMAN, J. (1999). The value of health insurance: the access motive. *Journal of Health Economics*, 141–52.

RAMPINI, A. A. and VISWANATHAN, S. (2018). Financing insurance. *CEPR Discussion Paper* **no. DP12855**.

SCHLESINGER, H. (2013). The theory of insurance demand. In G. Dionne (ed.), *Handbook of Insurance*. New York: Springer.

SYDNOR, J. (2010). (Over)insuring modest risks. *American Economic Journal: Applied Economics*, **2**, 177–99.

THALER, R. H. (1985). Mental accounting and consumer choice. *Marketing Science*, **4**(3), 199–214.